Nuclear Latency and Hedging:

Concepts, History, and Issues

Edited by Joseph F. Pilat

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The Nuclear Proliferation International History Program is a global network of individuals and institutions engaged in the study of international nuclear history through archival documents, oral history interviews and other empirical sources. Recognizing that today's toughest nuclear challenges have deep roots in the past, NPIHP seeks to transcend the East vs. West paradigm to work towards an integrated international history of nuclear weapon proliferation.

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Introduction

Joseph F. Pilat

Strategic latency is a critical national security issue that involves the ways in which scientific, technological, and engineering advances pose new potential threats and challenges to the global balance of power. Advances in areas such as biotechnology and nanotechnology, materials science, and high-level manufacturing have produced far-reaching benefits, but also risk being used for nefarious purposes. Even older dual-use technologies, especially when used in novel ways, may be exploited for questionable ends. Because the prospective threats from these advances are complex, cutting edge, decentralized, and by definition not well characterized, it is difficult to conceive (let alone develop) possible responses to such strategic and technological surprises.

Nuclear latency is one case of strategic latency. Although it has been an issue for nearly seven decades, since the dawn of the atomic age, there is no agreed definition of the term and the concept itself is difficult to characterize and measure. Most observers regard it as involving the pursuit of fissile materials and the means to produce them, as well as interest in their weaponization, including delivery vehicles. In this context—though without any reference to intent—nuclear latency entails the possession of some or all of the technologies, facilities, materials, expertise (including tacit knowledge), resources, and other capabilities needed to develop nuclear weapons, short of full operational weaponization.

The views expressed are the author's alone and are not the views of the Los Alamos National Laboratory, the National Nuclear Security Administration, the Department of Energy, or any other agency.

Left: KURCHATOW, RUSSIA - JUNE 23, 2016: The operator monitors the readings of devices and work equipment. Central control unit of Kursk NPP. - Image

Nuclear latency has technical and historical dimensions. Technically, it derives from the dual-use nature of the atom. It also must be considered historically by looking at the full range of capabilities possessed by aspiring, existing, and former nuclear-weapon states, and the diffusion of nuclear-weapon-relevant information through different outlets, including nonstate nuclear supply networks and the Internet. Latency is critical to understanding nonproliferation and counterproliferation, as well as arms control and disarmament. From both perspectives, latency is a reality that can be seen as positive or negative, but in any scenario it complicates the achievement of the objective. Is nuclear latency unique? Is latency a condition for nuclear-weapon states and for many non-nuclear-weapon states? Can it be a strategy for proliferant states? Can it be a viable nonproliferation strategy? How has latency been seen and addressed in the past? Will latency be a positive or negative for future efforts to control or eliminate nuclear weapons? To what extent will latency exist in a nuclear-free world?

To explore these and other issues from historical and policy perspectives, on May 11 and 12, 2017, the Los Alamos National Laboratory, in cooperation with the Woodrow Wilson International Center for Scholars, held a workshop on "Nuclear Latency and Hedging" at the Wilson Center in Washington, D.C., with support from the Carnegie Corporation through the Nuclear Proliferation International History Project. The workshop followed an earlier one in 2014. The papers in this volume are largely from the 2017 workshop.

History, Concepts, and Issues

Although nuclear latency is an important issue with significant implications for deterrence, assurance, nonproliferation, arms control, and disarmament, the literature on nuclear latency is both limited and flawed. Latency, however conceived, deals with a state's effort to build and maintain the capacity to "go nuclear" and credibly threaten the use of nuclear weapons. Given the country-specific and structural factors that drive proliferation as well as proliferation threat assessments, one cannot accurately assess latency without considering the strategic environment of the state in question.

All states have latency to some degree. To assess a state's latency, one must assess its human and material resources, technical knowledge and capability, industrial capacity, and access to nuclear materials. Strategic objectives also play a role. The continuum of latent capabilities ranges from general technology diffusion and the existence of nuclear-energy programs to conscious decisions to develop or maintain militarily significant nuclear-weapon capabilities. At one end of the continuum, in cases like Japan and South Korea, a state's nuclear power programs and levels of technological and military-industrial development give evidence of its latency. Likewise, Iran's latency became clear when it mastered enrichment, and even after the signing of the Joint Comprehensive Plan of Action on the Iran nuclear program in September 2015, it has retained a latent nuclear capacity. At the other end, latency may also exist in states with clandestine nuclear programs, before its leaders decide to weaponize their potential capabilities. In such cases, the latency may not be known or recognized as a possible threat.

Nuclear latency does not necessarily determine intentions, although a state's patterns, scales, and timing of investment in nuclear resources and technology could indicate its intent. States' weaponization, delivery, and support capabilities also provide critical indicators of intent, even if the information that could confirm this capacity is ambiguous or scarce. When assessing proliferation risks, it is essential to look at intentions as well as capabilities, even though motivations and intentions are difficult to assess. In this context, latency could be a bargaining chip, a means to attain status and respect, a means to obtain security assurances, a deterrent in itself, or a step in the path toward a bomb. For many states, motivations and objectives can change—and have changed—over time.

Nuclear Weapon and Energy Programs

Latency is a reality for many nonnuclear-weapon states today, primarily because nuclear energy technologies and programs have spread, often through open information-sharing and research but

Vienna, Austria - April 24, 2015: Flags of different countries on background of The United Nations building. Headquarters of the International Atomic Energy Agency (IAEA).

also through less than legal means. Many observers tie nuclear latency to civil nuclear power programs, arguing that the latency that derives from nuclear power programs was a technical reality that could not be avoided. Nuclear knowledge and capabilities are now widespread and will continue to increase as nuclear power programs, especially those that involve direct-use nuclear materials such as plutonium and highly enriched uranium, grow worldwide.

Even though material acquisition is the biggest technical hurdle to going nuclear, nuclear material production is only one component of a state's latency and may not be the most important factor. Access to materials, technology, and expertise is expanding, eroding earlier barriers to weapons, not only because of the cooperative opportunities provided under the Treaty on the Nonproliferation of Nuclear Weapons but also (and even more so) because of technology evolution, diffusion, and globalization. The problem is likely to worsen as a result of advances in additive manufacturing and enrichment, and the possible exploitation of unconventional uranium sources. The loss of U.S. leadership in key nuclear technologies, as well as in new enabling technologies such as additive manufacturing, makes it more difficult to try to control latency.

Indigenous nuclear capabilities have been the main focus of attention in discussions of nuclear latency, but the impact of external assistance—and of stolen technology or materials, along with the acquisition of related intellectual property through investments in start-up companies—also should be considered. Illicit trafficking could be decisive in defining a state's level of latent capacity.

Historical Cases: Latency in Europe and East Asia

Historical cases in Europe and East Asia reveal the appeal of nuclear latency, as well as the impacts of national governments, cultures, and histories on different states' approaches to the question of going nuclear. Brazil, Iran, Italy, Japan, South Korea, and Sweden all used civil nuclear programs to provide a degree of latency, with the nature and motivations for their latency changing as different governments controlled or influenced the course of the programs. The Italian case in particular shows the importance and limits of prestige or status as an incentive to latency or weapons. The cases of Japan and Sweden highlight the impact of international nuclear trade and interdependence as a disincentive to overt proliferation.

Nonproliferation and Counterproliferation

In the past decade, Iran has been a focal point of the debate over latency as it relates to nonproliferation and counterproliferation. As the Iran case suggests, some states may use latency as a strategy, particularly in order to avoid negative international reactions ranging from diplomatic isolation to sanctions to military intervention. Some observers have argued that factors such as the wider availability of technology, the increased likelihood of detection, stronger nonproliferation institutions, the growth of interdependence, and commercial incentives all encourage states to develop nuclear latency instead of pursuing new full-fledged nuclear-weapon programs, and that this may be the most common future trend. This trend has significant implications for safeguards, export controls, and other nonproliferation measures.

Latency is not covered by nonproliferation agreements, and can be difficult to detect. The International Atomic Energy Agency has only a limited ability to safeguard weaponization activities that do not directly involve nuclear material, which poses a serious problem if latency is understood as a precursor to material acquisition and weaponization. Latency also affects detection and responses; if a latent nuclear state decides to weaponize its nuclear program, it can do so on a much shorter timeline, which likely will influence the response of the rest of the world.

Arms Control and Disarmament

As for arms control and disarmament, both latency and some level of hedging about states' nuclear capabilities and intents will exist even in a world free of nuclear weapons. Nevertheless, the disarmament debate has not given latency adequate attention, and no bilateral, regional, or multilateral arms control agreement has directly addressed latency.

Even in instances where the issue of latency has been raised in the past quarter-century, the arguments have been insufficiently thought through and lacking empirical support. In the disarmament debate, latency has been described as a means of reducing the vulnerabilities created by the reduction or ending of nuclear-weapon programs. A state that retains its nuclear latency may be able to deter potential threats and preserve a degree of reversibility that mitigates the risks of a nonproliferation or disarmament agreement. The view that latency will have a positive deterrent effect even if a state does not already have nuclear forces raises serious questions about what does and does not deter, and may not be credible if the targeted state determines that the latent state attempting to deter it cannot or will not be able to act in time to thwart its behavior.

Beyond the deterrence implications, in a world of greatly reduced or zero nuclear weapons, latency would create high levels of crisis and arms race instability. Latency might enable states to rapidly reverse their disarmament activity. Nuclear reversal or rollback, as states from South Africa to Iraq and Libya ended or mothballed their nuclear-weapon programs, is not necessarily permanent. The technological challenges of reconstitution, even for a state with the capability of the United States, should not be ignored. States that want to maintain their nuclear options would require, among other things, human capital and facilities that will need to be exercised.

Deterrence and Compellence

Both the nonproliferation and disarmament narratives recognize the potential deterrence effects of latent capabilities, either as a security threat that must be addressed (via nonproliferation) or as a hedge capability that allows bolder steps toward disarmament. In Iran, for example, its latent proliferation program appears to have had real or potential deterrent value against a range of threats—even if it did not weaponize its technology—in part because of the ambiguity created by latency. In some cases, latency might actually invite an attack, but in other circumstances it can deter conflict, which may increase other states' interest in and pursuit of latency in the future. In similar fashion, the role of latency in compellence is important. Saudi Arabia and other states have used the threat of nuclear proliferation to gain economic and political concessions from the United States.

Looking Ahead

The papers in this volume, and the workshops on nuclear latency in 2014 and 2017, have produced no general consensus on nuclear latency. Follow-on work, including exploring additional historical cases and assessing the impact of evolving technologies on latency, will be vital to developing a better understanding of the concept and its national, regional, and international implications. There was a clear sense that more analysis is required on the relationship between latency and deterrence and compellence.

Right: arial view of iran nuclear compound.

Observations on Latency and Hedging

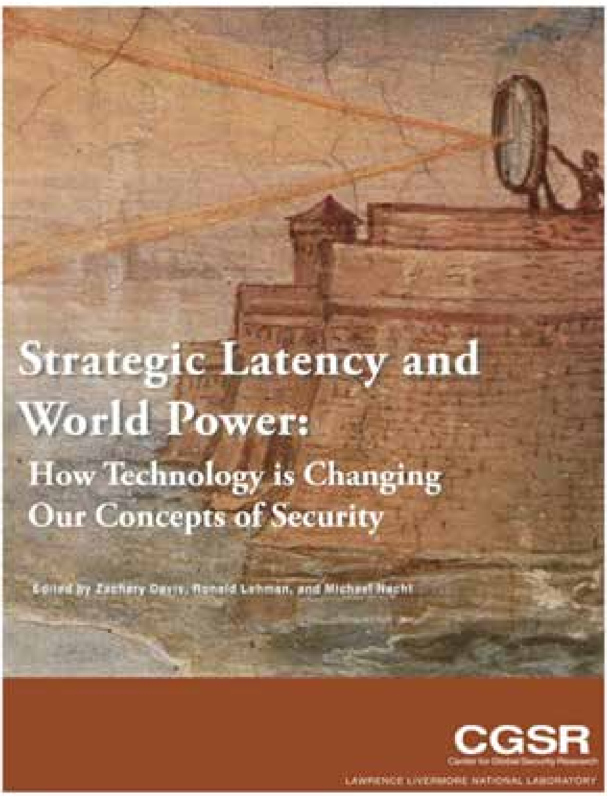
Michael Nacht

The concept of latency continues to be used frequently in the literature of international security. Sometimes the term "disruptive technologies" is used instead of latent technologies. The term *latent* itself can indicate that something is dormant, or that it remains untapped, and therefore *strategic latency* suggests that the latent concept or technology has long-term fundamental implications. With this understanding, early in the Obama administration the Department of Defense reorganized the Office of the Undersecretary of Defense for Policy. The assistant secretary of defense for global strategic affairs would have five areas of responsibility: nuclear weapons policy, which led to the 2010 Nuclear Posture Review; missile defense, which led to the Ballistic Missile Defense Review in the same year; space policy, which would develop space policy strategy documents; cyber policy, which created specific policy guidance for cyber command; and nuclear counterproliferation policy.

Yet even though the reorganization had taken the sensible approach of clustering defense technologies into one bureau, the new organization did not lead to an examination of the cross-cutting nature of their interactions. In 2010, the bureau led

Right: Missiles with warheads, stand in a row, ready to launch. Courtesy of shutterstock.com an effort, using outside experts, to examine the fundamental aspects of "cross-domain deterrence" and how emerging technologies affect U.S. and adversarial policies. The study emphasized the complexities and uncertainties introduced by space and cyber capabilities into the traditional deterrence architecture dominated by nuclear weapons.

In the years that followed, Ronald Lehman, then director of the Lawrence Livermore National Laboratory's Center for Global Security Research, led a complementary effort emphasizing "strategic latency." Lehman had held senior government posts as director of the U.S. Arms Control and Disarmament Agency (1989-1993); assistant secretary of defense for international security policy (1988-1989); and chief U.S. negotiator of the START I Treaty in Geneva (1985-1988). As the intellectual father of the term *strategic latency*, he vigorously supported research and a publication about its importance to national security.



The volume in question was *Strategic Latency and World Power: How Technology Is Changing Our Concepts of Security,* published in 2014 by Lawrence Livermore National Laboratory. The book is a collection of about 20 chapters by specialists on different aspects of the problem. Lehman's chapter offers multiple definitions of strategic latency, including rapidly deployable, diverse technologies with limited visibility that could be militarily and geopolitically decisive. Thinking back on the development of nuclear weapons, it is evident that the early research work on atomic physics was path-breaking. Yet this research was not conducted in the United States. It was done in Europe, and even the prominent scientists who were working on those advances or who were attentive to what was going on—some of the most eminent physicists in the world, including Ernest Rutherford and Albert Einstein—wholly doubted that their work had any military applications.

A first point to make, then, is that the connection between new technology research and weapon applications is not always self-evident. In the 1940s, the United States would not have become involved in nuclear research if not for the fact that it was secure while Europe was at war and Britain was under attack. It was a secret committee in the British government—the MAUD committee, which stood for Military Applications of Uranium Detonation—that produced the critical report demonstrating that nuclear fission can lead to a nuclear weapon, and advocated that Britain develop that weapon.

But the British government decided that they could not go forward. They did not have the resources. They did not have invulnerable facilities. They did not have the manpower, and they were grossly underequipped compared to the United States. So, reluctantly, the British came to the United States to inform the Roosevelt government about these implications. Ultimately, of course, it was the United States that took on the Manhattan Project, and built and delivered the bomb.

A related point, then, is that even people who are knowledgeable, active, and engaged may not be the people who actually produce the defining technologies that truly affect national security. It is usually a large cast of characters.

Today, nuclear weapons are so interrelated and dependent upon cyber capability and space capability for penetrating missile defenses, that one cannot consider nuclear latency without taking into account these other technologies.

Consequently, *Strategic Latency and World Power* considered uses of robotics, lasers, and three-dimensional printing, all of which can enhance nuclear capabilities and nuclear-weapon proliferation. In addition, it included a number of case studies, notably on Chinese technologies, other chapters on Turkey and Japan, and a comparative study of Russia, South Korea and Brazil. Each case study demonstrated the importance of the technological culture of a society, which in every case is almost unique. Moreover, in an open marketplace, the private sector drives much technological research and development. The notion of producing a devastating new weapon completely in secret under government control like the Manhattan Project is still possible, but is likely to be rare in the future. Such efforts would be augmented by a wide variety of players, public and private, from all over the world, feeding into different kinds of systems for particular purposes. It makes the analytical problem extremely challenging.

> "...one needs to understand how the private sector promotes technological advances because the private sector is the engine of technological growth..."

One of the additional findings in the *Strategic Latency and World Power* volume was that one needs to understand how the private sector promotes technological advances because the private sector is the engine of technological growth in most of the technologies of interest. This involves speaking to venture capitalists in order to understand how they provide incentives for technological growth, how these companies are organized, and what incentives and disincentives they have for encouraging their personnel to think creatively. Silicon Valley is a fabulous example. It turns out that Silicon Valley is in fact many different Silicon Valleys, approaching technological growth in numerous ways. Many others have examined Silicon Valley and sought to apply its lessons to their own circumstances. Every day, the region's venture capitalists are visited by scores of non-Americans who ask: "How do you do it? How do we replicate what you have done?"

Even as the private sector has become the dominant engine of technological growth, government control of new technologies has diminished. The Defense Advanced Research Projects Agency has existed for decades, and more recently former Secretary of Defense Ash Carter founded the Defense Innovation Unit Experimental (DIUx) to promote closer private-public interaction. Yet there is little indication that there is any sort of a symbiotic relationship between the two cultures in the United States.

Early in the Obama administration's first term, General Keith Alexander, then the director of the National Security Agency, worked with William Lynn, then the Deputy Secretary of Defense, on a series of high-level meetings on public-private interactions. The corporate chief executive officers (CEOs) who attended the meetings were among the most famous technology CEOs in the world, and they all attended at the same day at the same time in the same room. They obviously had something they thought they could sell, that they needed to learn, or that was a problem for them.

Several general observations emerged from these meetings. One was that in such a group, each private sector representative sees the other private sector representatives as competitors, and will be reluctant to reveal sensitive information on his or her problems to anybody else. In a number of the corporate cases, many of these CEOs were disdainful of government and of those in government, regarding people in government as failures who could not succeed in the highly competitive private sector. They have a distorted view of government officials, even at senior levels, as doing little more than reading and writing memos, attending meetings, and leaving the office promptly at close of business.

Some senior government people similarly lacked respect for those in the private sector, regarding corporate leaders as voracious individuals seeking to acquire lavish homes and yachts, and largely indifferent to the interests of the nation. Although these views are extreme characterizations, they raise real issues that impede communication and reflect the deep differences between the cultures of the public and private sectors. It has been asserted that communication improved in meetings in the latter part of the Obama administration. Whether the Trump team is continuing this dialogue is uncertain.

A prominent illustration of differences in public-private priorities and cultures was the San Bernardino terrorism case in December 2015, in which a married couple killed 14 people and wounded 22 others at a community center in southern California that was hosting a Christmas party. The couple, who lived in nearby Redlands, were Syed Farook, a U.S.-born citizen of Pakistani descent, and Tashfeen Malik, a Pakistani-born permanent resident of the United States. Farook and Malik escaped the scene of the crime, but were tracked down and killed by law enforcement officials. Officials found Farook's cell phone, which was an encrypted iPhone. As a case of international terrorism, the matter fell under the jurisdiction of the Federal Bureau of Investigation (FBI). The FBI went to Apple, manufacturer of the iPhone, and approached Apple CEO Tim Cook, requesting that it deencrypt the phone. The couple had an arsenal of weapons in their Redlands apartment, and the FBI reasoned that they could not have acquired all of these weapons by themselves. Who were they connected with in the United States and abroad? The call records on the deceased man's iPhone would be of invaluable assistance to the investigation of the case. The matter, however, turned out to be intractable. Apple maintained that to comply with the FBI's request would undermine customer confidence in the maintenance of their privacy and security pledged by Apple. The FBI invoked national security as the dominant concern. When Apple rejected the FBI request, the government took the company to court. In the meantime, a private Israeli firm, staffed by individuals who had worked in Prime Minister Benjamin Netanyahu's National Cyber Security Authority, offered their services to deencrypt the phone after the FBI's own cyberexperts failed to do so. The Israeli firm succeeded in deencrypting the phone, and the FBI subsequently dropped the lawsuit against Apple. The case profoundly illustrates the deep tensions between claims of civil liberties versus national security in times of heightened security threats.

The problem of technology in the San Bernadino case raises huge questions for the U.S. intelligence community and for other intelligence communities. How does one create early warning systems to track latent technologies from other countries that could surprise us? A core lesson to be learned is that one must follow people as well as technology. One needs to identify the new A. Q. Kahns—the physicist who founded Pakistan's nuclear-weapon program—as much as the new technologies. This is a demanding challenge that suggests a need for reorganization of U.S. intelligence capabilities.

It also suggests a reorganization of the U.S. acquisition process for its own benefit. This finding led to a second Lawrence Livermore volume on latency entitled, *Red, White, and Blue: Perspectives on Strategic Latency.* The colors in the title symbolize the key players: red for adversaries, white for politically neutral technological advances, and blue for the United States. Each party is playing a role in trying to adapt to a revolutionarily different world. The previously cited DIUx is a possible basis for greater connection between those who innovate and those who are responsible for monitoring those innovations, but it is only a modest start.

In some ways, this is an old subject. Bernard Brodie's classic book on sea power, published in 1941, explained how latent technologies shaped the new U.S. Navy. Other authors have written about how the artillery became modernized in the 19th century. For the U.S. government, an added challenge is how to assess technological developments in other countries. For example, the case study on Turkey in the first Lawrence Livermore volume revealed that Turkey had 25 ongoing major technological initiatives with military applications, aiming to meet the centennial of the founding of Kemal Ataturk's Republic of Turkey, which will be in 2023. Turkey is a NATO ally but also a competitor in the Middle East, where policies in Washington and Ankara do not always coincide. It is in U.S. national security interests to monitor the progress of Turkey's technological initiatives and the identity of key leaders in the process. How do we organize ourselves to take advantage of public-private interactions?

Endnotes

1 Zachary Davis, Ronald Lehman, and Michael Nacht, eds., *Strategic Latency and World Power: How Technology is Changing Our Concepts of Security* (Livermore, CA: Lawrence Livermore National Laboratory, 2014), https://cgsr.llnl.gov/content/assets/docs/Strategic_Latency.pdf.

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Nuclear Hedging and Latency: History, Concepts, and Issues

Ariel E. Levite

The point of departure in this assessment of nuclear hedging and latency is why and how numerous states that embarked on the path of developing nuclear weapons, or at least seriously toyed with the idea, never ultimately acquired them. By some estimates there seem to have been in total roughly 30 such states, approximately 20 by some other experts' accounts.[1] Regardless which of these estimates one adopts, it is clear that at the end of the day only a small fraction of those have crossed or even come close to the finish line.[2] Why is this the case? What explains the considerable contrast between the number of states that embarked on the nuclear-weapon path and those that ended up with nuclear weapons? This chapter is a further effort to look systematically at the nuclear hedging phenomenon in the early 2000s.[3]

Possible Explanations of Latency and Hedging

This gap between the great nuclear fears and the more reassuring reality lends itself to two distinctly different explanations. These possible explanations are not mutually exclusive—in fact, they complement each other—yet for heuristic purposes it is still expedient to look at them as

This article draws from concepts explored more substantively in Ariel Levite, "Never Say Never Again: Nuclear Reversal Revisited," *International Security* 27, no. 3 (Winter 2002/2003): 59–88.

analytically separate. The first explanation is that the intelligence estimates and other types of analysis used at the time (and in numerous analyses since) to classify states as nuclear aspirants have been skewed or even outright biased, and alarmingly ascribed nuclear-weapon intent even where little or no desire to acquire such weapons had existed. In contrast, the second explanation assumes that the original categorization of the nuclear aspirants had been largely on the mark, but suggests that states' dynamics and motivations for pursuing nuclear weapons changed over time and dissuaded most original nuclear aspirants from realizing their intent.

To reflect on the first possible explanation, it is essential to delve deeper into the nature of nuclear programs and the inherently dual-use nature of nuclear technology. Doing so quickly presents the sobering reality that has haunted the world from the onset of the nuclear age: most nuclear activities, especially in areas most germane to nuclear-weapon acquisition (e.g., the handling of fissile material through processing of uranium or reprocessing of plutonium, the study and application of the physics of chain reactions) have an inherently dual-use nature. At least in principle, they are not only domains for legitimate peaceful activity, but also important areas to engage in nuclear-energy programs. Such activities produce nuclear fuel for research reactors, light water power plants, breeder reactors, and nuclear propulsion, and dramatically drive down the quantity of high-level radioactive waste generated by reactor operations. They also support the production of isotopes for other peaceful nuclear applications, such as nuclear medicine. Such activities may be pursued in ways that are less or more reassuring from a proliferation perspective, and more or less sound from commercial or technical perspectives, but nevertheless they have legitimate purposes and rationales. With this realization in mind, what seems to so many now and appeared at the time as outright pursuit of nuclear weapons, may actually have been telltale signs of a somewhat different activity: *nuclear latency*.

A narrow definition of nuclear *latency* describes it as the acquisition of nuclear-weapon–relevant technology and fissile materials as an (unintended) consequence of nuclear power and other *nonnuclear-weapon* activity.[4] It is essential to seriously entertain this latency concept as a possible explanation for at least some observable nuclear behavior, especially in decades past. In those earlier decades, nuclear power was an attractive option for both generating electricity and meeting energy security requirements, with the added appeal of gaining the prestige and associated political benefits of engaging with a cutting-edge technology of the day. The lackluster image of nuclear power today should not color our interpretation of past nuclear behavior. In other words, it is distinctly possible that the nuclear activities that raised alarm at the time, while indeed highly relevant for the development of nuclear weapons, nevertheless might have been driven by other considerations, regardless how scientifically, technically, or commercially sound they may have been. This obviously does not preclude the possibility that that motivation could have changed over time. Some (though by no means all) of the nuclear activity observed or initiated between the 1950s and the 1980s might be explained with this idea in mind.

The accumulation of these latent capabilities, rather than analysis of intent, provided much of the basis for the judgments in the oft-cited U.S. National Intelligence Estimates (NIEs) of the period.[5] These assessments regularly noted how far away countries were from acquiring nuclear weapons. One possible explanation for the gap between the list of countries thought to have been developing nuclear weapons and those that actually have done so may have to do either with analytical flaws in the original NIEs and other proliferation estimates, or by their misdiagnosis or perhaps by misinterpretation by subsequent scholars who erroneously read latency to be a solid indicator of a nuclear-weapon program. To cite one concrete example, regardless of where one comes out at the end, it is essential to entertain the distinct possibility that the Japanese nuclear program (certainly in recent decades) has been driven largely by nuclear energy needs rather than weapon desires. Japan provides a striking example because of its security anxieties about the territorial claims of several of its neighbors, as well as the unchecked nuclear program of the Democratic People's Republic of Korea; its remarkable technological prowess, its ambitious and long-running nuclear energy program with a full-fledged indigenous closed fuel cycle; and its possession of the fissile material and other key elements needed to produce and deliver nuclear weapons.

Setting aside latency, there is another possible explanation for nuclear activity that seems like a nuclear-weapon program—an explanation which in fact has several permutations. What they all have in common is that they do acknowledge some state interest in nuclear weapons, but nonetheless are far less than an outright pursuit of these weapons themselves.[6] This explains much of the remaining variance between those states that were counted as nuclear-weapon aspirants but failed to obtain weapons. What all of these additional variants of the second explanation have in common is that they reflect varying degrees of *nuclear ambivalence*. It takes a deep immersion into the various historical case studies to fully appreciate how prevalent and prominent (yet largely understudied) nuclear ambivalence has been as a conceptual phenomenon, much as numerous empirical studies of nuclear proliferation have extensively documented its presence. This ambivalence often appears at various decision-making levels—individual leaders, state leadership as a whole, and above all among political elites—that affect leadership choices to pursue nuclear weapons. Less critical for our purposes but also relevant is nuclear ambivalence among the public at large. All of these forms of nuclear ambivalence are deeply rooted in the nature of and attitude toward nuclear weapons, and often nuclear energy more broadly as well, that tends to produce emotional and charged debates about choices in this domain. Even the proponents of nuclear (and nuclear weapon) activity may express nuclear ambivalence, deeming such pursuits at best as a *necessary evil*.

A measure of nuclear ambivalence, and the broader inclination to regard nuclear pursuits as a necessary evil, is evident in most if not all of the cases studied to date. Yet little systematic consideration has been given to the impact of nuclear ambivalence on the outcome of elite deliberations over the pursuit of nuclear weapons. Practically all earlier proliferation studies ascribed one or more rationales for undertaking nuclear-weapon-oriented activity. Several impressive taxonomies have been suggested to classify the possible drivers of nuclear aspirations, from prestige to security anxiety. Yet all of these considerations largely fail to account for or assign enough weight to the role of ambivalence in bounding, qualifying, and conditioning either ambitions or activity toward the acquisition of nuclear-weapon capabilities.

A careful reexamination of the various historical cases, not in the least those of nuclear rollback, reveals the saliency of the nuclear ambivalence phenomenon. It suggests that a healthy measure of nuclear ambivalence has been evident throughout and influential at key junctures. It has had an unmistakable impact on the commitment to and dynamics of the nuclear acquisition process, even when the surface intentions of state leaders at the time seemed to be unequivocally aimed at getting their hands on the bomb. Understanding the significance of this phenomenon recalls the challenge of refining one's understanding of the hedging and latency concepts. In practical terms, it implies that in at least some of the well-known cases that positively documented and even correctly interpreted telltale signs of nuclear-weapon ambitions, such evidence may have been indicative of purposeful behavior falling short (even far short) of an outright determination to acquire the weapons themselves, let alone indigenously. This is further encouragement to dig deeper into different variants and manifestations of nuclear ambivalence.

"...such evidence may have been indicative of purposeful behavior falling short (even far short) of an outright determination to acquire the weapons themselves, let alone indigenously."

Obviously, one prominent manifestation of such ambivalence is the *nuclear hedging* phenomenon. Hedging, itself a range, is the most extreme version of a nuclear weapon pursuit: a determination to reach the capacity to indigenously produce nuclear weapons in a realistic timeframe (weeks to a few years) alongside an important measure of restraint in how far to proceed along this path.[7] A second possible variant that has not been systematically discussed to date is *nuclear exploration.* It is far less than a conscious hedging strategy, largely amounting to a flirtation with the idea of acquiring nuclear weapons. It is characteristic of a situation where the leaders concerned are not sure they actually desire the weapons or can obtain them at a reasonable risk and effort, yet also are less than confident that they have no need for them or no capacity to obtain them. So they toy with the idea of having nuclear weapons, and launch some form of an exercise designed to help them determine what is required to obtain these weapons, what (and how long) it would take to get there, and what risks and benefits are associated with both the process and the outcome. Such exploration, certainly if undertaken seriously, does amass knowledge relevant to nuclear weapons and capabilities. Moreover, it emits signals that others might interpret as more definitive indications of interest in nuclear weapons. Matias Spektor's description of the Brazil nuclear-weapon program, if taken at face value, illustrates at the minimum the need to consider exploration as a generic explanation for nuclear pursuits.[8]

Here it is important to suggest a third possible variant of nuclear ambivalence: the "shot across the bow" nuclear strategy. It refers to actions that are designed to impress on others that one is seriously exploring a nuclear-weapon option in order to incentivize them to pay more attention to one's concerns and interests. It is grounded less in a desire to actually acquire the bomb and more in a belief that others—certainly one's adversaries, but equally one's allies and partners, or some combination thereof—might not otherwise consider one's requirements or overcome their reluctance to offer the tangible benefits or concessions being sought. The ultimate goal in such actions may be to obtain security guarantees and alliance arrangements; acquire conventional or nuclear capabilities;

secure economic, technological, and diplomatic benefits; exert pressure on others; or deter or coerce an adversary into some other action. Regardless of its intent, the essence of this nuclear strategy is to make it credibly look like a state is both determined to pursue and capable of pursuing nuclear weapons if left to its own devices. At the same time, it leaves open the option of converting the practical elements of this gambit into a real nuclear-weapon program if the shot across the bow goes unnoticed.

Finally, a related but analytically distinct fourth variant is that a state or certain factions therein are consciously and intentionally generating the indicators of interest in nuclear weapons. This is done explicitly to "invite" domestic and/or external pressure on the leader or others to desist outright from pursuing the bomb or at least refrain from some parts of the effort toward that aim. The rationale for this course of action is that it provides an exit strategy for a leader or leadership who are not necessarily keen to proceed along the nuclear path. Such leaders might find it politically easier to suppress the desire for nuclear weapons or arrest the activity proposed and undertaken by others when countervailing domestic and/or external pressures reinforce their hands. This strategy may have an additional benefit of achieving rewards or security alternatives that otherwise (in the absence of a concern that the state is headed toward nuclear weapons) would be difficult to obtain.

In total, then, there may be five possible explanations (including every variant of the second cluster of explanations) for observable behavior associated with interest in or work toward obtaining nuclear weapons. All reflect situations where there is no outright effort to obtain these weapons, even though none appears to outright preclude such a goal. The last four variants are not even mutually exclusive. They lay out a range of possible motivations for engaging in activities consistent with the pursuit of nuclear weapons. All five emit concrete signals attesting to interest in acquiring nuclear weapons even when their actual acquisition is not the ultimate intent. To explain this phenomenon, it may be useful to borrow from general system theory the concept of equifinality: namely, that similarly observable phenomena commonly associated with one end aim—in this case, the pursuit of nuclear weapons—might come from several different causal paths or trajectories. Awkwardly, the inclination to ascribe to it that single purpose is common in the nuclear proliferation realm, facilitated by a combination of partial and inaccurate knowledge or an overly alarmist interpretation bias.

To fully appreciate the significance of these insights into the motivations influencing nuclear aspirations and assess their importance in specific historical cases, most existing studies of nuclear proliferation would have to be reexamined both theoretically and empirically. But this task does present the important theoretical potential in the possibility that indicators of interest in and work toward acquisition of nuclear weapons may be evident even when there is no set goal to obtain them. Such an exercise may yield new insights into the overall nuclear proliferation phenomenon and the understanding of particular proliferation cases. In particular, revisiting the otherwise insightful taxonomies by Scott Sagan, Vipin Narang, and others should help complement and refine their propositions on why states appear to pursue nuclear weapons. Additionally, it may recast well-documented cases of nuclear-weapons pursuits which appeared (in terms of behavior observable to intelligence and scholars) to fit a familiar nuclear pattern, but in fact had different motivations. Finally, such an undertaking might yield new policy relevant insights on how to confront nuclear proliferation challenges.

The Analysts' Predicament

Obviously, the aforementioned observations also impel us to confront the gravity of the challenge for analysts who wish to identify and interpret correctly proliferation trends—to decipher the nuclear activity of concern and the motivations underlying it. The paucity of reliable data, deliberate concealment and deception efforts, and various biases consciously introduced by different parties all make the analysts' work more difficult. Even in democratic states, both formal nuclear states and others, significant matters related to nuclear weapons are typically shrouded in considerable secrecy. These problems do not merely confront analysts looking at the issue in real time but also haunt historians and political scientists seeking to reconstruct and understand the story long after the event, where other human, organizational, political (such as grandstanding, in the Kim Jong Un style), and security motivations blur and misrepresent the story. Even in otherwise transparent democracies, and many years after the event, sufficiently full and unvarnished access to primary and secondary sources seldom becomes available to establish a comprehensive, reliable account of a nuclear program. This is especially true for programs that never came to fruition. Two such cases are the Swedish and Italian nuclear- weapon programs.[9] It has been a long-term, herculean effort to unearth the missing pieces of the puzzle in both cases, with a no less challenging effort to assemble them correctly. When approaching historical cases of

Right: A video grab from KCNA shows a Unha-3 rocket (a variant of the Taepodong-2) launching at North Korea's West Sea Satellite Launch Site in Cholsan county, North Pyongan province on December 13, 2012.
Source: Reuters

proliferation, often with only partial access to the relevant data and a high probability that some of the available information is unreliable or biased, it is doubly important to reflect on the range of alternative explanations for the possible motivations shaping the contours of the nuclear programs.[10] Intelligence analysts who trying to accomplish this task in real time have an even more daunting task.

Moreover, this challenge is further hindered by a systematic interpretation bias in deciphering motivations that guide decisions on nuclear weapons and produce observable nuclear activity. The bias is evident in the inclination to see and ascribe clear nuclear-weapon intentions to far more ambiguous and ambivalent situations. There is a natural inclination to ascribe coherence to confusing indicators, an inadvertent consequence of the paucity of granular data that would help researchers discern the more nuanced motivations for nuclear-weapon activities. Scholars often ascribe more conventional interpretations to such activity and the logic driving it. In essence, it is an especially acute manifestation of the relationship between data availability and interpretation so aptly illustrated by Graham Allison in his classic alternative reconstructions of decisions in the Cuban Missile Crisis.[11]

To appreciate this bias, reconsider the previous description of alternative motivations for nuclear pursuits. Imagine the difficulty of trying to tell apart those engaging in such activity solely to generate bargaining chips, from those who are truly agonizing over whether such a program is necessary and what will it take, and those making nuclear noises precisely for the opposite reason, namely to generate countervailing pressure that will make it possible to stop such endeavors. Lest this sound too abstract, it can be illustrated by an example from the Swedish nuclear case. As Thomas Jonter points out, in retrospect it seems that a seminal development influencing the course of the program was the effort to include labor unions in the nuclear policy (weapon) discussion. Was the motivation in doing so to win them over for the weapon program, or to seek their involvement in order to shoot down the nuclear program? Or perhaps some even more esoteric and complicated reasoning? One cannot really tell without access to granular data on the motivations of the key players in Sweden at the time. Similarly, in Italian case, Leopoldo Nuti recalls how Italy arranged NATO briefings on its joint nuclear-weapon program with France and Germany. Was this effort designed to accustom its allies to the idea that Italy would end up with nuclear weapons, or to incentivize a pushback along with support for offering Italy something in return to give up the program? To return to Jonter's reconstruction of the Swedish story, when Sweden engaged in some back and forth with the United States on nuclear weapons, was its strategic aim to test the waters in order to determine how upset the United States actually would be if Sweden did take its nuclear program to the next level? To get the United States to relax its reluctance to support the program? To help dissuade Sweden from carrying forward its program? Or some combination of all of the above?

Further complicating the analytical challenge of reconstructing the motivations for nuclear activity is the fact that political elites common have divergent preferences on nuclear-weapon decisions, and these preferences evolve (and frequently transform) over time. Nuclear-weapon decisions typically generate strong emotions both for and against such pursuits, at times yielding preferences that otherwise would be difficult to predict based on general ideological preferences. Furthermore, because such programs typically involve prolonged maturation (and even reversal) periods, positions and preferences on the issue have considerable time to evolve. Some players that originally oppose acquiring nuclear weapons often modify their positions over time. They commonly do so in response to one or more of three sets of developments. Changing general circumstances in the domestic political or economic scene, technological developments, and new security and diplomatic conditions can change political elites' preferences. Developments in the nuclear program itself, whether in terms of possible or actual progress or in difficulties encountered, also encourage reflection and revision. Further, the emergence or disappearance of alternative courses of action to nuclear acquisition, and persuasion efforts from one's allies or dissuasion attempts by adversaries, may prompt them to revisit their opinions.

> "Even more challenging is the resolution to detect and interpret these motivations correctly in the early stages of their transformation."

The long incubation and maturation periods typical in nuclear programs compound the analysts' predicament because of the high likelihood that over the years changes might occur in the composition of the national leadership, or at least in the formal positions and personal fortunes of key stakeholders. Leaders who ascend to power might be far less wedded to certain courses of action started by or identified with their predecessors, even if political expediency initially prevents them from expressing these opinions. In practice, allowing for this possibility along with all of the other issues implies that a high level of evidence is required in order to fully and conclusively assess the true motivations behind nuclear choices and activities. Even more challenging is the resolution to detect and interpret these motivations correctly in the early stages of their transformation.

Collection Bias

A final issue to consider in this context is an intelligence collection bias.[12] As noted, the considerable possible variations in motivations guiding nuclear activity are compounded by the secrecy, concealment, and deception surrounding such activity. The objective challenge of making sense of the available information runs into two common types of information collection biases. These biases actually work in opposite directions, yet combine to complicate the challenge that analysts face in trying to determine the existence of an ongoing or defunct nuclear-weapon program, its seriousness, and the rationales behind it.

The first bias is overly alarmist collection. Intelligence communities in key states are institutionally wired to pick up and amplify in reporting disconcerting signs attesting to the existence of a military-oriented nuclear program. The positive aspect of such wiring is that it enhances the probability that worrisome signs, even when few and far apart, will be noticed and reported. The negative aspect of such an incentive structure is hypersensitivity, or the tendency to excessively amplify alarming signals that are weak, scattered, and disparate and to underrepresent the broader picture that would contextualize such signals. Without a sense of the context, it is difficult to distinguish true threats from cases that fall short, perhaps far short, of a full-fledged nuclear-weapon program, let alone an expedited drive to realize it.

The attendant risk of misrepresentation is especially acute in efforts to ascertain the absence, the reversal, or even the outright termination of a nuclear program, particularly in instances where the original evidence and analysis suggested the existence of a weapon program or serious intention to pursue one. This task is even more formidable in light of the common reluctance of political elites to publicly admit that they have reversed course, let alone provide the necessary access to confirm their reversal. Saddam Hussein's behavior in the mid-1990s immediately comes to mind. What kind of intelligence collection requirements could have yielded evidence to convince widely suspicious minds that his putative weapon program had ceased to exist? Could this level of evidence have been obtained in real time, or close to it, to reassure the international community that Iraq had an entirely peaceful program, or at least had transformed its previously disconcerting program in that direction? A more recent example might include the vexing analytical empirical challenges presented by the Iranian nuclear program after 2002 and even more so after the Joint Comprehensive Plan of Action (JCPOA).

But the nuclear collection bias does not end there; it has a second form. Access to part or parts of a nation's nuclear program may create an illusion that the intelligence coverage is comprehensive, thereby coloring the perspective of the analysts investigating its findings. Because much nuclear-weapon-oriented activity is veiled in secrecy and deception, it likely would be more difficult to track a clandestine nuclear-weapon program than a peaceful nuclear energy program. Yet the latter may be designed, in part or a whole, to conceal or to act as a legitimate complement of a nuclear-weapon program, and may naturally attract—or be deliberately designed to attract—intelligence collection efforts. Yet in most cases, nuclear energy and weapon programs do not have much overlap. Consequently, intelligence coverage of nuclear-energy programs often absorbs precious intelligence resources but does not reveal much that is alarming, even when some alarm is warranted. It thus risks creating a misplaced complacency about the completeness of the intelligence coverage, blinding the intelligence community to the existence of a parallel, entirely clandestine program. The blinding potential of a peaceful nuclear program, as well as its toll it exacts on scarce collection assets, should not be underestimated.

Both of these collection biases confront contemporary intelligence analysts, but also affect historians and other retrospective analysts because much about these programs typically remains secret for decades. The Australian, Canadian, and Swiss programs are all cases in point, as is the shroud of secrecy still pertaining to some aspects of the Italian effort. Historians and other analysts looking at these programs also may be overly influenced by the intelligence estimates of the day, which commonly are declassified after 30 years.

From an Analytical Challenge to a Policy Imperative

All of the analytical complications obviously put a premium on working backwards from the ultimate nuclear decision when it is known, regardless of whether it was to acquire nuclear weapons or to abandon such pursuits. Intelligence analysts typically do not have the virtue of retrospection, but academics do. For academics, reversal processes may be interesting in their own right, yet they also offer illuminating but relatively untapped insights and vantage points into the original motivations for a state's interest in nuclear weapons. In fact, the appreciation for the diverse motivations that guide observable nuclear reality comes precisely from looking at the process of moving forward with nuclear-weapon programs alongside the dynamics of walking them back. The rather common evolution from the former to the latter also provides a far better understanding of the former. What might have been

MOSCOW/RUSSIA - MAY 9: RT-2UTTKh Topol-M (SS-27 Sickle B) intercontinental ballistic missile on display during parade festivities devoted to 65th anniversary of Victory Day on May 9, 2010 in Moscow.

the ultimate original goal of the nuclear activity? How strong really were the motivations to propel the programs forward, regardless of what they initially looked like? What might have helped turned them around? What role did external forces play in bringing it about? Above all, this perspective provides vital inspiration to those who keep trying to dissuade such progress, even when the odds for success look remote.

This is hardly a matter of purely academic interest. Historical and conceptual analysis and policy-relevant work are inextricably linked. The mental constructs that guide one's approach to the proliferation problem have a huge bearing on the findings, which in turn impact strategic policy decisions. If one assumes that genuine telltale signs of nuclear-weapon ambitions are not only conclusive but also fundamentally deterministic, indicative of an inexorable march to the bomb, decision-makers have only two diametrically opposed policy options to deal with it. One is to acquiesce to such process and plan to live with its consequences; the other is to resort to panoply of measures, including extreme coercive actions, in the hope of stopping it. If, by contrast, historical experience inspires some confidence that in all but the most extreme cases such programs are anything but a done deal—even if success in stopping them cannot be guaranteed in every case—policymakers will feel that they have more space to experiment with various policy instruments to forestall such unwelcome developments. The Iranian case is particularly instructive in this respect, because developments until 2002 had left little room for optimism that Iran's march toward nuclear weapons could be really arrested, let alone peacefully. Since 2002, it has become more evident that at a minimum Iran was far less than committed to a crash program to obtain nuclear weapons, and consequently this revelation opened up an opportunity to explore at the very least a prolonged suspension of such Iranian ambitions. With the Trump administration's decision to withdraw from the JCPOA, the future of the agreement is in question.

Conclusion

This chapter explores the reasons why so few states that have been widely believed to be seeking nuclear weapons have ultimately acquired them. It advances two mutually complementary explanations to explain this anomaly. The first is that intelligence estimates and the other types of analysis used at the time (and in numerous studies since) to classify states as nuclear aspirants, and to develop theoretical propositions pertaining to them, have been skewed or even outright biased. Their overly alarmist conclusions ascribed nuclear-weapon intent where little or no genuine desire to acquire such weapons had existed. The second explanation is that this interpretation bias has largely been rooted in the failure to seriously contemplate the possibility that nuclear activity, even actions that may appear to be unequivocally or at least predominantly directed at acquiring nuclear weapons, might be driven by other motivations. Most of these in fact fall far short of determination to obtain the weapons themselves.

Proliferation analysts have been persistent and creative in trying to unearth the various motivations guiding states to pursue nuclear weapons. Heretofore, however, they have not been equally good at unpacking the various causal paths that may make a state seem to be trying to acquire nuclear-weapon motivations when it has no such ulterior motive. Consequently, and to the general detriment of international security, the proliferation studies undertaken to date have not really examined these possibilities when analyzing known past and present proliferation cases. In an effort to address this major weakness in the understanding of proliferation dynamics, this chapter has laid out and explained some of these understudied causal paths.

In addition to the lack of imagination in understanding causes and motivations, various analytical and collection limitations and biases complicate the challenge of understanding the real motivations underlying nuclear activity and how they can and do evolve over time. Yet the prolonged incubation and maturation period of nuclear-weapon programs does create important opportunities to better understand what guides them, and opens up chances to try influence their outcome. To seize these opportunities, researchers and analysts must be aware of the mental constructs guiding both the investigation of and policy deliberations on the nuclear programs, and expand these constructs to consider alternative explanations for observable nuclear-weapon activity. Finally, studying nuclear reversal processes is a vital means of generating insights for analytical and policy discourse, but such exploration must be done with considerable attention and care. It depends on the successful acquisition of pertinent high-quality primary data, without which the richness of the proliferation phenomenon will go underappreciated and its potential contribution to both proliferation research and policy analysis will be curtailed severely.

Endnotes

1 The most salient works, cited in my original paper, that estimate 20 states include T. V. Paul, *Power versus Prudence: Why Nations Forgo Nuclear Weapons* (Montreal: McGill-Queen's University Press, 2000); Mitchell Reiss, Bridled Ambition: Why Countries Constrain Their Nuclear Capabilities (Washington, DC: Woodrow Wilson Center Press, 1995). More recent analyses that suggest closer to 30 states are Philipp C. Bleek, "Does Proliferation Beget Proliferation? Why Nuclear Dominoes Rarely Fall" (Ph.D. diss., Georgetown University, 2010); Matthew Fuhrmann and Benjamin Tkach, "Almost Nuclear: Introducing the Nuclear Latency Dataset," *Conflict Management and Peace* Science 32, no. 4 (2015): 443–61; and "Nuclear Weapons Programs Worldwide: An Historical Overview," Institute for Science and International Security, http://isis-online.org/nuclear-weapons-programs.

2 The difference between the two set of estimates is only modestly explained by difference in data availability. It is mostly a function of employing different definitions (or benchmarks) for determining which countries are counted as nuclear weapon aspirants.

3 Ariel Levite, "Never Say Never Again: Nuclear Reversal Revisited," *International Security* 27, no. 3 (Winter 2002/2003): 59–88.

4 This definition generally agrees with that promoted by John Carlson. For his definition and the rationale supporting it, see John Carlson, "'Peaceful' Nuclear Programs and the Problem of Nuclear Latency," Nuclear Threat Initiative, November 19, 2015, http://www.nti.org/analysis/articles/peaceful-nuclear-programs-and-problem-nuclear-latency/.

5 For a full record of the declassified NIEs of the period. consult the National Security Archive at https://nsarchive2.gwu.edu/NSAEBB/NSAEBB155/index.htm.

6 Such interest in nuclear weapons could manifest itself in one or more of the above spheres: the pursuit of fissile materials, or at least active considerations of the means to acquire them (not necessarily just indigenously) and infrastructure to support them; the exploration, at the minimum scientifically and theoretically, of nuclear chain reactions, weaponization, system integration, and weapon delivery capability; military arrangements to support nuclear missions; and/or formal or informal deliberations among and within prominent government entities as well as elites. The more of these boxes that are checked, the stronger the signals about nuclear weapon intent. On

a comprehensive recent effort to examine ways to tell apart nuclear weapons pursuits from other types of activity, see Toby Dalton, Wyatt Hoffman, Ariel E. Levite, Li Bin, George Perkovich, and Tong Zhao, "Toward a Nuclear Firewall: Bridging the NPT's Three Pillars," Carnegie Endowment for International Peace, March 20, 2017, http://carnegieendowment.org/2017/03/20/toward-nuclear-firewall-bridging-npt-s-three-pillars-pub-68300.

7 My original article coining the term extensively discusses hedging: see Levite, "Never Say Never Again."

8 Matias Spektor, "The Evolution of Brazil's Nuclear Intentions," *The Nonproliferation Review* 23, nos. 5–6 (2016): 635–52. My own interpretation of the same Brazilian case suggests a more explicit Brazilian effort at pursuing nuclear weapons that also propelled the development of missile delivery capability and even produced several shafts to test the nuclear explosive devices. This effort petered out over time.

10 For a remarkable reconstruction of the Swedish nuclear program, see the following works of Thomas Jonter: *The Key to Nuclear Restraint. The Swedish Plans to Acquire Nuclear Weapons, 1945–1975* (New York: Palgrave Macmillan, 2016); "The United States and the Swedish Plans to Build a Bomb, 1945–1968," in *Security Assurances and Nuclear Nonproliferation*, ed. Jeffrey Knopf (Stanford, Calif., Stanford University Press, 2012); "The Swedish Plans to Acquire Nuclear Weapons, 1965–1968: An Analysis of the Technical Preparations," *Science & Global Security: The Technical Basis for Arms Control, Disarmament, and Nonproliferation Initiatives* 18, no. 2 (2010) 61–86; and "From Nuclear Weapons Acquisition to Nuclear Disarmament – The Swedish Case," in *Nuclear Exits*. *Countries Foregoing Nuclear Weapons*, eds. Ilkka Taipale and Vappu Taipale (London: Routledge, 2015). There is not yet a similar effort on the Italian program, but for some of the most important analysis of it, see Leopoldo Nuti's contribution in this volume on the hedging issue in the Nonproliferation Treaty ratification debate, as well as Nuti's "'A Turning Point in Postwar Foreign Policy': Italy and the NPT Negotiations, 1967–1969," in *Negotiating the Nuclear Non-Proliferation Treaty: Origins of the Nuclear Order*, eds. Roland Popp, Liviu Horowitz, and Andy Wenger (London: Routledge, 2017), 75–96. Other pertinent studies of the Italian program are Barbara Curli, *Il Progetto Nucleare Italiano* (1954–1962). *Conversazioni con Felice Ippolito* (Soveria Mannelli: Rubbettino, 2000); Silvio Labbate, *Il Governo Dell'energia. L'Italia dal petrolio al nucleare* (1945–1975) (Florence: Le Monnier, 2010); Mario Silvestri, *Il costo della menzogna. Italia nucleare 1945–1968* (Turin: Einaudi, 1968).

See also Steven Jerrold Baker, "Technology and Politics: The Italian Nuclear Program and Political Integration in Western Europe" (Ph.D. diss., UCLA, 1973). For an effort to integrate the insights drawn from comparison of the Italian and Swedish cases, see the unpublished article by Thomas Jonter, Ariel Levite, and Leopoldo Nuti, "Never Say Never Yet Again: Nuclear Reversal Re-examined."

11 For some background on the Woodrow Wilson Center Nuclear Proliferation International History Project, see https://www.wilsoncenter.org/about-6.

12 Graham Allison, *Essence of Decision: Explaining the Cuban Missile Crisis* (New York: Longman, 2010).

13 I am indebted to Richard Nephew for encouraging me during the workshop to elaborate on the nuclear collection biases.

Latent Nuclear Power, Hedging, and Irreversibility

Andreas Persbo

Traditionally, the line between a nuclear-weapon state and its nonnuclear-weapon counterparts has been drawn by a nuclear test. A state, once it is nuclear armed, demonstrates its ability to produce a nuclear explosive and then produces an arsenal of weaponry. Preventing the spread of nuclear weapons becomes a quest to prevent nations from conducting nuclear tests and to ensure that they do not manufacture nuclear arms. However, this point of view discounts a country's capability to produce weapons through its industrial complex and its ability to establish a nuclear force. Many more than the nine states that today are known to possess nuclear weapons can produce their own weapons, should they so desire. These countries are sometimes known as threshold states.

This chapter looks at nuclear nonproliferation and disarmament from a perspective of latency and hedging, viewing latency as a technological spectrum and hedging as the ability to make a choice to convert the latent power into weapons. Latent nuclear power, from this perspective, becomes a "supply-side" problem, where the ability of a country to increase its latency is related to the availability of classical factors of production (raw

Left: Stone canyon from uranium mining in Asia material, capital, and labor). Strategies to contain the increase of latent nuclear power then focus on the ways and means in which these factors of production can be curtailed or, in extreme circumstances, degraded.

Nuclear hedging, by contrast, is essentially a "demand-side" problem, and the desired hedge is decided by the time required to respond to external threats and the costs associated with this response. A state's decision to produce nuclear weapons, or the reasoning behind its desire to do so, is still poorly understood and cannot easily be explained by contemporary international relations theory.

The chapter then brings the two concepts together, attempting to explain from a utilitarian perspective how latent capability and desired hedging may influence a country's negotiation strategies and its willingness to accept strategic constraint. Would a set strategy, for instance, make a country better or worse off?

At the end, it examines how latent nuclear power is related to irreversibility in nuclear disarmament, and points to the difficulties in achieving high levels of irreversibility. It also touches upon the role of nuclear safeguards in assessing a state's latent nuclear power and in determining their impact on the same country's desired hedge.

Nuclear Latency

Nuclear latency is a condition where a state has the means to produce nuclear weapons, but does not have weaponized nuclear materials and is not developing them. Latent capabilities can arise in countries that have established a material pathway to the manufacture of a nuclear device but have never applied that path for military purposes, or in states that once possessed weapons but have abolished them without eliminating their means of production. A latent capability is not a binary phenomenon, but rather a spectrum of possible states, where high-latency countries can deploy explosives rapidly and low-latency ones can do so over an extended period of time, possibly decades. There have been few attempts to structure and categorize this concept in the literature. Methodologically, it ought to be possible to devise an assessment framework and assign places on it to all the countries of the world.

Latency can be approached using fundamental economic theory. In this case, the "supply" of "public goods" (nuclear explosives) is driven by the "demand" for those goods. Nuclear-weapon production, as with other types of production, converts inputs such as raw material, capital, and labor into outputs (the explosive device). The emphasis on industrial production makes latency a straightforward concept to elaborate. It also makes it easy to conceptualize empirical studies to assess and weigh the latent nuclear power of any government today. Hence, a state's latent capability to produce nuclear explosives can be expressed as a function of the classical factors of production. Like in all manufacturing, the state needs access to three essential resources, and its output will be related to their individual and collective availability.

NATURAL RESOURCES

The first factor of a state's nuclear-weapon output is the availability of the necessary natural resources. The government must have access, either domestically or through imports, to thorium, uranium, or plutonium. If the country has no stocks of previously produced material or a viable source of extraction or importation, it will not be able to produce an explosive device. The country would then by definition be a no- to low-latency power.

Uranium is a naturally occurring metallic element, with an abundance in the Earth's crust broadly comparable with tungsten and tin but without uniform distribution. The element is most prevalent in unconformity-related deposits, where the abundance can range from between 5,000 to up to 200,000 parts per million. The McArthur River mine in Canada and the Ranger mine in Australia are examples of such deposits. Uranium ore also can be mined from black shale, a rock of marine origin with high organic content, but the ore grade in such deposits are often less than 1,000 parts per million, and consequently a much poorer resource. France's now-closed Schaenzel mine is an example of this type of deposit. Three countries, Australia, Canada, and Kazakhstan, hold over half of the world's known recoverable resources of uranium. No more than 15 states have 96 percent of known uranium resources, with the rest holding the remaining 4 percent. Uranium's relative abundance makes it possible for most countries to extract it from their own territories, but in some regions the costs of so doing would be considerable and perhaps even prohibitive. The availability of uranium, therefore, is a major variable in assessing a state's latent capability. To be used in explosives, however, it must be refined, which requires input from other factors, principally capital and further labor. Because an existing stockpile of highly enriched uranium is capable of being directly used in an explosive device, such a stockpile would dramatically increase a country's latent power.

Laboratory tests with uranium

In nature, plutonium only exists in trace amounts, some of which are deposits from atmospheric nuclear testing. It is a byproduct of nuclear fission and is extracted from irradiated uranium. As the existence of plutonium is contingent on a reliable supply of uranium, the availability of extractable uranium deposits remains a deciding variable in assessing a state's latent power.

A state that possesses a stockpile of plutonium must already have a developed nuclear fuel cycle. Alternatively, but less likely, the state could have imported it in sufficient quantities from a producing state. Some states may have plutonium in spent fuel but cannot extract it—plutonium extraction is an industrial process known as reprocessing. Regardless of its source, a stockpile of unextracted plutonium would increase the latent power of the state that has it. If the plutonium is rich in the isotope 239, the only delay in manufacturing an explosive nuclear device would be the availability of capital stock and labor, and this would dramatically increase the latent power of the state.

Thorium is slightly more prevalent than uranium, and can technically be processed into fissionable uranium (isotope 233) through reactor irradiation. To date, few states have explored the thorium route, and the resulting uranium's use in nuclear weapons yield few advantages. For completeness, however, a country's available thorium reserves also should be assessed.

CAPITAL STOCK

The second variable deciding a country's weapon production rate is capital stock, here understood as machinery, tools, and buildings. The weapon itself is but the summit of a vast industrial infrastructure. To maintain a high level of latency and a viable hedge, a government must be able to transform ore into uranium or plutonium metal with a specific isotopic composition.

As noted above, it is not possible to construct a nuclear explosive device without access to the raw material. Absent a reliable import source of uranium, the state would need to invest in uranium exploration, mining, and milling, which in turn will require capital such as buildings and equipment. The process is capital and labor intensive, with only a fraction of the ore (expressed in parts per million) milled into uranium.

The product of the mining process is sometimes referred to as "yellowcake," a concentrate powder named for its physical appearance. The yellowcake will need to undergo further refinement until the uranium is ready to be used in an enrichment process or in a nuclear reactor. This stage is referred to as uranium conversion and fuel fabrication. If the idea is to use the uranium in reactors, the power is smelted into purified uranium dioxide and shaped into fuel rods or fuel assemblies. If there is a desire to enrich the uranium further into the isotope 235, it is converted into a product known as uranium hexafluoride, a powder that can easily transition from solid to gas form. Both processes take part in a conversion facility, which may be a relatively sizeable chemical factory.

Uranium enrichment can take many forms, but the preferred option deploys gas centrifuges. Here, uranium hexafluoride is heated until it forms a gas. This gas is then fed through a "cascade" of connected gas centrifuges operating at very high velocities. The process exploits the minute weight difference between fissionable isotopes—235 and 237—and uranium-238, with centrifugal forces pushing the heavier isotope toward the outer casing of the centrifuge (where it is scooped up as "tails," or depleted uranium), leaving the desired product in the center to be extracted. Enrichment requires significant capital investment.

If the country wants to produce plutonium, it will need to irradiate the uranium in a reactor. Plutonium is formed when the irradiated uranium captures neutrons and gains isotopic weight.

All plutonium is fissionable, but the isotope 240 has a very high spontaneous neutron emission rate, making it less suitable for explosives. To optimize the production of the more suitable isotope 239, a reactor must be run at low burnup levels with a supply of natural uranium fuel. Building any nuclear reactor requires significant capital investment.

Once the uranium has been irradiated, it must undergo further processing to separate the plutonium from the uranium and remove any undesired byproducts. This is known as reprocessing. The uranium can then undergo further treatment and be used again. The plutonium can be transformed into metal shapes. Reprocessing, like conversion, is a dirty chemical industry that requires a heavy capital investment.

The production of the explosive devices themselves, the least capital-intensive part of the total work, requires only some specialized equipment and sites. However, in order to produce the equipment needed to deliver explosive devices effectively to target, the state would need to invest in a significant industrial process or be able to import suitable delivery vehicles. This process is more amorphous and more difficult to control than the production of nuclear materials.

LABOR

Although natural resources and capital are required to produce nuclear explosive devices, the labor component is equally important. The labor component is understudied compared to the technologies involved in weapon production. However, the various stages of fissile material production require both unskilled and skilled labor. Tens of thousands of workers may be needed to mine the uranium ore. The later stages of the production process require more specialized workers, such as engineers and scientists. The weapon concept and design will not require a large pool of expertise, but those who work in these areas must be highly educated and skilled.

The construction of a nuclear explosive device is more an engineering and management challenge than it is a scientific one. The science behind nuclear weapons is today well known, and may be considered accessible to virtually all states.

Strategies to Increase Latent Powers

In what strategies would a state seeking to increase its latent power engage? It would choose the course of action—and an investment strategy—that best fulfills its desired hedge. First and perhaps foremost it would need to ensure a good supply of uranium. State investment in uranium prospecting and extraction is likely to precede other decisions. Other fuel cycle decisions will not be taken until a country has established how much uranium it possesses and what estimated costs are associated with its extraction. If a country cannot secure a domestic supply of uranium, it will attempt to import it.[1]

The second objective would be to ensure a ready pathway from uranium yellowcake to either uranium or plutonium metal. It is difficult but not impossible to build nuclear fuel cycle facilities clandestinely. However, there is no legal need to attempt to hide an investment in fuel cycle technology, as it is allowed and even encouraged under the Treaty on the Nonproliferation of Nuclear Weapons (NPT). Paradoxically, by giving legal cover for the enhancement of latent nuclear power, the NPT creates the conditions for a long-term proliferation problem.

The third objective would be to decide on and then develop the means to deliver the explosive to a target. In some cases, the country may envision that its nuclear weapon will be used in a battlefield setting, and it will focus on developing bombs or other devices that can be delivered by aircraft or otherwise used to target troops and military installations. In other cases, it may want to establish countervalue capabilities as well, and so will plan to develop ballistic missiles that can strike an enemy's cities and civilian population.

Strategies to Decrease or Contain Latent Powers

Other actors may want to decrease or contain the buildup of a state's latent nuclear power. Traditionally, this has been done by controlling the spread of raw material and capital. Entities such as the Nuclear Suppliers Group (NSG) and the Missile Technology Control Regime (MTCR) aim to ensure that capital, and to some degree raw material, does not reach countries that are attempting to establish a viable nuclear hedge. International safeguards administered by the International Atomic Energy Agency (IAEA) also enable states to monitor how other states are using nuclear material, but they do not prevent the buildup of latent nuclear power as such.

Some states have natural uranium deposits, and of course it is not physically possible to eradicate these elements when they are in the ground. However, individual states and the international community in general can take stops to further control and monitor uranium mining. In some circumstances, mining falls under IAEA safeguards, but only in a rudimentary sense. For instance, at present there is no international system to account for uranium mining. Major mining countries traditionally have resisted efforts to develop safeguards on uranium mining and exploration, the benefits of such safeguards notwithstanding. In the absence of a more rigorous international accounting system, one option for action would be to focus regulatory assistance on major uranium-producing countries, to ensure that their national monitoring systems are as strong as they can be.

Yellowcake (also called urania) is a type of uranium concentrate powder obtained from leach solutions, in an intermediate step in the processing of uranium ores. Source: https://en.wikipedia.org/wiki/Yellowcake

A moderately successful strategy for dealing with countries that may be engaging in nuclear proliferation is to deny access to capital. Here, efforts such as the NSG and the MCTR are important. This approach is unlikely to stop a determined proliferator from acquiring the requisite technologies, but it may slow them down. Another technique would be to actively degrade or destroy capital, either covertly (through industrial sabotage) or overtly (by attacking and destroying essential fuel cycle facilities). Such actions would degrade a country's latent nuclear power, but would likely reinforce its desire to establish a viable hedge, not least because it may feel more threatened by external actors.

"This would include a broad agreement on prohibiting the production of fissile material for weapon purposes, and a means of channeling capital investments away from fuel cycle technologies with high latent potential."

An unappetizing option is to deny the state access to labor—a difficult task that raises many ethical dilemmas. Nuclear knowledge is diffused and accessible today, and knowledge lost can be replaced. To say the least, it would be implausible and counterproductive to deny academics, researchers, or engineers from certain countries access to higher and further education in nuclear fields. Physically removing key individuals from a country—for example, by killing them—would also only produce short-term results and far-reaching negative effects.

A longer-term objective for nuclear nonproliferation would be to reach a new agreement on acceptable forms of nuclear investment. This would include a broad agreement on prohibiting the production of fissile material for weapon purposes, and a means of channeling capital investments away from fuel cycle technologies with high latent potential (such as heavy water reactors) to those with lower potential (such as light water reactors). It also would be beneficial to place uranium enrichment and reprocessing under international control. These instruments would not stop a country from embarking on a program to build up its latent nuclear power, but they would make it easier for the international community to intervene in such activities, as by definition they would be unlawful.

Nuclear Hedging

Hedging is a technique for managing risks and protecting oneself against adverse circumstances. In economics and trade, the concept broadly means taking a market position that to some degree offsets the exposure present in a commercial exchange. Hedging is different from insurance, which involves transferring the risk to another actor. To take a hedging position requires an investment to offset the risk. The word is used similarly in international relations theory, although it has never been clearly defined.

Ariel Levite defines hedging as "a national strategy of maintaining, or at least appearing to maintain, a viable option for the relatively rapid acquisition of nuclear weapons, based on an indigenous technical capacity to produce them within a relatively short time frame ranging from several weeks to a few years."[2] This is a good starting point. Levite notes that hedging "may be adopted either during the process of developing a bomb or as part of the rollback process, as a way of retaining the option of restarting a weapon program that has been halted or reversed."[3] A rollback occurs when a state has acquired nuclear weapons but has agreed to give them up, with the implication that that state will forego future research and production of nuclear-weapon technology. Levite pins much of his argument on a "national strategy," which implies a government's *intention* to either develop nuclear explosive devices or to make a conscious effort to at least keep that option open. Wyn Bowen and Matthew Moran, elaborating on this argument, have put the hedging concept together with nuclear latency, observing that "hedging can be characterized as nuclear latency with intent."[4] This is an elegant formulation of the problem, although it is not without its difficulties.

It is difficult to establish a government's putative "intent" to maintain a nuclear-weapon program, and a government's allies and adversaries naturally will have vastly different perspectives on whether or not such an intent exists. Moreover, hinging the question of nuclear latency on intentional strategy excludes the unintentional consequences of other choices. A state may want to develop its nuclear industry for energy production purposes—with the unintentional consequence that it also builds its latent power, as well as the option to establish a nuclear hedge. Governments also may intentionally engage in hedging to ensure a fallback position should a chosen policy position collapse. For example, a government may choose to retain a military force (conventional, unconventional, or a combination of both) to protect peace (the "policy position") through armed deterrence (the "fallback"). Similarly, states that have signed up to the NPT may want to retain or develop capabilities to produce nuclear materials and explosive devices, even though the treaty prohibits weapon acquisition. Article IV.1 of the NPT allows countries to "develop research, production and use of nuclear energy for peaceful purposes without discrimination" as long as this does not lead to the development of a nuclear weapon or explosive device. Because of the dual-use nature of nuclear technology, nations can build latency—and thereby gain the option to hedge—without violating the legal terms of the treaty. Yet even in such circumstances, a government's true intentions are seldom easy to ascertain. With so many possible options and myriad reasons for hedging, it would make sense to discard references to intent, and observe whether a state could *viably* or *feasibly* engage in a strategy. The question then becomes not if a country may want to develop nuclear weapons at any given moment, but whether it could do so if it wanted to. A state that can successfully acquire nuclear weapons will have a viable hedge.

A state's capacity to constitute (or reconstitute) a nuclear weapons program is related to Levite's second point, on the "viability" of the hedge. The word *viability* simply means "ability to work successfully," and is directly contingent on a country's latent power. If a state's latent power grows, so does its capability to establish a nuclear hedge. Inversely, a reduction of latent power gradually takes away the option to hedge. What constitutes success is not further defined. Would a country have a viable hedge if it can construct a nuclear device irrespective of the time and cost required? Alternatively, does the viability of the hedge depend on the timeframe in which a nuclear explosive can be constructed, and at what cost? Viability evidently is a subjective judgment.

For some states, a viable hedge may be to acquire enough raw material, capital, and labor to allow for the realization of a nuclear device in a matter of months. Iran is one possible case study here, depending on the ultimate fate of the Joint Comprehensive Plan of Action (JCPOA), especially after the U.S. withdrawal. Iran's fuel cycle is fairly well developed, but it lacks the ability to direct its industrial establishment to produce a deliverable weapon within a year, in part because of the JCPOA. Has the JCPOA prevented Iran from attempting to secure the capability to acquire weapons within a shorter timeframe? If so, what happens if the agreement is no longer in play? Will Iran feel that its external threats are not enough to warrant actualization of the hedge in a shorter period of time? The Iranian government may have calculated that giving the appearance of manufacturing a nuclear explosive will increase the risk that other states will use force to prevent Iran's acquisition of nuclear weapons, and that in the interim the best strategy is to maintain very high latency levels and prepare to "sprint to the bomb" should it need it. For now, maintaining high latent powers serves Iran's objectives, and preserves a *viable hedge* even under the JCPOA.

Other states may have different views on the viability of a hedging option. For example, even if the United States and the Russian Federation were to agree to draw down their considerable nuclear forces, they both would strive to hedge against the reemergence of the other's nuclear forces. They both maintain the capability to project overwhelming force globally, especially through intercontinental ballistic missiles. If one of the parties were to place an explosive device on a missile, it would be able to strike its opponent within half an hour. It could then hold the other party hostage to a nuclear threat without fear of retribution. In such a situation, a viable hedge would be measured in days or even hours—certainly not in months, as in the case of Iran.

The subjective desire to establish a hedging position appears to be adversely related to the level of confidence in the behavior of other actors, and the perceived risk that one party would behave adversely. If two parties have absolute confidence that the other would follow an agreement to the letter, then neither would need to establish a hedging position or even monitor the other's commitment to the agreement.

With both national strategy and viability as established factors, hedging appears to be a function of the *time* in which a nuclear capability can be constituted, as well as the associated *costs.*

ACCEPTABLE TIMEFRAME

States may view time differently; however, in all examples, the state seeks to establish a position allowing it to respond to a perceived threat in a timely fashion. If threat perceptions change, the utility of a specific hedging position changes with them.

To take one example, does sheltering under a nuclear umbrella reduce a state's perceived threat perception? It is fashionable to adopt Thucydides and observe that "the strong do what they can and the weak suffer what they must."[5] Those with the means to produce nuclear weapons will do so, while those without those means seek their patronage and protection. But the only way another country would know whether a nuclear-weapon state would use such weapons to protect its interests is in a time of conflict. Before that, it is a complex probabilistic assessment. The client state presumes that its patron will come to its aid; if it is not confident that its patron will do so, it would seek assurance through other means. The adversary likewise cannot rule out a nuclear response to its aggression; if it did, it would have no fear of engaging in conflict. This can be problematized further. Is it not possible that the aggressor feels that it can engage with impunity, as its nuclear weapons would protect it from retaliation? Nuclear weapons may well create stability on the level of nuclear warfighting, but will not be able to fully deter all forms of aggression—a concept sometimes referred to as the "stability-instability paradox."[6]

To take another example, to what degree would a country's own actions contribute to the threat perception? Can the threat of violence check a country's nuclear ambitions? If the fear of imminent armed action outweighs the potential safety of a future nuclear-weapon program in the mind of the decision maker, would it be more hesitant to dash for the bomb?

Finally, to what degree is the threat perception based on cognitive and motivational errors? A government may feel under threat even if its perceived aggressor does not perceive its own stance as inherently threatening. Moreover, an action that one government takes to protect itself may be interpreted by another as fundamentally threatening. The psychology of international politics is generally understudied.[7]

ACCEPTABLE COST

A country also should be able to achieve a viable hedge within an acceptable cost. If the cost is unacceptable, the country would not move into a hedging position, but instead seek alternative ways to safeguard its position. The cost a nation is willing to pay to establish a viable hedge ought to be a factor of the perceived threat level. The higher the threat, the more a state is willing to invest in establishing a viable hedge.

It would be useful to ascertain how much the present nuclear-armed states are spending on their nuclear arsenals as a proportion of both their defense spending and their gross domestic product (GDP). The data on such expenditures are scarce, but estimates indicate that nuclear-armed states generally spend between 0.2 and 1.0 percent of their GDP on these weapons, amounting to between 3 and 20 percent of the overall defense budget.[8] The ability to manufacture nuclear weapons does not belong exclusively to the world's rich nations. Three out of nine weapon-possessing states—namely, India, Pakistan, and North Korea—are listed as low-income or lower middle-income nations on the eligibility list produced by the Organization for Economic Co-operation and Development (OECD) Development Assistance Committee.

Nuclear weapons are a cost-effective way to ensure an ability to inflict massive destruction on an opponent. Their relatively low share of GDP, as well as defense spending overall, makes them relatively easy to maintain over an extended period. A nuclear-weapon program requires substantial capital investment in the beginning, although capital costs diminish over time as major infrastructure is put in place. After maturity, costs level out, and amount mainly to upkeep and modernization. In the context of disarmament, the cost of dismantling (and later replacing) the capital infrastructure is likely to be a significant disincentive to nuclear-weapon states.

Another cost associated with a nuclear-weapon program relates to the means of delivery. The cost of developing ballistic missile technology in particular can be a hurdle for less financially endowed states, but as the North Korean experience illustrates, it is by no means out of reach for an impoverished state that is determined to have the bomb.

Arms Control Transactions

It is possible to envision a matrix of latent capabilities and desired hedging. States such as the United States and the Russian Federation would appear on one end of the spectrum and countries without nuclear assets or raw material on the other end of the spectrum. The rest of the international community could be characterized by its measured latent nuclear power, as well as its capacity to use this power in a viable hedging strategy. Countries will aspire to achieve a level of latent capability that corresponds to their desired hedge. If perceived levels of threat primarily drive weapon acquisition, nonproliferation policies

TABLE 1: MATRIX OF LATENT CAPABILITIES AND HEDGING

Latent Power/ Desired Hedge	Viable	Feasible	Unviable
No (Absolute)	Weapons deployed in a matter of minutes (weapons on active deployment)	Weapons deployed in a matter of hours (through detargeting or other measures)	Does not apply. Weapons are present and can be deployed.
High	Weapons deployed in a matter of days	Weapons deployed in a matter of weeks	Does not apply as the desired hedge is feasible
Medium	Weapons deployed in a matter of months	Weapons deployed in a matter of years	Does not apply as the desired hedge is feasible
Low	Does not apply. Weapons cannot be deployed within a reasonable timeframe (less than 10 years).	Weapons deployed in a matter of decades	Does not apply as the desired hedge is feasible
No	Does not apply as the country lacks one or more factors of production	Does not apply as the country lacks one or more factors of production	Does not apply as the country lacks one or more factors of production

should aim to reduce states' threat perceptions or, failing that, to complicate their efforts to achieve high levels of latent nuclear power. Disarmament efforts should strive to remove a country's actual capability to produce and deliver nuclear explosive devices, and then reduce its latent power.

Under what conditions would governments be willing to decrease their latent nuclear power? When would they be willing to transition from a viable hedge to a feasible hedge? If latent nuclear power is the ability to materialize a hedge, and the hedge in turn is driven by a state's perception of risk, changes would likely occur only when the underlying condition changes. If there is no fundamental change in the risk perception, a state may only consider amending its hedging position slightly.

For example, the United States and the Russian Federation might choose to stand down their nuclear forces (if this could be done in a way that could be monitored) so that weapons can be deployed in a matter of hours rather than a matter of minutes. One method of doing so would be to prohibit the deployment of weapons capable of striking the enemy quickly, such as by limiting patrols of nuclear-armed submarines. Pakistan is sometimes assumed to store its nuclear weapons separately from its delivery vehicles, which slows down its deployment rate.[9] Other nuclear-armed states could develop similar arrangements. However, as long as there is no meaningful way of verifying the deployed status of an opponent's weapons, the nuclear-weapon states are unlikely to consider lowering their guard. Nonnuclear-weapon states with high latent nuclear power also would only be willing to consider a change in the feasibility of the hedge if their risk-calculus changes fundamentally.

MODIFYING A HEDGING POSITION

If one assumes that a state wants to maintain or increase its latent nuclear power, nonproliferation and disarmament discussions will tend to focus on maintaining position. This means that states that desire high latent nuclear power would be unlikely to support or promote initiatives that constrain or reduce this power.

Powerful states may not support an obligation that somehow constrains their ability to produce fissile material, such as a fissile material cutoff treaty (FMCT). They would not, for instance, be likely to support an obligation that foregoes the production of highly enriched uranium as such. Neither would they likely sign up to a ban on nuclear reprocessing. By doing so, their nuclear power would decline. They might, however, sign up to obligations containing a "general purpose criterion"—that is, production for weapon purposes—as this obligation would not constrain or reduce their nuclear power. States on the lower end of the latency scale, such as African or Central American states, would be more willing to accept an explicit prohibition as it would not leave them worse off. Given that they have little capability, they would be able to increase their latent power up to the level of prohibition, where they would then achieve parity with other states.

In situations where the latent nuclear power is unchanged, but where the viability of the hedge is modified, states may be more likely to reach agreement on nonproliferation or disarmament. For example, a government may be willing to keep its capabilities to manufacture and deploy explosives intact, but compromise on the timescale. When Iran accepted the terms of the JCPOA, most of its latent nuclear power remained untouched, but a combination of limitations on raw material and capital investment and an enhancement of international monitoring moved its hedging position from viable to feasible.

WILLINGNESS TO SCALE DOWN ON LATENT POWER

Realist theory dictates that when a state perceives an increase in external threat, it has an incentive to increase its latent nuclear power. Conversely, when a state feels that the threat environment has become more benign, it should be willing to reduce its latent nuclear power. If the state is facing a high level of external threat, and it nevertheless decides to reduce its latent nuclear power, it would be *worse off*. Under this assumption, governments would be unwilling to reduce their latent nuclear power in all situations where the threat facing the state is perceived to be *unchanged*. This philosophy underpins many of the arguments made by the nuclear-weapon states with respect to disarmament. Nuclear disarmament is a long-term endeavor that may require fundamental changes in international relations. In the meantime, the international community as a whole must make it a priority to manage latent nuclear power by eliminating the causes of conflict, rather than the means.

This position is both logical and internally coherent, but it does lead to a troubling conclusion. If a general reduction in risk cannot be achieved, the general pressure to increase the latent nuclear power of all nations will remain. From this perspective, nuclear nonproliferation is a rearguard action designed to stave off the number of nuclear-weapon-capable states for as long as possible. However, given that the underlying conditions will not change, this ultimately is a losing proposition. Disarmament, from this perspective, becomes a dangerous folly, as it would only diminish the security of the possessing states and their allies.

Scott Sagan raises South Africa as an example of how both a changing external threat, combined with a drastic transformation of the domestic policy landscape, led to the country abolishing its small arsenal of nuclear weapons.[10] Although this decision has been internationally lauded, South Africa kept its stockpile of weapon-grade uranium, and hence retained its high latent power. From a perspective of hedging and latency, South Africa's decision to "disarm" more closely resembles a shift in its hedging position, rather than a general decrease of its latent power. When South Africa gives up its stockpile of uranium, it will *decrease* its latent power, and more effectively move toward disarmament. Whether or not it decides to do so in coming years remains an open question.

To take another example, the Treaty on the Prohibition of Nuclear Weapons (TPNW), was supported by states with no to low latent nuclear power (with a few notable exceptions, such as Argentina, Brazil, South Africa, and Sweden). More powerful states, as well as those in alliance relationships with nuclear-armed states, did not support the TPNW. In any case, the treaty itself does not require those states that sign and ratify it to reduce their latent nuclear power, but neither does it prohibit them from increasing it if need be. Had the treaty put in place more stringent requirements, such as an increase in international verification and monitoring, or a limitation of acceptable fuel cycle technologies, support for it likely would have waned. The TPNW did not worsen the position of any state that supported it.

Hedging, Latency, and Irreversibility

Analyzing the international community through a lens of latent power changes the perspective on nuclear and nonnuclear states. Countries are not in a binary state of either possessing or not possessing weapons. Instead, the world can be viewed as a collection of states with varying degrees of latent nuclear power. By assigning weight to observable phenomena, such as uranium availability, industrial assets, level of education of the workforce, and overall economic strength, it should be possible to place all states on a latency scale. Individual states' capabilities could then be empirically assessed. High latency likely would be concentrated in regions where states possess fuel cycle capabilities and are able to manufacture the means of delivery (such as Europe, South Asia, and parts of Northeast Asia). Regions of the world without such capabilities, such as Africa and Central America, likely would have low latency. The picture can be refined further if viewed through the prism of hedging. Here, countries with high latent capability could be further classed as having a *viable hedging option or a feasible hedging option*, depending on how quickly nuclear weapons can be manufactured and deployed for military purposes.

A research methodology assessing latent power also could be used to track changes in latency over time, both for individual states and for regions of interest. The resulting data would produce an overall capability assessment, which in turn could be used both to focus on regions of particular concern and assess the strength and effectiveness of proposed nonproliferation and disarmament actions.

It is important to take latency into account when designing viable counterproliferation strategies and setting up appropriate disarmament measures. The latency dimension comes to the forefront when discussing *irreversible nuclear disarmament*. Logically, a latent capability to manufacture arms must have an inverse relationship with irreversibility in nuclear disarmament. If a state takes disarmament action, but maintains its capability to produce explosive devices and deliver them to target within days or weeks, the action is highly reversible, and the state has high latent power. By contrast, if the country takes action to remove its capacity to produce material for weapons, its latent power drops significantly, and the irreversibility of the action increases. Table 2 illustrates this relationship.

From a latency perspective, it is not necessarily important for a state to possesses nuclear weapons. The distinction between nuclear- and nonnuclear-weapon states is there, of course, but less pronounced. Rather than focusing on the weapon itself, a latency perspective aims at capabilities. The hedging perspective adds the state's potential to apply that capability for military purposes, within a specific time and at a certain cost.

TABLE 2: LATENCY AND IRREVERSIBILITY

Latent Power	Capacity	Irreversibility
No (Absolute)	The state possesses nuclear explosive devices.	Not applicable
High	The state has the capability (expressed as raw materials, capital and human resource) to produce fissile material *as well as* capability to assemble the material into nuclear explosive devices *and* the means to deliver the device to target.	Low. Weapons can be assembled and used in a matter of days or weeks.
Medium	The state has the capability to produce fissile material but *lacks* one or more capabilities required to assemble the material into nuclear material devices or lacks credible means to deliver the device to target.	Medium. Weapons can be assembled and used in a matter of months or a few years.
Low	The state lacks one or more capabilities to produce fissile material, but may acquire *all of them* over time.	High. Weapons can be assembled and used in a matter of years or decades.
No	The state is unable to acquire one or more capabilities to produce fissile material, and is *highly unlikely* to be able to acquire them over time.	Near absolute. Weapons can be assembled and used in a matter of decades.

From an arms control perspective, it therefore may be useful to talk about three types of states: armed states, unarmed states, and disarmed states. *Armed states* are those that currently have and can deploy weapons, and may or may not be capable of producing them. This is the equivalent of having a handgun holstered and at your side, ready for use. An interesting category of armed nuclear states is those that possess weapons but have foregone the capability to produce them. France, for instance, has dismantled much of its old manufacturing capability, but still maintains the weapons.

Unarmed states do not have nuclear weapons but nonetheless could produce them within a certain timeframe and below a certain cost. Several states belong to this category; Japan is the most often quoted example, but Iran and several European states also fit into this category. This is the equivalent of owning a handgun but keeping it in the gun safe, ready to be taken out if need be.

Disarmed states do not have nuclear weapons and cannot produce them within a certain timeframe and below a certain cost. Some states in this category may, for instance, have some fuel cycle technologies but would need significant capital investment to achieve full manufacturing capacity for nuclear weapons. This is the equivalent of not owning a handgun.

Verification systems should be designed to take into account latent nuclear power; to some degree, they already are. For instance, in nuclear safeguards, the frequency of inspections and the total number of inspection days are related to the amount of material a state has in its possession. The IAEA has been working to make the best use of this system. In its State-Level Concept, it envisions a so-called State-Level Approach to implement safeguards, one that takes into account a state's nuclear and nuclear-related activities and capabilities as a whole. Central to the State-Level Concept is a technique known as "acquisition pathway analysis," which assesses a state's current and potential ability to produce nuclear weapons. This analysis, as well as other information, forms the foundation of an annual implementation plan that aims to detect diversion and misuse in a timely manner, as well as provide confidence on the absence of undeclared nuclear material and activities. The idea is to apply safeguards in a tailored fashion, instead of slavishly following the quantity-related rules in the safeguards agreements.

Similarly, verification regimes for nuclear disarmament should also take into account a state's latent nuclear power. For instance, if the objective of disarmament is solely to remove nuclear weapons, it may be enough to think of a verification regime that accounts for all weapons on a state's territory and monitors their destruction. An alternative would be to remove weapons from active deployment and keep them in central storage, perhaps even under onsite monitoring. Using the terminology above, the state would move from being *armed* to being *unarmed*: it would put its handgun in the gun safe. Such disarmament measures are, of course, *highly reversible*, but this may well be a condition for taking the measure in the first place.

If the objective is to disarm a state, measures should be taken to remove not only the weapons but also the capacity to produce them. This would involve difficult decisions to destroy or disable significant capital investments such as uranium conversion facilities, enrichment plants, and reactors. If the objective is not to reduce a state's latent nuclear power, verification measures must be implemented in a manner that makes any attempt at nuclear reconstitution both time-consuming and costly. This could be done by placing under international monitoring all principal facilities that are able to produce nuclear material, forcing a state into a position where the only way to actualize a hedge would be to either discontinue international inspection or embark on a costly venture to establish parallel clandestine fuel cycle facilities. Abandoning verification and monitoring is a high-risk strategy, as it clearly signals an intention to realize the hedge.

Viewed from a latency perspective, the only guarantee against the reemergence of nuclear weapons is the "green field option," where all fuel cycle facilities are verifiably removed from a country. This is a politically unrealistic option, and so the world would have to learn to live with and manage latent nuclear power for the foreseeable future. It is unknown how much latency would be acceptable in an unarmed world, though it may be worthwhile to try to predict where this future equilibrium. All states would have a stake in this discussion, as disarmament, from a latency perspective, becomes as much a question as to how to *reduce* the power of those countries that have, and how to *maintain and limit* the power of those states that have not.

Conclusion

Nuclear nonproliferation and disarmament, when viewed from a perspective of latent nuclear power, can be expressed as restrictions on a country's capability to produce weapons and the viability of establishing a credible nuclear arsenal. Political statements are easily reversible—almost meaningless—unless the conditions on the ground change. Has a country indeed disarmed if it gives up its explosive devices, but remains capable of producing them at short notice? Most would say yes. Without disagreeing with that answer, the introduction of the concept of armed and unarmed states is an important nuance.

Nonproliferation, from this viewpoint, is not exclusively a matter of preventing the spread of weapons, but of managing countries' underlying capacities to produce them. In this regard, this chapter is not conclusive and leaves many issues up for discussion and further elaboration. However, one fundamental question stands out. What is the level of acceptable risk in the system? Expressed differently, if latent nuclear powers cannot be eliminated from this world, what is an acceptable level of latency? Depending on the answer to this question, many more problems arise. If only low latency can be tolerated, is the NPT framework enough, or would it need to be modified? Would the safeguards system administered by the IAEA also need to be modified?

Disarmament also should be viewed from a different perspective. If perceptions of risk drive a state's desire to establish a viable hedge, how can the major states—the United States and the Russian Federation—manage to climb down from atop their nuclear arsenals? Is it enough to abolish nuclear weapons in name but remain able to produce them? Is that disarmament? If the objective of a world without nuclear weapons is not merely to abolish the implements of war, but also the means of producing them, how can a degradation of latent nuclear power occur? Would a fundamental change in international affairs be required?

This chapter does not examine other phenomena that could explain why states desire to hedge against other actual or latent nuclear-weapon states. Neither does it look into the possibility of the misperception of threat in any great detail. What it does attempt, however, is to explain nuclear proliferation as a system, and it proposes a different lens through which the motivations and capabilities of states can be assessed and explained.

Existing initiatives and international agreements all can be explained through a lens of latent nuclear power and the capability to establish a viable hedge. Initiatives such as the NSG and the MCTR, as well as the IAEA safeguards system, all have an incredibly important role to play in achieving a world without nuclear weapons. However, the latency-hedging perspective also points toward lacunae in the existing nonproliferation and disarmament architecture. Further work to understand these shortcomings is required so that adequate remedies can be proposed.

Endnotes

1 See, for example, William Burr and Avner Cohen, "Israel's Secret Uranium Buy," *Foreign Policy*, July 2, 2013, http://foreignpolicy.com/2013/07/02/israels-secret-uranium-buy/. Burr and Cohen provide an account of Israel's procurement attempts in the 1960s.

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Future Directions in Nuclear Latency and Its Management

Kory Sylvester

The potential dual use of the nuclear fuel cycle to support both civil nuclear power and nuclear-weapon programs has bedeviled the international community since the inception of the nuclear age. Civil nuclear energy programs inherently rely on and produce fissile material and power reactors of considerable size (and attendant neutron fluxes), which means that they can provide tangible if incomplete benefits to a would-be proliferator, from materials and services to know-how and training. This is scientific fact and will not change with time.

For decades, the international community has attempted to deal with the problem. It is difficult to close the often-pointed-to "loophole" in the Treaty on the Nonproliferation of Nuclear Weapons (NPT) that allows states to pursue any and all nuclear technologies for peaceful purposes, as long as they are declared and placed under safeguards. This opportunity enables states to pursue a latent strategy that may include even sensitive enrichment and reprocessing (ENR) capabilities, at large scale, under the guise of a purely civil program. Nothing prevents states from stockpiling plutonium and highly enriched uranium, both of which are directly useable in weapons. Such stockpiles potentially allow a country to produce, at short notice, large numbers of nuclear weapons—and so nuclear latency is followed by nuclear "breakout."

The latency threat is nothing new. Indeed, the world has lived with the loophole for a long time. Global investments in nuclear power have risen and fallen, as have states' interests in latency strategies. The technical threat posed by existing nuclear facilities, and the national interest in pursuing such strategies, have always existed on a spectrum with periods of increasing and decreasing significance.

Today, the international community is in a period of heightened concern. Latency strategies are openly discussed in regions around the world as viable options to deal with security problems, as are debates on what to do about it. If nuclear constraint or rollback is needed to address concerns, how far-reaching should they be? What level of residual latent capability is tolerable or achievable?

The case of Iran hangs heavily over these debates. After a prolonged debate and negotiation, the 2015 Joint Comprehensive Plan of Action (JCPOA) sought to limit the scale of nuclear activities in Iran, targeting a projected breakout time of one year. The Trump administration saw this agreement as unacceptable, withdrawing from the deal in 2018 and seeking to replace it with a more restrictive agreement of longer duration. The situation has heightened concerns of a regional "latency race," with Saudi Arabia expressing its intent to participate if necessary.

There is also a related question of latent development in other fields relevant to weapons. Delivery vehicles, such as air or missile platforms, are relevant in considering latent capabilities and their attendant risks. The case of the Democratic People's Republic of Korea, with its open testing of missiles capable of carrying nuclear payloads across distances that expand the reach of its threat, highlights the importance of intercontinental ballistic missile (ICBM) developments. The perception of the latent threat depends to some degree on its geographic range. What should a negotiated solution look like? As with Iran, the desired end state of the North Korean or indeed of any nuclear threat or problem—the level of nuclear latency that may be tolerated—is uncertain. States differ on what should be required and what may be achievable through negotiations. Military strikes to limit latent risks have been discussed, having been employed in the past, and serve as a reminder of the stakes involved.

From a nonproliferation perspective, is any latent capability always bad? As is often the case, it depends on the context and alternatives. At certain times and in some situations, the international community encourages and promotes latency, and at other times seeks to restrict it. In the context of negotiated settlements, it often depends on what the market will bear. Some states were willing to accept a degree of latency in Iran for assurances of a terminated weapon program. Compared to a weapon program (or military action), a heavily monitored fuel cycle was accepted. It is not clear what might be agreed upon in the case of North Korea, but zero latent capability has been the Trump administration's stated goal—a higher standard than was achieved in negotiations with Iran.

From the perspective of disarmament, some degree of latency for previously armed states likely will be needed to assuage their concerns. If they are ultimately to rid themselves of nuclear weapons, they nonetheless will wish to retain the ability to reverse course should the security situation change. In any event, by virtue of their past experience, a degree of latency will always remain. This ability may, however, enable disarmament to proceed. In this context, latency can be an asset.

What is the future of latency and international efforts to manage it? Latency concerns, if managed properly, can limit latency races of the present and facilitate disarmament in the future. If managed improperly, the world will face enhanced security risks and obstacles to progress on both nonproliferation and arms control agendas.

Technical Elements of Latency and Past Control Efforts

From a technical perspective, the elements of a latent nuclear-weapon capability can be broken down into three components: the acquisition of fissile material, the production of delivery vehicles or mechanisms, and the design and fabrication of a nuclear device. Each component has its own necessary inputs and ancillary requirements.

To a greater or lesser extent, international and unilateral mechanisms have attempted to limit the degree of latency achieved in each of these areas. National export controls, bilateral agreements for cooperation, and international rules as articulated by the Nuclear Suppliers Group seek to contain and regulate fissile material production. Fuel leasing and takeback arrangements have limited reprocessing and the accumulation of spent fuel. Fuel banks have been established to ensure supply. The list is extensive in this domain because it is perhaps the more tractable of the three categories.

International safeguards provide another important component, but nevertheless they are not a counter to latency. They do not aim to limit capabilities but rather to deter their misuse through the risk of early detection of proliferation attempts. In fact, the NPT and the regime surrounding it promote the right to such capabilities under full-scope safeguards.

As the other chapters in this volume point out, individual states have taken steps to limit the spread of nuclear technology while encouraging some commercial activities. Through a combination of engagement; military, commercial, and scientific cooperation; and political pressure, efforts to acquire sensitive technologies have been discouraged. These efforts achieved important successes, particularly in the early phases of the nuclear era.

The Acheson-Lilienthal plan, drafted and promulgated in 1946, was the first and the most ambitious proposal for international control of nuclear energy. It was staggering in scale and ambition. It called for an international authority to own and operate the most sensitive facilities and materials, outlawing independent, national efforts in so-called "dangerous" nuclear activities. These included enrichment and reprocessing activities, but also the mining of uranium.

When it comes to restricting the development of suitable delivery systems, the missile technology control regime encourages members to restrict their exports of missiles and unmanned aerial vehicles (as well as related technologies) capable of carrying a 500-kilogram payload at least 300 kilometers or delivering any type of weapon of mass destruction. It is difficult to enforce limits in this domain given its inherent dual-use nature. Conventional military weapon development, along with scientific and commercial uses such as space exploration and satellite launch capabilities, provide alternate rationales for technology development that might mask its use in a nuclear weapons program.

In terms of preventing nuclear-weaponization activities, the problem is even more complex and problematic. National export control mechanisms apply, but their effectiveness is an open question. Many of the components involved have other applications as well and can be pursued with little notice. Few international efforts have been made to limit such capabilities. The NPT contains an implicit commitment to forgo nuclear-weapon development, but from a practical perspective it is difficult to enforce this restriction. It is worth noting that section T of the JCPOA is one example of an attempt, on a cooperative basis, to prohibit certain weaponization activities. This key section attempts to close the aforementioned loophole in the NPT by preventing Iran from undertaking certain nuclear-weapon development activities and controlling the dual-use equipment used in such activities, including computer modeling, multipoint detonators, and neutron sources. However, these guidelines are as yet untested, and considering the uncertain state of the JCPOA at present it is difficult to determine how they may be enforced.

"...preventing Iran from undertaking certain nuclear-weapon development activities and controlling the dual-use equipment used in such activities, including computer modeling, multipoint detonators, and neutron sources."

Why Would a Nation Pursue Nuclear Latency?

Latency as a strategy is the pursuit of nuclear capabilities with ulterior motives in mind. But what are these motivations? What does latency look like and how does one know that it has been achieved? Of course, what is required depends on one's ambitions. Whether it is a flirtation, conscious hedging for a future weapons program, or a "shot across the bow" warning, the technical demands will vary significantly.[1]

Latency requires a state to have the requisite capabilities and materials in place so that they can be redirected at the appropriate time. It provides options in case a nation feels that it may need to change course in the future. What one aims to achieve at that time defines what is technically required.

What are possible goals for a latent capability? Will it be used to threaten? To coerce another party into some course of action? To extract a concession? Or is it to deter an adversary? To support the development of a warfighting capability? The mix of needed capabilities, as well as the required scale (quantities of materials and capacities of facilities), varies in each case.

A particular concern is the need for delivery vehicles. If coercion or blackmail is the intent, the acquisition of sophisticated delivery systems is of less relevance. Should a nuclear device be produced, a boat or plane may suffice: ICBMs or nuclear submarines are not required.

In contrast, if deterrence (however minimal) is the objective, greater attention will have to be given to delivery systems. There is little military value of a nuclear device that cannot be delivered to a target. In this case, scale matters as well. A few weapons may be sufficient for coercive purposes, for blackmail or extortion, but may be of limited military utility.

Indeed, any proliferation option provided by a latency strategy must consider an adversary's potential reaction to its use. After proliferation, what next? What countermeasures can be employed? Improperly executed, a latency strategy can leave a proliferator in a vulnerable or seriously disadvantaged position, making the threat of use incredible.

The Acheson-Lilienthal report raised this issue. Its authors imagined that latency, properly managed, would play a critical role in the deterrence and enforcement of a nuclear regime. Their premise was that countries engaging in prohibited activities would be relatively easy to detect. "Dangerous" nuclear activities such as enrichment and reprocessing would still be located on national territory, but would be owned and operated by an international authority. They could be commandeered by that host state, but this action would be known immediately, sending an alarm to all countries.[2]

Quoting from the report:

> Seizures will afford no immediate tactical advantage. They would in fact be **an instantaneous dramatic danger signal,** and they would permit, under the conditions stated, a **substantial period of time** for other nations to take **all possible measures** of defense. For it should be borne in mind that even if facilities are seized, **a year or more** would be required after seizure before atomic weapons could be produced in **quantities sufficient** to have an **important influence on the outcome of war**.[3]

This passage is notable for several reasons. It sets a certain standard for "tolerable" latency. This is defined by providing a period of time in which nations could take countermeasures—not least of which might be to implement a crash program of proliferation themselves. It also implies that the act of proliferation would not necessarily be sufficient itself. Proliferation would have to take place at a scale sufficient to influence the outcome of war, such as in the deterrence or warfighting objective noted above.

In this formulation, one therefore must contemplate how big an arsenal might be required to decide an imagined conflict. This will dictate the size and scope of the requisite latent capability, which places clear and significant demands on breakout capabilities. If a significant number of deliverable weapons are desired, they must be acquired in a relevant timeframe. States must also consider their own vulnerabilities to preventive strikes intended to halt breakout actions. This places heavy demands on latency, and highlights the important role of ready stocks of weapon-usable material. Threat perceptions of the adversary, its capabilities, and its intent all shape latency requirements.

At the other end of the latency spectrum, with far less in the way of capability demands, are objectives of prestige and leverage with allies. These objectives can be achieved with no overt weaponization or perhaps even dangerous activities. Scientific interest and expertise go some way toward achieving this objective.

If the overall objective is to dissuade an adversary from investing in certain sensitive capabilities, it may be enough to advertise the fact that doing so would spur similar investments in response. Technology development in this scenario would mirror those of an adversary. Here, too, adversaries and their capabilities may shape and drive a nation's own capabilities.

Each of these motivations for latency can be seen as a form of messaging, or at least as having a messaging component. If a nation has not yet made the decision to weaponize or to proliferate, and instead is adopting a latency approach, something must be preventing it from taking those extra steps. The message of latency could invite a debate or negotiation on steps that would prevent further actions toward weaponization.

Measuring Latency

Having established a range of motivations and technical objectives for latency, how can we begin to assess how close a nation is to achieving it? Here, the Acheson-Lilienthal report provides a useful guide. In their work, an increased state of latency would be achieved by solving any or all of three "major problems" of weapons production: provision of raw materials (uranium or thorium); production in suitable quality and quantity of plutonium and U–235; and the fabrication of weapons themselves.[4] This formulation allowed all fuel cycle, and other nuclear activities, to be placed into one of two categories: safe or dangerous. One can interpret the dangerous activities as providing critical latent capabilities. Safe ones do not.

Relevant metrics for assessing activities were time, technical difficulty, and cost. How quickly and easily a material or facility might be converted to the task of weaponization, and what resource demands were required to do so, determined the degree of latency provided. Each of these factors can be estimated but rely on a host of assumptions. Time and cost are related to each other with obvious tradeoffs. Technical difficulty is dependent on the skills and related capabilities in place in the state. These metrics should be assessed in relative terms, allowing facilities or activities to be rank ordered rather than assessed in absolute terms. This was the approach taken in the Acheson-Lilienthal report. Facilities involved in the production of highly enriched uranium or plutonium, or which "by relatively minor operational changes" could produce such material, would be "dangerous."[5] This is to say that they would convey a high level of latency to the operator and thereby pose unacceptable risks. Scale was of importance, too. If the capacities of the facilities or the quantities that could be produced were rather small, then these facilities could be deemed safe. Only a certain quantity of material would be sufficient to produce "military significance." This is consistent with the deterrence or warfighting objectives noted above.

Scientific and engineering skill "above all" would also be required. However, Dean Acheson and David Lilienthal recognized that scientific development is ever evolving and over time can alter the situation. Activities that were at one point deemed exceedingly difficult might become much less so in the wake of a technical breakthrough. Enrichment technology is one such example of a scientific advancement. Early mechanisms for enriching uranium relied on grossly inefficient techniques such as gaseous diffusion, which required enormous industrial facilities and massive electricity sources. This changed significantly as gaseous diffusion techniques were refined in ways that dramatically reduced the size and power demands needed to enrich uranium. Other advances, such as laser-based enrichment techniques (which have yet to be realized), could provide another quantum change in performance.

Assessments of latency and proliferation risk have always emphasized the element of time as a critical factor. This is to be expected, as time is a useful means for capturing the impact of other factors in a common unit. Presumably, more difficult and expensive paths to weaponization will take more time to implement. Time also is relevant from a response perspective. It not only is a measure of the distance from the objective of the proliferator, but also the time available for multilateral or unilateral responses. As an example, in Acheson-Lilienthal, if material from a power reactor were diverted, it might be "some two to three years" before it could be used to make "a small number" of weapons. It is for this reason that in their rubric, such reactors could be regarded as safe for domestic ownership and operation. This assessment involved a number of assumptions that would not necessarily hold today, but nonetheless it illustrates the point.[6]

"Activities that were at one point deemed exceedingly difficult might become much less so in the wake of a technical breakthrough."

The significance of any absolute level of latency must be evaluated in the context of the purpose of the associated breakout. In the last example, the military significance of "a small number" of nuclear weapons is again raised, presumably in a warfighting context. It is easy to see the large and negative impact of significant stocks of fissile material: it is the fastest way to achieve a large number of operational weapons in short order. Even though the prevalence of fissile material is a recognized problem, many tens of metric tons of surplus plutonium and highly enriched uranium still exist in stockpiles around the world. This clearly illustrates the difference in analyzing a problem and pursuing effective solutions.

On estimates of time as a means for assessing latency, it is important to recognize that this is a natural approach with practical import, but caution is warranted. Time as a surrogate can be problematic and misleading. It is notoriously difficult to estimate the effect of time on latency with any degree of confidence, as such an estimate inherently involves many assumptions about knowhow, resources, and engineering design. Today's globalized world and the involvement of both the public and private sectors further complicates this question. The serious proliferation risk posed by the Pakistani nuclear physicist A. Q. Khan is one example of the problem, as his efforts to disseminate nuclear technology and resources accelerated the development of several nuclear-weapon programs. Further state-to-state collaboration also can short-circuit any kind of technical assessment about a state's inherent capabilities and the time needed for it to reach key stages of nuclear-weapon development. Time-based assessments are not necessarily reliable.

Does Nuclear Latency Bring Increased Risk?

Is a latent state a risky state? Does the mere presence of a capability mean that it is more likely that it will be misused? Here we have a certain Rorschach test problem, in which an observer of a state's nuclear capabilities often will see something that reflects its existing threat perceptions. This bias will always exist and should be recognized. As common interpretations of risk are directly linked to assessments of intent, this is unavoidable.

It is possible to make an objective assessment on a relative basis. Large stocks of direct-use fissile material satisfy virtually all levels of possible latency. Enrichment and reprocessing capabilities follow, with small medical and research facilities far behind. This establishes a rank order of attractiveness for proliferation but not necessarily a gauge for assessing risk. The link between capabilities and risk of proliferation is more subtle, perhaps depending more on how a program is initiated and pursued than on the technical nature of the facilities themselves. Examining the program in a statewide context for its internal consistency and overall coherence can be more telling.

It is tricky to distinguish between a peaceful nuclear program and a latent proliferation threat. The inherent dual-use nature of the nuclear fuel cycle complicates efforts to link fuel cycle choices with proliferation intent in a simple manner. However, the timing and the scale of capabilities, less than their particular nature, often offer suggestive insights. Previous work has observed that the type of facility may be less important than the degree to which it is congruent with known state policies and programs.[7] Investments should be looked at in light of whether they are driven and implemented as commercial, scientific, or strategic endeavors. The context in which the fuel cycles are pursued and the degree of their integration with other state-level objectives and programs also can be indicators of risk, given alternate rationales for a program. Nonetheless, even though such assessments can be useful for raising questions and drawing attention to areas of concern, they are a far cry from the "instantaneous dramatic danger signal" imagined by Acheson and Lilienthal.

Latency, Arms Control, and Disarmament

This chapter has discussed nuclear latency from a nonproliferation perspective. In this regard, latency can only have a negative impact on international security. No breakout capability is better than some. However, from a disarmament perspective, properly managed latency can play a constructive role. Recent disarmament debates have focused on humanitarian consequences of nuclear use and the 2017 Treaty on the Prohibition of Nuclear Weapons. This has provoked a divisive debate between proponents of the treaty and critics who see it as unrealistic and counterproductive.

Latency can have either a positive or a negative impact in the context of nuclear disarmament efforts. Unconstrained expansion of ENR activities in more states around the world will pose challenges. The presence of such capabilities will create an environment where breakout can be achieved in short order. In this environment, the prospect of relinquishing nuclear weapons may not seem attractive.

"...if the development of such capabilities is limited and stable, and there is little pressure for states to develop new indigenous ENR capabilities, disarmament can appear less risky."

In contrast, if the development of such capabilities is limited and stable, and there is little pressure for states to develop new indigenous ENR capabilities, disarmament can appear less risky. States that have this capability would be known and accounted for in the threat environment. In addition, latency retained by the now "former" weapon states could facilitate disarmament decisions. Taking the disarmament leap would involve fewer uncertainties and require less faith.

Acheson-Lilienthal referenced a variation on this theme, in the context of the necessity "to write into the charter itself a systematic plan governing the location of the operations and property of the Authority so that **a strategic balance** may be maintained among nations."[8] This strategic balance, they argued, would allow an effective response:

> The real protection will lie in the fact that **if any nation seizes the plants or the stockpiles** that are situated in its territory, **other nations will have similar facilities** and materials situated within their own borders so that the act of seizure need not place them at a disadvantage.[9]

One such model for this balance might be the kind of alliance structure currently used to provide collective security in the North Atlantic Treaty Organization (NATO) and elsewhere. A different kind of nuclear umbrella could be generated—one that relied on the presence of ENR capabilities or stockpiles of fissile material, rather than nuclear weapons.

The Future of Latency and Efforts to Manage It

Looking forward, what can or should be done about nuclear latency? There is no silver bullet for the problem, but there is always a need to refine approaches and develop better alternatives to the status quo. The objective should be to tolerate (or even encourage) latency where it is needed and develop attractive alternatives where it is not. A calibrated response—one that both supports nonproliferation and lays the groundwork for further arms reductions—should be pursued. Historical efforts for managing the strategic risks of nuclear weapons, from alliance formation to arms control, can point in directions worthy of examination.

A concerted international effort to deal with the NPT loophole is warranted. The pursuit of sensitive enrichment and reprocessing technology is often referred to as a sovereign right of states. (Article IV of the NPT, which grants states the right to benefit from peaceful uses of nuclear materials, is often referenced in this regard.)[10] Previous attempts to limit these rights have been difficult to advance. From the George W. Bush administration's attempts at outright prohibition to the adoption of "gold standard" approaches (where commitments are made to forgo ENR as part of bilateral agreements for cooperation), the record is mixed at best.

Although it is difficult to formally restrain such efforts, more can be done to remove incentives for pursuing them, at least as independent national efforts. Acheson-Lilienthal's effort to outlaw domestic ENR ownership and operation was a bridge too far, but can similar outcomes be gained voluntarily by other means?

It seems clear that states should have access to the benefits of ENR. It is also clear that this access to benefits does not necessarily mean access to capabilities.[11] There is no reason for each and every state to have an enrichment or reprocessing capability, regardless of the scale of its nuclear program. This makes sense in terms of economic efficiency as well as of security. Fuel banks have been established to address concerns over the availability of low-enriched uranium, and they are constructive, but they leave other issues unaddressed.

There is a potentially useful analogy with peaceful nuclear explosions (PNEs). When the potential benefits of PNEs were unknown, access to this service was ensured for nonnuclear-weapon states under the NPT. ENR could be treated in a similar fashion. Providers of these services could extend beyond the P5 (the five permanent members of the United Nations Security Council) to nonnuclear-weapon states, and in that way the benefits could have wider political participation and potential support. Such arrangements could be developed on a regional or global basis, aimed at achieving the "strategic balance" as described in Acheson-Lilienthal.

Although such ENR alliances may be of some potential benefit, they pose many implementation questions. How could such arrangements be organized? On what global basis could or should they be formed, taking into account geopolitical factors? What would a "stable" outcome look like? What are the regional implications? How could states be induced to join such ENR alliances? Would multinational ownership or operation be required? What other requirements might be established? These are all questions that would need to be addressed.

When in place, these latency arrangements could support monitoring and detection efforts. Any ENR-related activities taking place outside these efforts would provide clearer signals for detection, thus enabling states and international monitoring entities such as the International Atomic Energy Agency to focus their attention on potential problem areas. This effort could be combined with the notion of ENR-free zones, which would mirror nuclear-weapon-free zones. These would be voluntary commitments by states aimed at reinforcing the ENR arrangements and encouraging other states to take similar actions. A state could even champion its membership in an ENR-free zone as further demonstrating its commitment to nonproliferation.

Such arrangements nonetheless could be implemented in ways that would be at odds with nonproliferation objectives. Proliferators have engaged in technical collaboration in the past, and the ENR alliances should not be used to facilitate technology transfer to this end. Technical participation should be conditional on good standing in nonproliferation regime. It may be within a state's right to form such alliances, but they would necessarily be sanctioned by the international community. Likewise, where ENR facilities are to exist, they can be made "safer," with established requirements for responsible use. Enhancing detectability was an important theme in Acheson-Lilitenthal:

> . . . the Authority will be aided in the detection of illegal operations by the fact that it is not the motive but the operation which is illegal. Any national or private effort to mine uranium will be illegal; any such stockpiling of thorium will be illegal; the building of any primary reactor or separation plant will be illegal.[12]

This enhanced detectability is achieved through the organization of the fuel cycle itself, and the ENR alliances, but the concept applies at the facility level as well. The idea of improving the "safeguardability" of ENR plants has been discussed in governmental and academic fora, and is an area for continued improvement. Difficult-to-detect scenarios in which fissile materials might be diverted (or the facility might be misused) may be eliminated through clever design changes, or otherwise made readily discernable.[13] Such strictures can be made a requirement for new ENR facilities of the future.

A related but separate concept is the implementation of use controls in facility design. In Acheson-Lilienthal, an area identified for further work was the possibility of reversing decisions made about the domestic use of a technology if it was later determined to in fact be dangerous. The report asks the question: "How may safe activities, assigned to national hands, be withdrawn if new discoveries show them to be dangerous?"[14] In this context, physical means of halting a particular operation could be built into a facility design. If certain steps are taken to misuse the facility or divert material, it could be switched into safe shutdown mode. Such a concept raises many technical and other questions, but would pose an interesting design challenge.

Conclusion

The further expansion of indigenous ENR programs poses many nuclear security problems. As an international objective, the international community should strive to make them unnecessary, unprofitable, and appear out of place. Where they do exist, they should be part of a well-conceived and implemented regional approach, with an eye to enhancing stability, not undermining it. Such ENR centers could help manage stocks of direct-use material as well, mitigating what is perhaps the biggest concern for nuclear breakout. A cooperative global effort to eliminate surplus stockpiles of such material would be a productive first step toward managing current and emerging latency problems.

Endnotes

1 See Ariel Levite's chapter in this volume.

2 Detection of undeclared facilities was seen as relatively straightforward, owing to the fact that, at the time, it was presumed that large industrial facilities would be needed to proliferate and the

involvement of the international authority in all things nuclear would allow for detection.

3 *A Report on the International Control of Atomic Energy, Prepared for the Secretary of State's Committee on Atomic Energy* (Washington, DC: U.S. Government Printing Office, March 16, 1946), 49 (emphasis added).

4 See *Report on the International Control of Atomic Energy*, 30.

5 Ibid.

6 For example, as a practical reality, many power reactors have ample amounts of long-cooled spent fuel in their cooling ponds. The requirement to wait for short-lived radionuclides to decay before the recovery of plutonium does not exist. Such material is much easier to process in less-sophisticated chemical separation plants.

7 K. Budlong Sylvester and J. Pilat (Los Alamos National Laboratory), "Using 'State-Wide Consistency' as a Measure of Motivation to Proliferate," *Proceedings of the Annual Meeting of the Institute of Nuclear Materials Management (INMM)*, Phoenix, AZ, July 2005 (LA-UR-05-5184).

8 *Report on the International Control of Atomic Energy*, 36 (emphasis added).

9 Ibid., 49 (emphasis added).

10 The text also makes clear that this right should be exercised in conformity with nonproliferation commitments under the treaty.

11 There have been cases of failure in the past (e.g., Eurodif), but this does not suggest that these approaches should be dismissed for all time. The alternative of uncoordinated expansion of ENR remains unattractive.

12 *Report on the International Control of Atomic Energy*, 42

13 This notion also appeared in Acheson-Lilienthal, in reference to safe and unsafe features of design. "It [the Atomic Development Authority] would be in a position to insure that in the plan of operations, in the physical layout, in the system of audits, and in the choice of developments, full weight and full consideration can be given to the ease of detecting and avoiding diversion and evasion." Ibid.

14 *Report on the International Control of Atomic Energy*, 41.


VATTENFALL

From Nuclear Latency to Nuclear Reversal: The Case of Sweden

Thomas Jonter

Today, it might be hard to imagine that at the beginning of the 1960s, peaceful Sweden was close to putting together an atomic bomb. In fact, in U.S. military intelligence circles, Sweden was on the list of potential countries in line to become the fourth nuclear-weapon state. For example, in a speech in 1959, Senator John F. Kennedy identified Sweden as one of five potential proliferators (along with Canada, France, the People's Republic of China, and Switzerland) that could be the next nuclear weapon power. Kennedy, who became president of the United States in 1961, mentioned that Sweden was a likely candidate for that position since it had "doubled its budget in this field during the fiscal year." Military analysts and decision-makers in the United States feared that if a peaceful and neutral small state such as Sweden acquired nuclear weapons, other small states and middle powers might follow suit.[1]

To explain how Sweden's nuclear latency capability developed and why it shelved its nuclear weapon plans, one must analyze the relationships among five factors: the military, scientists, private industry, political decision-makers, and the

Left: Vattenfall, a Swedish energy company that owns most of the nuclear reactors in Sweden, and is a state owned company. Courtesy of Shutterstock.com.

United States.[2] The initial impetus to acquire nuclear weapons came from the military. In 1948, the chief of the defense staff commissioned the Swedish National Defence Research Institute (Försvarets Forskningsanstalt; FOA) to investigate the possibilities of manufacturing nuclear weapons.[3] The military wanted, for obvious reasons, to create as strong a Swedish defense capability as possible, and nuclear weapons were considered to be a vital ingredient in such a defense system. These plans, however, also had the support of a small faction within the Social Democratic government. Prime Minister Tage Erlander and Defense Minister Torsten Nilsson were clearly in favor of Swedish nuclear weapon acquisition in this early period. The main arguments in favor of Swedish nuclear weapons were that they would be necessary to deter the Soviet Union from attacking Sweden and to uphold Sweden's policy of political nonalignment.[4] The scientists were given the assignment to find out how Swedish nuclear weapons could be produced, and they had strong incentives to get funding to conduct research in a new and challenging research field.

In 1947, a government-controlled company, AB Atomenergi (AE), was founded to conduct nuclear-related research and development in Sweden. AE was responsible not only for nuclear research and development but also for the construction of reactors, uranium production plants, and heavy water plants. In 1949, the FOA and AE signed an extensive collaboration agreement. In general terms, the agreement stipulated that the FOA would be responsible for conducting overall research into nuclear weapons, including studies on the effects of such weapons. In a parallel effort, AE would draw up and provide basic information on the possible production of weapons-grade plutonium, and also would investigate the possibility of producing or procuring unsafeguarded heavy water—that is, heavy water that would not be subject to subsequent inspections by the supplying country. AE was also assigned the task of building reactors and a reprocessing plant, as well as the manufacture of the fuel elements to be used in the reactors for the production of weapons-grade plutonium. In other words, the civilian nuclear energy program was to be designed in a way that would enable Sweden to manufacture nuclear weapons if the Swedish Parliament were to vote in favor of such an option.[5]

Private industry also became an important actor because the Swedish nuclear weapon production fell under the aegis of the civilian heavy water reactor program. The large and capital-intensive heavy water program that served as the basis for both the civilian and nuclear-weapon programs was called "the Swedish line," for its ambition to become independent in the nuclear energy field. Private industry was not opposed to strong government involvement; as Swedish industrial leaders saw it, only the government had the financial resources to invest in such a long-term and capital-intensive project. However, they also felt that the government should neither infringe on free enterprise nor interfere with the rights of private companies to act and invest according to the principles of a free market. Some major private players in Sweden, such as a company called ASEA, also wanted to play leading roles in a future profitable nuclear market. A pattern of conflict was developing between the government and private industry about who should be the leading player in the national development of nuclear power and on what terms.[6] The goal of private companies such as ASEA was to produce electricity as inexpensively as possible to make a profit. This goal became hard to reconcile with the aim of producing plutonium of weapons-grade quality in heavy water reactors loaded with natural uranium, particularly when it became possible to purchase enriched uranium from the United States starting in the 1960s.

Swedish politicians had to tackle the question of whether Sweden should acquire nuclear weapons, and if such a decision would serve national security aims. This decision-making process was complicated by the fact that the politicians who decided on funding for nuclear weapon research and development were dependent on the scientists and the military for basic information about ongoing nuclear energy developments and security policy analyses. Without their expert input, it would not be possible for Swedish politicians to make well-founded decisions over time. However, these deliberations by the Swedish decision-makers did not take place in a vacuum. The surrounding world, especially the United States, had an important impact on how these plans for nuclear weapons developed. Despite the aim of the dual-use program, which was to find a solution to technical problems and to enable Sweden to become self-sufficient in terms of nuclear energy, it instead created a conflict between civilian and military goals as well as undesired leverage for the United States. As a consequence of incorporating the production of nuclear weapons into the civilian nuclear energy program, Sweden, despite intentions to the contrary, grew dependent on U.S. technology. This technological dependence on the United States increased over the years and provided the United States with leverage to dissuade Sweden from using its civilian nuclear program to produce weapon-grade plutonium.

> "As a consequence of incorporating the production of nuclear weapons into the civilian nuclear energy program, Sweden, despite intentions to the contrary, grew dependent on U.S. technology."

The dynamic relationships among these five actors affected the decisions made at the outset of Sweden's nuclear-weapon research program and influenced Sweden's eventual decision to refrain from acquiring nuclear weapons.

Laying the Groundwork: 1945-1957

The first comprehensive FOA study on the possible production of nuclear weapons by Sweden was completed in 1948. It concluded that plutonium would be preferable to U235 as nuclear material in explosive devices, and determined that it would take about eight years, and probably longer, to produce a nuclear weapon.[7] The next main FOA study on the issue would not be completed for another five years. This time, the FOA assigned the task to Dr. Sigvard Eklund, head of research at AB Atomenergi, who was later to become the second director general of the International Atomic Energy Agency (19611981). The 1953 study confirmed that plutonium was to be preferred to U235 for use in explosive nuclear devices. Contrary to the first study, new research indicated that heavy water was preferable to graphite for use as a moderator in reactors. This study also analyzed the preferred capacity of future reactors, as well as the required amount of uranium and heavy water, to be imported from Norway for this purpose. There were, however, no guarantees that Norway would be able to meet Sweden's requirements. Indigenous production was a possible alternative, but the report concluded that this would cause additional delays and costs.[8]

The FOA's third study on nuclear weapon production was completed in November 1955. As with previous studies, this one also found plutonium to be a better alternative than U235 in explosive devices, for three reasons. First, using plutonium would make it possible to build reactors that could be used for both producing energy and manufacturing nuclear weapons. Such a solution was also considered financially beneficial. Second, Sweden's limited personnel in the field of nuclear energy could thereby be put to more effective use. Third, progress could be made in civilian energy development, even if Sweden ultimately decided *not* to manufacture nuclear weapons.[9]

The study is a good illustration of the rapid pace of advancements in nuclear technology during this period. Swedish researchers were constantly making new discoveries in the field, owing to the United States' decision to release previously classified information under the Atoms for Peace program launched by President Dwight D. Eisenhower in 1953. The picture had become a great deal clearer since the 1953 study. Nuclear weapons weighing only about 100 kilograms (kg) containing 6 kg of plutonium were now being discussed, devices far lighter than those previously envisaged by the FOA. The new devices, which came to be known as tactical nuclear weapons, were considered easily transportable and easy to use in both missiles and torpedoes. The figures were not exact and, following subsequent research, were subject to revision. The 1955 study established that it was technically feasible from then on for Sweden to produce a nuclear weapon, provided it had access to plutonium.[10] In terms of technology, the plutonium question had been resolved, although the technical specifications would be modified in time. The FOA also had a clear picture of the steps involved in the production process and the approximate cost of the entire project in terms of capital, as well as scientific and technical expertise. Sweden already had a reactor, the so-called R1, which had been commissioned in 1954 and was located near the Royal Technical University in the center of Stockholm. FOA and AE staff also had developed considerable competence in the field. In addition, Sweden had large uranium ore reserves, albeit of a low grade. The evidence indicates that Sweden achieved a latent nuclear-weapon production capability around 1955, although subsequent research would lead to successive adjustments to production plans.[11]

But how were the nuclear warheads to be delivered? The weapon carrier systems that were discussed at that time were primarily the Swedish-built attack aircraft, such as the A 32A Lansen (Lance) and J 35A Draken (Dragon). The nuclear warheads would be carried by missiles. These planes were constructed by the Swedish company SAAB, itself an important part of the Swedish defense industry. In the mid-1950s, there was a new type of aircraft on SAAB's drawing boards, a supersonic bomber designated A 36. The idea was to construct the bomb bay of the A 36 so that it would be capable of carrying heavy nuclear weapons that could be dropped over Soviet territory. However, this project was cancelled in 1957.[12]

In 1957, the FOA presented a fourth study, completed in two stages, that presented elaborate design proposals and economic estimates for nuclear-weapon production and brought the weapons project into a new stage of preparedness.[13] Two reactors were of special interest for the plans to produce weapons-grade plutonium: the Ågesta nuclear power station south of Stockholm and the Marviken nuclear power station close to the city of Norrköping. The Ågesta station went into operation in 1963. The reactor was a prototype facility with a thermal output of 65 megawatts (MW), 55 MW of which were used for heating the Stockholm suburb of Farsta and 10 MW for electricity generation. The Marviken station was scheduled to be built during the 1960s.[14]

The Growth of Domestic and U.S. Opposition: 19581961

By 1958, Swedish nuclear-weapon research had reached the point whereby it was possible to make a political decision on the issue. In the meantime, the issue had become a complicated business for Prime Minister Erlander and his government. Growing criticism within the Social Democratic Party and in the media, along with an antinuclear-weapon grassroots campaign by the newly founded Action Group Against Swedish Atomic Weapons (Aktionsgruppen mot Svensk Atombomb; AMSA), forced Erlander to work out a compromise acceptable to proponents and opponents alike. Two reports were presented to the Riksdag for consideration. The first, known as the "device program," was to be implemented if Sweden indeed chose to acquire nuclear weapons; the second, called the "protection program," was to be used if the legislature rejected the development of nuclear weapons. This latter program would focus on research on civil defense preparations against possible nuclear attack, rather than on the design of a Swedish nuclear device.[15]

As stated in the "protection program" itself, the purpose of this alternative was to cover defense research needs. Extensive research would be needed to devise a plan for Sweden to be able to protect and defend itself against an enemy with nuclear-weapon capability. As part of this research, the plan was to first obtain knowledge of an aggressor's nuclear-weapon capability so that the Swedish defense forces could be configured in the best possible way. In the proposal, the government recommended that the protection program should be adopted because it was not yet the right time to make a final decision. The bill, which was approved by the Riksdag in July 1958, proposed that the FOA be given more funds to conduct protection research. Thus, the protection program was approved and the device program was rejected.[16]

What was the official position held by the other parties in the parliamentary debate in July 1958? Conservative Party leader Jarl Hjalmarsson declared that his party was in favor of the acquisition of tactical nuclear weapons only, but that the Conservatives would not be seeking a final decision on the matter at that time. The Liberal Party and the Centre Party toed the government line, also arguing that a decision on the matter would be premature, given the lack of answers to a number of technological questions. However, in the debate that followed, the main argument for a further postponement of the decision was the uncertainty surrounding the future security situation. The underlying consensus was that Sweden should adopt its policies to any changes in the security situation in the coming years, while continuing its defense research. With this approach, Sweden would have enough time to respond if the international situation were to deteriorate and a future assessment of security needs were to demand the acquisition of nuclear weapons.[17]

The growing political opposition to plans for the nuclear weapon began to affect Prime Minister Erlander himself. The evidence indicates that, as early as late 1957, he began to have doubts about equipping the Swedish military with nuclear weapons.[18] Irrespective of his personal convictions, Erlander prioritized the achievement of broad political consensus on the nuclear-weapon issue. This combination of factors meant the Social Democrats would make a joint decision on the matter with the three main political opposition parties in parliament, namely the Liberals, Conservatives, and the Centre Party. With this approach, Sweden would have enough time to respond if the international situation were to deteriorate and a future assessment of security needs were to demand the acquisition of nuclear weapons."[19]

From January 1957 on, Sweden was seated in the United Nations (UN) Security Council and played an active role in the work of the committee charged with nuclear disarmament issues. In the same month, Sweden advanced a proposal for a nuclear-test moratorium. Foreign Minister Östen Undén worked energetically to promote international disarmament during the next few years, greatly influencing public opinion in Sweden and also Erlander himself. At a government meeting in December 1958, Erlander voiced some skepticism in regard to the alleged benefits of nuclear weapons for Sweden. The Soviets might well feel provoked by such a move, Erlander argued, and perhaps feel forced to launch a preemptive nuclear attack on Sweden in the initial phase of a major war. Undén had advanced this argument in earlier discussions, and there is reason to believe that Erlander was gradually moving toward Undén's way of thinking, specifically that equipping the Swedish defense forces with nuclear weapons might actually jeopardize rather than enhance Sweden's security. Erlander continued to focus on gaining broad political consensus on the nuclear weapon issue, avoiding any public position on the matter, in the hope that the Social Democratic Party would eventually decide the matter in consultation with the Centre, Conservative, and Liberal parties. Even as he appeared to take the middle ground, Erlander encouraged grassroots opposition toward Swedish nuclear weapons at the same time, and this provided Undén and the Federation of Social Democratic Women with the opportunity to organize political grassroots campaigns against the idea. Similar to his actions on previous occasions, Erlander once again aimed to postpone the crucial decision, while still allowing weapons-related research to continue.

> "...Erlander once again aimed to postpone the crucial decision, while still allowing weapons-related research to continue."

Meanwhile, sentiment surrounding nuclear weapons had started to change in the Swedish Social Democratic Party in general. In November 1958, Erlander announced that a committee would take on the task of studying and evaluating the nuclear option. Erlander appointed members of both factions to form a study group called the Social Democratic Party Executive Committee for the Study of the Nuclear Weapons Issue. Internally, it came to be called the Atomic Committee, and was chaired by Erlander himself, with the objective of seeking a consensus position for the party.[20]

There was a great deal of mistrust within the group, however, and the summer and autumn of 1959 saw defamatory accusations and hasty departures from meetings.[21] Atomic Committee secretary Olof Palme, who would succeed Erlander as prime minister in 1969, worked hard to forge a compromise between opponents and proponents. In the end, Palme was able to propose a broader protection research program based on the assumption that Sweden would have breathing space at least until the mid-1960s, when international developments presumably would make Sweden's next steps clearer. In other words, a final decision would be postponed yet again, while protection-related research continued.

In December 1959, the study group presented its results in a report that would pave the way for future defense research. In addition to its policy recommendations, the far-reaching study discussed various technical solutions in relation to the possible manufacture of nuclear weapons. It is clear from the report that its authors had difficulties drawing a precise boundary between the vague concepts of "protection" versus "design" research. The study did, however, recommend that no design research should be carried out that was directly aimed at the manufacture of nuclear weapons. The report also drew another line to delineate acceptable activities for the existing protection program, stating that weapons-grade plutonium must not be used in the context of future defense research.[22] However, in practice, the FOA would still carry out studies on design research and prepare cost calculations on the possible production of nuclear weapons in the coming years. The concept of protection research served, for practical purposes, as a cover for continuing technical preparations that would enable Sweden to move quickly to nuclear weapon design should policy change. The Swedish parliament continued to support this "freedom of action" policy in subsequent years.[23]

Swedish Nuclear Weapons and the United States

How did the United States react to Sweden's plans to acquire nuclear weapons? As mentioned above, successive U.S. administrations strongly opposed Sweden's nuclear weapon plans. The main U.S. fear was that the risk of further nuclear proliferation in the world would increase substantially if a peaceful and democratic country such as Sweden were to acquire nuclear weapons. At the same time, Washington understood that Stockholm would be increasingly dependent on technological cooperation with the United States to support the development of its civilian nuclear energy program, which gave Washington some leverage in persuading the Swedish leadership to abstain from the military option. Furthermore, U.S.-Swedish defense cooperation had deepened during the second half of the 1950s, including the permission to procure and manufacture U.S. missile systems under license. This cooperation created an additional degree of Swedish dependence on the United States that further curtailed Stockholm's freedom of action. Owing to the increasingly intimate cooperation between the two states in the sensitive area of military technology, formal and (given Sweden's neutral status) primarily informal channels of communication emerged. Through this network, the United States discreetly communicated the acceptable limits of Swedish nuclear research from an American perspective in order for the cooperation to continue.[24]

It gradually became clear that this increased collaboration with Washington did indeed have its price, specifically less independence and reduced possibilities for integrating plans for nuclear weapon manufacture into the civilian heavy water program. One of the preconditions was that any nuclear components or materials supplied by the United States must not be used for military research. As Sweden's nuclear-related research and development became more dependent on U.S. assistance and collaboration, the United States found itself in a position to steer Sweden away from its military plans. One effective measure taken by the United States was to lower the price of enriched uranium at the end of the 1950s, which substantially reduced future fuel costs for operating light water reactors. This made it possible for private companies to start investing in light water technology, which was now competitive, as it was no longer necessary to spend a fortune on developing methods to enrich or process uranium. The light water technology now competed on the international market as a financially more feasible and reliable reactor system than the heavy water system. This measure weakened some of the prerequisites for producing nuclear weapons within a civilian nuclear program. The lower costs of enriched uranium from the United States also made it conceivable that the Ågesta and Marviken reactors would use this nuclear material in the future. If this was done, however, it would become more difficult to use these reactors to produce weapons-grade plutonium (although reactor-grade plutonium could be used in weapons). U.S. uranium supply policies thereby created commercial incentives to direct civilian nuclear programs such as Sweden's toward technologies that were far more difficult to divert for military purposes.[25]

The Gradual Abandonment of the Military Option: 1960-1968

By 1961, the Swedish military command was preparing the formulation of a new defense plan. The strong consensus within the military up to then, which was in favor of equipping the Swedish defense forces with nuclear weapons, was beginning to disintegrate. There were several reasons for this loss of unanimity. One cause was the competition between different branches of the armed services. Both the army and the navy feared that they would lose out in future struggles for budget appropriations, since the air force was expected to be awarded the bulk of additional nuclear-related budgetary resources given that nuclear weapons would be delivered by aircraft. But even within the air force, there were growing doubts about the advantages of having nuclear weapons. The air force had other costly projects to defend, among them the development of a new fighter aircraft. If the nuclear-weapon plan were implemented, these aircraft might have been discontinued or at least had their development budget reduced. This lack of consensus within the military was a key reason why the nuclear-weapon issue was not dealt with conclusively or in detail in the defense review known as ÖB62 ("Överbefälhavarens rapport 1962," or the supreme commander's report). Instead, the matter was delegated to a special secret review board, called the Nuclear Device Group, which enabled the military command to maintain a united front.[26]

In February 1962, the Nuclear Device Group presented its findings. In the published report, the group observed that the U.S. nuclear doctrine of massive retaliation, which had been in force up until then, was no longer operative. The Kennedy administration had put forward new ideas stressing the importance of conventional arms in a possible future conflict. It therefore was no longer deemed likely that nuclear weapons would be used to cause massive devastation to enemy territory in the initial stages of the next war. Most likely, nuclear weapons would be employed on a smaller scale for tactical purposes, based on ad hoc assessments of what the situation required—a doctrine later termed "flexible response." The apparent reduced role of nuclear weapons in the strategic thinking of the U.S. military catalyzed a general rethinking on the part of Swedish military planners.

"In the published report, the group observed that the U.S. nuclear doctrine of massive retaliation, which had been in force up until then, was no longer operative."

For practical purposes, the Nuclear Device Group's report findings implied a retreat from the hard line that the military had upheld, one that insisted that in the future Sweden's defense forces must be equipped with nuclear weapons in order to achieve a credible retaliatory capability for deterrence purposes. Despite this apparent retreat, the report underscored the importance of maintaining freedom of action, with the possible production of tactical weaponry as a fallback option. Some 100 tactical devices were envisioned, the first of which could be ready by 1972, unless steps were taken to accelerate the process.[28]

The ÖB62 report, also following the logic of flexible response thinking, advocated that Sweden enhance and expand its conventional military forces and capability, since in all likelihood an attack against Sweden would be carried out by conventional means. The report maintained, however, that Swedish nuclear weapons remained a viable option, but for practical purposes even the military was now discounting this possibility.[29] By the time of the supreme commander's next report, issued in 1965, the military had retreated even further from its earlier advocacy in favor of building nuclear weapons. The 1965 report stated that an acquisition decision would be foremost a political matter, and merely requested funds to continue nuclear-related research.[30] Why did the Swedish military stop pushing for nuclear weapons? Although this change can be attributed in part to waning domestic support for such a program (described more fully below), it also reflected a changed assessment of U.S. defense policies toward Sweden in the early 1960s, particularly concerning the expectation of U.S. assistance in the event of a Soviet attack.

Another important factor, likely the one that had the greatest influence on the change in the Swedish military command's attitude, was the position the United States took with regard to Sweden's plans to develop nuclear weapons. In 1960, the U.S. government had adopted a firm policy of opposition to any Swedish acquisition of nuclear weapons. Nonetheless, it recognized that it might need to assist Sweden in the event of Soviet aggression, a decision that opened the door to a possible security guarantee. These decisions emerged from discussions and decisions made by the National Security Council (NSC) during President Eisenhower's terms, following periodical reviews of policy toward various countries and regions. In April 1960, the NSC decided on a policy toward Sweden's plans for acquiring nuclear weapons. NSC 6006/1 stated that the United States should not "provide nuclear warheads; and [should] discourage Sweden from producing its own nuclear weapons."[31] According to the NSC's conclusions, it would be better for the whole Western world if Sweden channeled its resources into renewing and strengthening its conventional defenses instead of wasting resources on the development of nuclear weapons. From the U.S. perspective, Sweden formed part of the Western bloc, even though it was not a member of the North Atlantic Treaty Organization (NATO). If Sweden were to be attacked by the Soviet Union, it would be in the United States' national interest to assist Sweden: "In the event of Soviet Bloc aggression against Sweden alone, be prepared to come to the assistance of Sweden as a part of NATO or UN response to the aggression."[32]

In May 1962, a State Department planning paper entitled "Guidelines for Policy and Operations Sweden" replaced the NSC 6006/1 document from 1960.[33] The most noteworthy change was a new formulation of U.S. intentions in the event of a Soviet attack on Sweden: "In the event of Soviet Bloc aggression against Sweden alone, we should undertake to come to the assistance of Sweden as a part of NATO or UN response to the aggression." The formulation "be prepared" had been replaced by "should undertake," which implied a much stronger commitment. Many researchers have interpreted this statement as effectively extending a U.S. security guarantee to Sweden. If Sweden were to abandon its plans for developing nuclear weapons, the United States would in turn promise to place Sweden under the U.S. nuclear umbrella.[34] A 2002 Swedish security policy commission report referred to an unspecified 1962 document which, in the commission's view, contained the promise that Sweden would enjoy U.S. protection in the event of war and that Sweden was, for all practical purposes, under the umbrella of U.S. nuclear forces.[35]

There is, however, no documentation to prove a definitive U.S. commitment in 1962 to protect Sweden based on an actual agreement with the Swedish government. A closer look at the available sources reveals scant support for the alleged issuance of a U.S. security guarantee. For a number of reasons, such a guarantee would have been unlikely. First, an explicit security guarantee of that kind would have constituted unnecessary risk-taking on the part of the United States. Why promise the government of neutral Sweden something that the United States might not be able to provide in a real crisis situation? Second, given the official Swedish policy of nonalignment, it is unlikely that the Swedish government would have entered into any such agreement with the United States. It would have been a hazardous policy on Sweden's part to agree to any such arrangement, even in the absence of a formal agreement. However, there are indications that the Swedish military command perceived a change in U.S. attitudes, and that interactions and communications with leading U.S. military personnel were interpreted as some kind of strengthened defense commitment. Common defense planning and expanded technological cooperation in the military sphere between the United States and Sweden during the 1960s had established secret as well as direct lines of communication between the military command structures of both countries.[34] This perspective might also explain why the Swedish military changed its position so swiftly on the nuclear weapon issue, and opted instead to concentrate on developing Sweden's conventional defense capabilities. The fact that the ÖB62 report argued in favor of investing in strong conventional defenses in the future supports this interpretation, as does the fact that the secret Nuclear Device Group was skeptical of proposals to

> "If we disarm ourselves because of U.S. pressure, then we will become like Yugoslavia or Afghanistan's Taliban, to be beaten to death."

equip the Swedish defense forces with nuclear weapons. The evidence does not reveal whether the Swedish government was aware of any gentlemen's agreement between the U.S. and Swedish military apparatuses. For example, Prime Minister Erlander's diary contains no references to security guarantees—yet considering that he was such a diligent diarist, if Sweden had received such assurances from the United States, why would he have avoided mentioning such an important matter in his diary?In addition to a more determined nonproliferation stance by the United States, in the course of the 1960s Sweden became increasingly involved in international efforts to halt the spread of nuclear weapons altogether. At the UN and through regional cooperative efforts, Sweden advanced proposals aimed at creating nuclear-weapons-free zones and achieving nuclear disarmament. For example, in October 1961, Foreign Minister Undén put forward a proposal to create an "Atom-Free Club" in the UN General Assembly. This idea, soon known as the Undén Plan, encouraged states that did not have nuclear weapons to further commit themselves to "abstain from developing, acquiring or, on another party's account, storing such weapons." On December 4, 1962, the General Assembly adopted a resolution based on Undén's proposal. The Undén Plan must be understood as part of a more ambitious strategy aimed at the ultimate objective of full and comprehensive nuclear disarmament. By having the non-nuclear countries form such an Atom-Free Club, Undén and his supporters hoped to pressure the existing nuclear powers into entering negotiations on a nuclear test ban treaty, in itself considered an important step on the path toward complete nuclear disarmament.[37]

The Swedish commitment to nuclear disarmament could also be seen in to the context of what Nina Tannenwald describes as a new emerging international social environment, where the nuclear taboo had become "part of a broader discourse—a set of practices—of international law and diplomacy of the society of states, which defines what it means to be civilized member of the international community."[38] The international commitment to nuclear disarmament, channeled through the UN and the international peace movement, strengthened the arguments against Swedish nuclear weapons and enabled Undén and Swedish antinuclear activists such as AMSA and the Social Democratic Women's Association to take more assertive positions in this new international social environment. Maria Rost Rublee argues that all of these initiatives and actions resulted in an emerging nonproliferation norm. The nonproliferation norm also had an impact on Swedish decision-makers; the international commitment to nuclear disarmament affected the domestic political debate in Sweden to the extent that even the Conservative Party was beginning to adjust its position. Overall, public opinion further supported the position that Sweden should abstain from acquiring nuclear weapons, as reflected both in the positions taken by the political parties and in the general public debate in the early 1960s.[39] The Swedish rollback can be described as a nuclear reversal process, explained by Ariel Levite as a phenomenon that often begins "slowly and hesitantly and proceed incrementally. . . . [and] rarely if ever cemented until the trade-offs are apparent and the risks of the decision minimized."[40] Most states do not make formal decisions to acquire nuclear weapons before this stage has been reached. Accordingly, state leaders do not formally express that they have given up their plans for nuclear bombs before they have to, because such premature formal commitments are politically risky and, even more important, not politically and strategically necessary.

After 1965, when ASEA ordered Sweden's first light water reactor, the civilian nuclear energy program proceeded with little regard for military requirements. In 1966, an the United States and Sweden signed an agreement in which the United States guaranteed that it would deliver enriched uranium to Sweden until 1996. The intention was to load the Marviken reactor with enriched uranium. This meant that Sweden would have to set up a parallel and purely military reactor program in order to be able to produce nuclear weapons in the future. For this reason, the military leadership felt that it had to pursue a policy of phased procurement to enable access to the necessary nuclear technology and nuclear materials of weapons-grade quality if the policy of freedom of action was to be sustained. The Swedish government, however, in its 1966 planning, refused to continue with this policy, and thus Sweden's nuclear-weapon planning effectively was discontinued.[41] In 1968, the Swedish parliament voted no to Swedish nuclear weapons, and Sweden signed the Treaty on the Nonproliferation of Nuclear Weapons (NPT) in August of that year. Sweden's nuclear- weapon aspirations were now definitely dead and buried. Finally, in 1970, Sweden ratified the NPT.

How far had the FOA progressed in its research by the time the nuclear-weapon plans were abandoned? In principle, and from a technical point of view, the FOA knew exactly what to do, and in theory the country had reactors and domestic uranium ores in place that could have been used. However, Swedish also was missing some important ingredients of a functioning production chain, namely a reprocessing facility and adequate amounts of heavy water unbound by safeguard inspections. Technically, it would have been possible to manufacture a single nuclear explosive device, given the availability of weapons-grade plutonium, but a single device hardly would have constituted a weapons program of serious intentions. By all accounts, after completion, the planned program would have included about 100 nuclear warheads. Within the framework of such a large-scale serial production program, it probably would have taken Sweden several more years to manufacture its first nuclear device. Sweden also had not solved the problem of the delivery system. Even though some installations were prepared to equip Swedish attack aircraft with nuclear weapons, additional technical arrangements were needed to solve the problem.

Conclusion

Over time, the postwar Swedish strategy to incorporate the production of weapons-grade plutonium into the civilian nuclear energy program became unfeasible. In the face of the problematic and time-consuming efforts to reconcile civilian and military nuclear objectives, the Swedish nuclear effort, despite government intentions to the contrary, became dependent on U.S. technology. This technological dependence increased over time and afforded the United States the opportunity to steer Sweden away from efforts to produce weapons-grade plutonium through its civilian nuclear energy program. Another consequence of the choice to integrate the production of nuclear weapons into the civilian nuclear energy program was that different sectors of Swedish society had time to form and articulate critical assessments of and resistance to nuclear-weapon plans, especially in those sectors where critical political and technical decisions were taken. The fact that that in the end, Prime Minister Tage Erlander allowed an open debate on the issue made this political resistance possible and relevant. The vigorous public debate over nuclear weapons prompted leading politicians to rethink their positions and put forward new arguments for Sweden's defense planning, which led to a profound change in the way in which decision-makers regarded the acquisition of nuclear weapons. International nuclear disarmament discussions and the emerging nonproliferation regime also affected Swedish public discussion and strengthened the arguments against the country's nuclear-weapon ambitions, and at last paved the way for Sweden to say "no" to acquiring nuclear weapons.

Endnotes

1 Remarks of Senator John F. Kennedy at Dave Epps Memorial Dinner in Portland, Oregon, August 1, 1959, John F. Kennedy's Speeches, John F. Kennedy Presidential Library and Museum, https://www.jfklibrary.org/archives/other-resources/john-f-kennedy-speeches/portland-or-19590801.

2 On U.S. policy toward Sweden's nuclear weapons plans, see Thomas Jonter, "The United States and Swedish Plans to Build the Bomb, 1945–68," in *Security Assurances and Nuclear Nonproliferation*, ed. Jeffrey W. Knopf (Stanford, CA: Stanford University Press, 2012), 219–45.

3 For an overarching analysis of the Swedish nuclear weapon plans, see Thomas Jonter, *The Key to Nuclear Restraint: The Swedish Plans to Acquire Nuclear Weapons, 1945 1975* (London: Palgrave Macmillan, 2016).

4 Swedish National Defence Research Agency (FOA), Incoming documents 1948 E III a, vol. 4, H 35, the FOA archive, Stockholm (hereafter FOA archive).

5 For example, in his memoirs the Swedish Social Democratic prime minister Tage Erlander writes that for several years in the late 1940s and early 1950s, he supported a nuclear weapons program for Sweden. Tage Erlander, *1955–1960* (Stockholm: Tiden, 1976), 75 et passim.

6 "Överenskommelse" [The Agreement], H 129, October 30, 1950, FOA archive.

7 On the conflict between the Swedish government and private industry, see Maja Fjaestad and Thomas Jonter, "Between Welfare and Warfare: The Rise and Fall of the 'Swedish Line' in Nuclear Engineering," in *Science for Welfare and Warfare: Technology and State Initiative in Cold War Sweden*, eds. Per Lundin, Niklas Stenlås, and Johan Gribbe (Sagamore Beach, MA: *Science History Publications*/USA, 2010).

8 It was estimated that it would take 2 years to set up the mining and production operation; 5 to 10 years to produce 500 to 1,000 tons of uranium at a production capacity of 100 tons per year; and 1 year to produce bombs ready for use. FOA, Outgoing documents 1948 B IV, Volume 4, H 35:2, FOA archive.

9 "Preliminär utredning av betingelserna för framställning av atombomber i Sverige" [Preliminary investigation of the conditions for the production of atomic bombs in Sweden], 1953-03-05 H 4011-2092, FOA archive.

10 Torsten Magnusson, "Utredning av betingelserna för framställning av atomvapen i Sverige" [Inquiry into the conditions for the production of atomic weapons in Sweden], November 25, 1955, 87-H 163:1-21A, FOA archive.

11 Ibid.

12 *Latent capability* is the term widely used in international literature to denote a state that has the capability and components to build nuclear weapons, but has not yet done so. See Stephen M. Meyer, *The Dynamics of Nuclear Proliferation* (Chicago: University of Chicago Press, 1984).

13 Lennart Berns, "A 36 – SAAB:s atombombare avslöjad" [The A36 – SAAB's nuclear bomber unveiled], *Flygrevyn* no. 4 (1991).

14 The basis for the commission report "Svensk kärnvapenforskning 1945 1972" [Swedish nuclear weapons research 1945 1972] (Stockholm 1987); "Rapport över Etapp 2:1 av utredningsuppdrag beträffande reaktorer för produktion av vapenkvalitet" [Report on Stage 2:1 of investigation assignments regarding reactors for production of weapons quality], July 1, 1958. The report is still classified

15 Thomas Jonter, *Nuclear Weapons Research in Sweden: Cooperation Between Civilian and Military Research, 1947 1972*, SKI Report 02:18 (Stockholm: Nuclear Power Inspectorate [SKI; Statens kärnkraftinspektion], 2002).

16 FOA, "Forskningsprogram för framtagande av underlag för konstruktion av atomladdningar" [Research program for the production of basic information for the design of atomic explosive devices], July 4, 1958, H 4041-2092, FOA archive.

7 Bill 1958:110; SU B 53; rskr. B 83.

18 Speech by Hjalmarsson, Riksdag (RD), Andra Kammaren (AK), July 29, 1958, no. Bilaga (B) 6, 23; Speech by Heckscher, 87–88; Ståhl, 80; Osvald, 81–82, RD, AK, July 29, 1958, no. B 6; Speech by Aastrup, 56; Ståhl, 80; Osvald, 81–82, RD, AK, July 29, 1958, no. B 6.

19 For example, in December 1957 Erlander mentioned to Undén that he had started to have second thoughts about acquiring nuclear weapons: "There was a discussion about atomic weapons. Erlander explained that he had been a supporter of Sweden having tactical nuclear weapons in its defense forces, but he had now come to an almost opposite view." Östen Undén, *Östen Undén: Anteckningar* [Östen Undén: Notes], vol. II: 1952–1966 (Stockholm: Kungl, 2002), 579.

20 Jerome Garris, "Sweden's Debate on the Proliferation of Nuclear Weapons," *Cooperation and Conflict* 8, no. 4 (1973), 192.

21 Anna-Greta Nilsson Hoadley, *Atomvapnet som partiproblem: Sveriges socialdemokratiska kvinnoförbund och frågan om svenskt atomvapen 1955-1960* [Nuclear weapons as a party problem: Sweden's Social Democratic Women's Association and the issue of Swedish nuclear weapons, 1955 1960] (Stockholm: Almqvist & Wiksell International, 1989), 36.

22 Karl Molin, "Party Battle and Party Responsibility: A Study of the Social Democratic Defense Debate," in *Social Democratic Society: 16 Researchers on Social Democratic Policy and Society,* eds. Klaus Misgeld, Karl Molin and Klas Åmark (Stockholm: Tidens förlag, 1989), 335.

23 Sveriges socialdemokratiska arbetareparti. Kommitté för Studium av atomvapenfrågan, *Neutralitet, Försvar, Atomvapen; Rapport till Socialdemokratiska Partistyrelsen* [Neutrality, defense, nuclear weapons: Report to the Social Democratic Party] (Stockholm: Tiden, 1960).

24 Thomas Jonter, "Sweden and the Bomb: The Swedish Plans to Acquire Nuclear Weapons, 1945-1972," SKI Report 01:33 (Stockholm: SKI, 2001), 45-53.

25 Two government commissions have investigated U.S.-Swedish military technological cooperation during the Cold War, *Om kriget kommit: förberedelser för mottagande av militärt bistånd 1949-1969* [If war had come: Preparations for the reception of military assistance, 1949 1969] (Stockholm: Statens offentliga utredningar [SOU], 1994). For an English summary of the report, see *Had There Been a War . . . Preparations for the Reception of Military Assistance 1949-1969. Report on the Commission of Neutrality* (Stockholm: Fritzes 1994); Fred och säkerhetr. S*vensk säkerhetspolitik 1969-1989: Slutbetänkamde.* [Peace and security: Swedish security policy 1969-1989: Final thoughts] Del 1. (Stockholm: SOU, 2002), 108. See also Jonter, "The United States and Swedish Plans to Build the Bomb"; and Mikael Nilsson, *Tools of Hegemony: Military Technology and Swedish-American Security Relations 1945-1962* (Stockholm: Santerus Academic Press Sweden, 2007).

26 Jonter, "The United States and Swedish Plans to Build the Bomb," 237.

27 Wilhelm Agrell, *Svenska Förintelsevapen: Utvecklingen Av Kemiska Och Nukleära Stridsmedel 1928 1970* [Swedish weapons of mass destruction: The development of chemical and nuclear weapons 1928-1970] (Lund: Historiska media, 2002), 281-87.

28 "Kärnladdningsgruppens betänkande" [Report of the Nuclear Device Group], HH 006, FOA archive.

29 ÖB 62 [Supreme Commander's 1962 Report], 66.

30 ÖB 65: Utredning om et militära försvarets fortsatta utveckling [Supreme Commander's 1965 Report: Investigation on further development of military defense], Stockholm, 1965.

31 "Statement of US Policy toward Scandinavia (Denmark, Norway and Sweden)," NSC 6006/1, April 6, 1960, in U.S. Department of State, *Foreign Relations of the United States, 1958–1960: Western Europe*, vol. VII, part 2, eds. Ronald D. Landa, James E. Miller, David S. Patterson, and Charles S. Sampson (Washington, DC: U.S. Government Printing Office, 1993), Document 300.

32 Ibid.

33 Bromley Smith Notice to holders of NSC 6006/1, "Recission of NSC 6006/1, U.S. Policy Toward Scandinavia (Denmark, Norway and Sweden), dated April 6, 1960," May 2, 1962, Lot File 63 D 351, Records Relating to Department of State Participation in the Operations Coordinating Board and the NSC, 1947-1963, Box 99, RG 59, U.S. National Archives and Records Administration (College Park, MD).

34 Agrell, *Svenska Förintelsevapen*, 303.

35 *Fred och säkerhet,* 108, part 1, 221-23.

36 Agrell, *Svenska Förintelsevapen*, 303.

37 Stellan Andersson, *Den första grinden: svensk nedrustningspolitik 1961-1963* [The first gate: Swedish disarmament policy, 1961 1963] (Stockholm: Santérus Förlag, 2004), 86.

38 Nina Tannenwald, *The Nuclear Taboo: The United States and the Non-Use of Nuclear Weapons since 1945* (Cambridge: Cambridge University Press, 2007), 46.

39 Maria Rost Rublee, *Nonproliferation Norms: Why States Choose Nuclear Restraint* (Athens: University of Georgia Press, 2009), 34–52. In her study, Rublee compares several countries that abstained from acquiring nuclear weapons. With regard to Sweden, Rublee argues that the emergence of a nuclear nonproliferation norm in combination with the growing opposition within the Social Democratic Party created a new national view of nuclear weapons, which in the end made it impossible for the Swedish government to go nuclear.

40 Ariel Levite, "Never Say Never Again: Nuclear Reversal Revisted," *International Security* 23, no. 3 (2002/03): 59 88.

41 Bill 1966:1, Appendix 6, 188 et seq.

Italy as a Hedging State? The Problematic Ratification of the Nonproliferation Treaty

Leopoldo Nuti

Since the mid-1950s, the Italian approach to the growing importance of nuclear weapons in international relations was based on the aspiration to reach a parity of status with the other Western European countries. As a consequence, Italy had a remarkably hostile reaction to the Treaty on the Nonproliferation of Nuclear Weapons (NPT), which was perceived as a direct threat to the achievement of this goal. The signature and the ratification of the NPT, therefore, turned out to be some of the most difficult foreign policy decisions the Italian government had to face after the crucial choices of the early postwar years. This chapter attempts to provide a plausible explanation for the intensity of the debate that the NPT stimulated, and more specifically for the actions that the Italian government took during the long delay between the signing (1969) and the ratification (1975) of the treaty. During that period,

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Left: 12 June 1968, the General Assembly adopted resolution 2373
Source: http://legal.un.org/avl/ha/tnpt/tnpt.html

in fact, there were parallel efforts to bolster Italy's status in such fields as uranium enrichment and nuclear naval propulsion, which plausibly can be interpreted as an attempt to achieve a latency status. The diplomatic ploy to indefinitely postpone the NPT ratification that took place in 1974 and 1975 confirm the plausibility of this interpretation, as it clearly was a last-ditch attempt to preserve some freedom of maneuver. A vitriolic debate in the Italian media and a concerted effort from some of Italy's key allies, however, eventually forced the government to ratify the treaty in May 1975.

Italy and Nuclear Weapons

From the mid-1950s, the Atlantic Alliance's increasing reliance on nuclear weapons generated serious concern in the Italian government. Always sensitive to their country's ranking in the international system, Italian diplomats realized early on that the strategic choices of the Dwight D. Eisenhower administration threatened to reinforce the existing hierarchy among North Atlantic Treaty Organization (NATO) members. Countries that had some form of access to the new weapons inevitably would be placed in a position of higher responsibility inside the alliance, as they would be the ones to make the crucial decisions about their use in case of war; while NATO's nonnuclear members would be further sidelined. Such a challenge ran against one of the main goals of postwar Italian foreign policy, namely the restoration of a position of parity with the other European powers.

The solution that the Italian government developed to meet this new challenge was to resort to the same multilateral approach that had been one of the hallmarks of its foreign policy since the late 1940s. To achieve a nuclear status, Italy should rely on a strategy of cooperation, mainly with the United States but also, if and when possible, with other Western European countries. This policy was based on the assumption that the United States eventually would share its weaponry with its allies and that NATO would be the logical framework to establish some form of multilateral nuclear integration. Consequently, throughout the 1950s all Italian governments repeatedly accepted the deployment of U.S. atomic weapons on Italian territory. At the same time, the lingering doubts that the United States might not, after all, decide to fully share its nuclear technology made Italy pursue a parallel track. A possible European cooperation on the military applications of nuclear energy seemed a logical step, albeit not always an easy one for a country that was deeply committed to the construction of Europe and was engaged in building a European Community for the civilian use of the atom. The idea of a European bomb, therefore, constantly loomed in the mental landscape of the Italian foreign-policymaking elite: sometimes as an alternative to the Atlantic one, when the United States seemed to backtrack from a policy of nuclear sharing, sometimes as the necessary step to reinforce the European pillar of the Alliance. What was clear, in any case, was that a national choice seems to have been repeatedly excluded. The available documentation shows that whenever nuclear issues were discussed at the highest level by the Supreme Defense Council, the conclusion was always the same. No single NATO country in Europe—be it a nuclear or nonnuclear-weapon state—could afford to deploy an effective atomic deterrent all by itself. A collective effort was needed, with much support from the United States, which had to be convinced that an integrated Atlantic force was in everybody's best interest.[1]

For the rest of the decade and into the early 1960s, this policy did not change, even though the John F. Kennedy administration took a much more hesitant approach to nuclear sharing. Perplexed as they were by a number of choices that the U.S. government took, Italian diplomats saw no alternative to relying on its major ally for achieving a nuclear status. Uninspiring as it might have been, the Multilateral Force proposed by the Kennedy administration had to be accepted without too many illusions, wrote Adolfo Alessandrini, the Italian ambassador to the North Atlantic Council. It was "the only possible way we can insert ourselves, namely through the cooperation with the United States, in the world of nuclear strategy."[2]

The same attitude shaped the Italian response to the proposal of U.S. Secretary of Defense Robert McNamara to strengthen the alliance's nuclear-planning process. Until the very end of 1966, therefore, Italian nuclear aspirations centered around the principle of achieving some sort of parity with the other major European countries inside NATO. What is more important, Italy supported arms control and disarmament policies, but with the clear understanding that they should not jeopardize its national aspirations. "Our goal is disarmament," said Italian president Giovanni Gronchi to the Supreme Defense Council in December 1957, "but as long as we do not get there, we have the duty to adequately defend ourselves." As late as June 1966, the point was firmly repeated by Prime Minister Aldo Moro in his instructions to Foreign Minister Amintore Fanfani: none of the disarmament proposals discussed at the Eighteen Nation Disarmament Conference in Geneva should affect the "collective nuclear projects" that Italy supported.[3]

"The document basically cut the Gordian knot between nuclear sharing and nonproliferation by making clear that the United States preferred the latter to the former."

This world view, and the assumptions on which it was based, came under severe strain by late 1966, when the United States circulated a new draft for a nonproliferation treaty at the Geneva conference. The document basically cut the Gordian knot between nuclear sharing and nonproliferation by making clear that the United States preferred the latter to the former, much to the chagrin of its nonnuclear allies. Finally accepting the Soviet point of view that the dissemination of nuclear weapons inside NATO was indeed a case of proliferation, Article 1 of the new draft stated that nuclear states should not transfer nuclear weapons "to any recipient whatsoever"— a comprehensive formulation that clearly included the Atlantic Alliance. As more contents of the new draft became known, the Italian government was horrified to discover that many of the premises on which its nuclear aspirations had been conceived were being wiped out by none other than its foremost ally. The indignant reactions by most politicians and diplomats show how widespread this feeling of betrayal was, from the president of the Republic to most of the diplomatic corps. At the same time, while there were some grumblings about a *national* option or a possible rejection of the treaty, the official position of the Italian government was to change as much of the new U.S. draft as possible but without opting for any radical alternative. For the next two years, until it signed the NPT in January 1969, the Italian government saturated the Lyndon B. Johnson administration with a plethora of requests for modifying the treaty, perhaps secretly hoping that its demands would help make sure that it never saw the light of day.

An Expanding Array of Nuclear Activities

At the same time, the government and the National Nuclear Energy Committee (Comitato Nazionale per l'Energia Nucleare; CNEN) stepped up the tempo of Italian activities in the civilian nuclear sector. This initiative can be explained by a number of reasons that appear to have little to do with the NPT. Some, as a matter of fact, might have taken place even if there had been no treaty at all, and they may be interpreted as the results of independent historical and technological processes. The coincidence, however, is remarkable, and what limited documentary evidence is available makes one wonder if the government authorized the CNEN to probe the limits of the nuclear order being created under the NPT. In an aide-memoire handed to the U.S. Arms Control and Disarmament Agency (ACDA) director William Foster in March 1967, for instance, the Italian government raised several questions about what specific technological developments the NPT could or could not banish.[4] Two of these points in particular are worth exploring more in depth, as they reflect Italian aspirations to play a larger role in nuclear matters: specifically, joint enrichment projects and naval propulsion.

At the crucial time when the negotiations for the NPT were coming to a head, there was a strong resurgence of interest in uranium enrichment across Western Europe. From a technical and economical point of view, there was a concrete fear of a bottleneck in the fuel supply for what seemed at the time the growing demand of the European nuclear sector. By the mid-1960s, almost all the nuclear fuel for European reactors was safeguarded natural uranium coming from the United States through a U.S. agreement with the European Atomic Energy Community (Euratom). The United States, however, was planning to switch from natural uranium reactors to light water ones that would require enriched (rather than natural) uranium as fuel. The Europeans, who planned a similar switch, worried lest in the future the United States might not be able to produce the increased amount of low-enriched uranium necessary to support their own expanding nuclear sector—a fear, incidentally, that turned out to be all too real when in June 1974 the Nixon administration temporarily suspended the export of low-enriched uranium.[5] On top of all this, the impact of the June 1967 Six-Day War and the consequent threat of a critical shortage of Middle Eastern oil supplies hastened the European interest in a possible independent source of nuclear fuel.

Almost simultaneously, a remarkable technological shift would remove one of the major obstacles to the construction of a European enrichment plant. Until then, the sheer cost of building a gaseous diffusion plant had helped temper

European interests in having an independent source of enriched uranium. By the mid-1960s, however, a number of European governments had made significant inroads into the new technique of centrifugal enrichment, which promised to be remarkably cheaper than its previous alternative. By early 1967, the British, Dutch, and German governments had all reached this conclusion, and the last two had actually said so in public in a meeting of the European Atomic Forum, the association of European nuclear industries.[6] The three governments would soon start a negotiation to set up a joint consortium that eventually led to the Treaty of Almelo in 1970 and the establishment of Uranium Enrichment Consortium (URENCO).[7]

A whole web of parallel and multilateral negotiations accompanied these developments. At the end of 1965, the British suggested reactivating and expanding their gaseous diffusion plant at Capenhurst and asked the West German government whether it might be interested in participating in the project.[8] In May 1967, the Germans enquired whether the French might be interested in expanding their own military enrichment plant at Pierrelatte into a civilian facility with German support,[9] and at the end of the same month the Euratom Commission approved a memorandum that officially recommended the creation of a European enrichment plant. The rise in the number of light water enriched uranium reactors, the memo argued, would put a strain on the capacity of the U.S. fuel supply to Europe, and neither the expansion of Capenhurst nor that of Pierrelatte, if done at a national level, would be able to meet the resulting gap.[10]

As these projects unfolded, in June 1967 the CNEN approved a document that indicated its interest in the long-term procurement of uranium supplies, including participation in international initiatives.[11] Simultaneously, the CNEN's director for external relations, Achille Albonetti, outspokenly advocated the creation of a European enrichment plant. It was a necessary step, he wrote in a number of editorials, to give Europe the necessary independence in such an advanced technological field and to bridge the growing gap between Europe and the United States.[12] He even hinted that such a nuclear Europe could develop its own weapons and use them as leverage to obtain the disarmament of the other nuclear powers. Even if this ambitious military goal could not be accomplished, Europe still needed a joint enrichment plant, and any opportunity had to be exploited. In one of his articles, for instance, he encouraged the United Kingdom to share its nuclear know-how and its nuclear hardware with its European allies.[13]

> "...the CNEN also started exploring the opportunity to cooperate with the United Kingdom in the field of centrifugal enrichment."

The other key figure to fully endorse a European plant was the minister of industry and president of the CNEN, the influential Christian Democrat politician Giulio Andreotti. At the December 1967 Euratom Council meeting, he strongly declared his approval of such an initiative, and he seems to have been the main supporter of the council's decision to set up a study group to assess Europe's supply situation as well as to make some recommendations on the matter.[14] Simultaneously, at the national level he urged the CNEN "to take action as soon as possible" in the field of securing uranium supplies, because "there was a remarkable flourishing of initiatives worldwide" and "by waiting any longer, there was a risk of finding all possible channels closed."[15] By the end of 1967, there was enough interest in uranium enrichment for the CNEN to decide to create an intergovernmental agency, the Italian Enriched Uranium Group (Gruppo Italiano Arricchimento Uranio; GIAU), with the task of coordinating the research and the initiatives of all the private and public companies working in this field.[16] On August 2, 1968, the government's Interministerial Committee for Economic Planning (Comitato Interministeriale per la

Programmazione Economica; CIPE) officially decided that Italy should participate in the construction of a European enrichment plant, stating that such an opportunity could not be missed.[17] Not long afterwards, the CNEN also started exploring the opportunity to cooperate with the United Kingdom in the field of centrifugal enrichment. By the end of 1968, the British hinted to the Italians that they were willing to discuss the possible participation of any fourth country to the tripartite arrangement they had been negotiating with the Germans and the Dutch. The Italians were pleased and took the offer seriously, declaring that they wished to be considered as "full partners from the start."[18]

Both these initiatives failed. The Euratom idea never really took off, repeating the fiasco of the first attempt during the treaty negotiations in the mid-1950s. As for joining URENCO, the British seemed interested in opening up the partnership to the Italians but met with a certain resistance from the other two members of the consortium, who were not ready to grant Italy full affiliation.[19] Italy (and Belgium) were invited to "associate" themselves with the other three countries "through a 10 per cent in the Enrichment Organization and 5 per cent in the Prime Contractor," but were excluded by the policymaking Joint Committee.[20] The risk of joining as an unequal partner, coupled with some perplexities about the ultimate success of a new technology, toned down the Italian interest in the project.[21] Some lengthy negotiations eventually succeeded in defining the draft of a possible intergovernmental agreement between the URENCO group and Italy, and by late 1973 Albonetti wrote to Andreotti that he saw some indication that the three partners might eventually change their attitude toward Italy's full membership. For the time being, however, Albonetti recommended that it would not be wise to rely entirely on such a flimsy perspective, particularly because there was another opportunity to enter the field of uranium enrichment as a full partner of another consortium.[22]

In June 1971, the Italian government had approved the development of a parallel negotiation to associate Italy with another project in the field of uranium enrichment, and entered a negotiation with the French Atomic Energy Commission (Commissariat à l'Energie atomique; CEA) to define the possible participation in the French project for the expansion of Pierrelatte, what would later be called EURODIF.[23] In December 1971, the Italian Parliament approved a law that restructured the CNEN and allowed it to participate in international consortia working on the industrial development of peaceful uses of nuclear energy. In January 1972, the CNEN and the CEA signed a memorandum of understanding that granted Italy a participation in 22.5 percent of EURODIF's activities, a quota that would be later extended to 25 percent when Sweden opted out of the consortium. By the end of the following year, the Italian government was called to make the final decision about financing its share of the project, and Albonetti wrote to Andreotti to recommend reaching a positive conclusion as quickly as possible.[24] After a somewhat difficult debate, the CIPE approved the memorandum on December 24, 1973. Albonetti actually believed that the Italian decision rescued the entire project, as the French initiative seemed to be faltering with no other major European partner to support it.[25]

Clearly, Italy tried hard to join *both* projects, and above all it considered it of paramount importance to avoid any fracture between them. According to a 1973 Foreign Ministry memo, the Italian goal was actually to eventually merge the two projects into a common European agreement.[26] This broad approach was confirmed by the fact that Italy also joined the Association for Centrifuge Enrichment, an international study group on various aspects of centrifuge plant usage (including technology, construction, and finance) that was set up on June 1, 1973, partly to reply to an initiative from the European Community (EC) Commission that was trying to reconcile all the different projects.[27]

What needs to be highlighted here is the coincidence of the upsurge of a strong interest in the field of enrichment with the progress of the negotiations of the NPT. A number of economic and technological factors influenced this acceleration, but the impact of the concerns engendered by the NPT should not be underestimated. In April 1967, for instance, an internal Foreign Ministry memo stressed that the NPT draft would impose severe controls on any Italian initiative in the field of uranium enrichment or of plutonium reprocessing.[28] And in 1973, the Foreign Ministry highlighted the need for Europe to have an autonomous enrichment capacity that would make it fully independent from any existing oligopolies—a belief which, as shown earlier, Albonetti firmly shared.[29]

The research and development level also went through a similar determination. Throughout these years, Italy developed an intense enrichment research program, with the CNEN studying and producing a number of components for a gaseous diffusion plant (in particular, compressors and barrier supports, but also less technologically advanced equipment), while also continuing to carry out its own research on centrifuges. As long as there was no certainty that EURODIF would actually see the light, the CNEN worked on centrifuges with some alacrity, in order "to demonstrate the feasibility of machines which, despite their low unit capacity," might allow the production of enriched uranium at relatively accessible market prices. According to a 1977 report, the objective was reached "in part with the tests on enrichment in UF/6 of machines with small-size steel rotors, thus making it possible, also, to test theoretical forecasts and acquire an understanding of the process as a whole." After EURODIF was created, however, research on centrifuges continued at a slower pace, and gradually was placed on the backburner but not totally abandoned. Some interesting work also was done on the design of a pilot cascade plant for a few hundred machines.[30]

Italy had also been active in the field of fuel reprocessing for quite a while. Italian technicians had worked from the very beginning in the Organisation for European Economic Cooperation's Eurochemic plant, and in 1970 the CNEN had inaugurated its first pilot national reprocessing plant, EUREX I, at Saluggia.[31] The plant had been designed specifically to reprocess the highly enriched uranium fuels used in research reactors, and according to one estimate its plutonium extraction capacity varied from 8 to 200 kilograms (kg) of plutonium a year.[32] A second pilot plant was built at the CNEN Trisaia center to study "fuel reprocessing and refabrication techniques related to the thorium-uranium cycle, as an alternative to the U-Pu [uranium-plutonium] cycle," but after a troubled start it was decommissioned shortly after its completion. By 1974, however, both EUREX and the former Trisaia center (now renamed Impianto Trattamento Elementi Combustibili [Combustible Elements Treatment Plant], or ITREC) were "commissioned to start a wide range of experimental activities in the field, of the power reactors oxide fuel reprocessing and, respectively, fast reactor fuel reprocessing. To support these pilot plant activities an adequate research and development work at laboratory scale was also implemented."[33] According to a 1977 study, the goal of the new range of activities was to develop "the necessary experience and knowledge which would allow [the Italian] domestic industry to design, build and operate a commercial size reprocessing plant when, by the late 1980s, this plant will be justified by the extent of the Italian nuclear program." A much larger reprocessing plant, EUREX II, had in fact been planned to be operational by around 1985.[34]

On a final note, it should be pointed out that in 1955 the Ministry of Defense had created a Center for the Military Applications of Nuclear Energy (Centro per le Applicazioni Militari dell'Energia Nucleare; CAMEN), in Pisa, operated jointly by the Naval Academy and by the University of Pisa. After a somewhat uncertain start, in 1957 CAMEN's activities took off, and shortly afterwards it was supplied with a swimming pool research reactor by the U.S. firm Babcock & Wilcox.[35] The reactor went critical on April 4, 1963, and reached its maximum power of 5 megawatts in 1967. CAMEN, on which there is a very limited literature, seems to have focused most of its research around the reactor itself, the study of naval propulsion, and the diffusion of radioactivity. Apparently in 1964, an effort by its director, Admiral Germano Polano, to have a full-fledged study of the feasibility of a national option was stopped before it could be completed.[36]

Naval Propulsion

In his October 1967 article, Albonetti wrote that the other matter that deserved the attention of the Italian government was naval propulsion, and in the late 1960s there was indeed a remarkable intensification of Italian activities in this field. In December 1962, Italy had formally requested U.S. assistance to build a nuclear submarine, but the negotiations never went anywhere, and the project was finally abandoned. In December 1966, however, the Italian ministers of defense (Roberto Tremelloni) and of trade and industry (Andreotti) signed an agreement for a joint Navy-CNEN project to develop a nuclear-propelled surface ship. The U.S. State Department informed the Italians that the mixed civilian and military nature of the vessel was likely to raise a strong U.S. congressional opposition, and suggested leaving the navy out of it.[37] The CNEN replied with a detailed memo that explained the nature of the initiative, specifying that the future reactor would be a pressurized light water one, requiring low-enriched uranium at 4.7 percent. The ship would be a "logistical supply ship," any information provided by the United States should not be classified, and if necessary Euratom safeguards could be applied to any nuclear fuel the United States could provide. The only concession that Italy could not afford to make, the memo continued, was about the participation of the Italian navy, which was necessary because only the Defense Ministry could supply the required funding for the project.[38] In April 1967, Albonetti and Rear Admiral Luigi Tomasuolo went to Washington to continue the negotiations, but they met with a stiff resistance.[39] Faced with such a negative outcome, Andreotti expressed the intention to launch a broader effort to find the required LEU for both the critical test and the regular future supply of the reactor.[40] Albonetti then approached the director of British Atomic Energy Authority Overseas Relations Office, J. L. Croome, to enquire about the possible price of the materials necessary for "the performance of a critical experiment, the irradiation tests of fuel elements, the fabrication of the first reactor core."[41] Similar requests were also sent to the U.S. Atomic Energy Commission and the CEA. The British government took a long time to reply. As one British Foreign Office official aptly noted, the United Kingdom found itself "caught in the cross fire of [its] European Common Market and Anglo-American interests."[42] All the participants in the debate inside the British government stressed the obvious linkage among the possible nuclear fuel supply to Italy and the parallel negotiations about the NPT and the joint enrichment plants. "Our hope of associating European countries in the development of Capenhurst as a European source of enriched uranium will be damaged if we refuse to assist the Italians in this case," noted a memo by one of the supporters of the Italian request. "If we do not supply, . . . France as a good European might make material available if only to show the UK as a bad European." A denial, the memo concluded, "would be interpreted by the Italians as discriminatory and against their interests. Their willingness to sign a Nonproliferation Treaty would hardly be enhanced."[43]

The British and American vacillations greatly annoyed Albonetti. When he visited London in October 1967, he accepted Croome's official explanation for the delay, but also restated his firm intention to go ahead in one direction or the other, adding that he:

> felt that they could not be entirely dependent on others for supplies of enriched materials for nuclear ships, whether for marine or naval purposes. Privately off the

> record, he added some fairly intemperate remarks about the attitude of the Americans. . . . he had also made enquiries in France and he thought that the French would be prepared to supply their requirements in exchange for plutonium derived from Latina.[44]

> Such an irritation was apparently quite widespread among the diplomatic corps. The director of Euratom and Atomic Energy Affairs at the Foreign Ministry, Counselor Stefano D'Andrea, warned a U.S. diplomat that the fact that the United States was refusing "even" the supply for the nuclear ship would have far-reaching consequences:

> It could force both industry and the government to come to the proper conclusion that Italy must look to itself in this regard and not be in a position to be dependent on others. . . . The obvious step [would be] to devote enough of its own resources to produce its own enriched fuel regardless of the policies of others. . . . Italy might at first try to interest some of the other European countries in a joint venture but if this failed, it should be prepared to pay the cost of doing it alone.

> . . . He also mused that perhaps France was right and Italy wrong when it came to making the decision whether to be independent or dependent on others as regards supply of this material. To sum up, the US obduracy might in the end force Italy to do what it probably should have done long ago: ensure its access to enriched uranium alone or with a minimum of other co-producers.[45]

Eventually, the British Foreign Office agreed to offer the CNEN the low-enriched uranium for the land-based critical experiment of the reactor. The Italian agency, however, replied that it was interested in the offer only if the British could also ensure the fuel for the reactor of the ship, opening up yet another, more complicated round of negotiations. By the end of 1968, the talks became strictly interwoven with the parallel ones on centrifugal enrichment once again, and many in the Foreign Office thought it necessary to compensate the likely Italian exclusion from the trilateral consortium by meeting their demands for the ship's fuel.[46] When the British government finally made up its mind and replied to the Italian request, it was November 1968. The CNEN, however, kept silent until August 1969, when Albonetti told the British that the CNEN and the Navy were no longer interested in their offer. The Italian authorities, he wrote, had decided to accept another offer, "considered more convenient"—which was clearly the French one, even if Albonetti did not mention it explicitly.[47] It is plausible that the choice was influenced not only by the economic conditions that the CEA offered, but also by the fact that France was going to accept Italy as a full partner inside EURODIF, whereas the British could not do the same about URENCO. Eventually, the CEA agreed to supply 2,000 kg "of 4.7 per cent enriched uranium for the research reactor and 5,000 kilograms for the ship's first fuel load."[48]

Notably, at around this time Italy also was involved in a specific project to develop a national ballistic missile. Although this project was not strictly related to the development of civilian nuclear capacities, it is interesting to place all these activities in a more complex perspective. Both the Italian navy and air force had shown a keen interest in rocketry from the mid-1950s, and they experimented with a variety of weapons, both national and international.[49] From the 1960s, moreover, Italy had developed a bilateral space research project with the United States, the San Marco, to build a seaborne launching facility near the equator and to launch an Italian satellite carried by a U.S. Scout launcher. At the same time, Italy also joined other European countries in the development of the European space organizations—the European Space Research Organization and the European Launcher Development Organization.[50] By the end of the

1960s, however, the Italian navy began to develop a special national project for the creation of a solid-propelled, two-stage rocket, and in 1971 a Special Interforce Group was created to design such a rocket, construct its first stage engine, and test it in flight. Many specialized Italian defense and electronic companies were involved in the project, and by the mid-1970s the Alfa missile was completed an 8-meter long rocket with a circumference of 1.4 meters which reportedly could deliver a one-ton warhead at a distance of 1,600 kilometers (km). The missile tests all took place (successfully) in the second half of 1975 and continued until April 1976, when the program seems to have been discontinued.[51] The limited historical literature on this topic provides no explanation for the project's rather abrupt termination.

The NPT Ratification Debate

By the early 1970s, Italy had signed the NPT but at the same time it had also strengthened its nuclear status across the board. More significantly, after the signing the Italian government took no immediate steps to ratify the treaty. Apparently, the inactivity was based on an unassailable formal justification: together with West Germany and the Benelux countries, the Italian government was committed not to ratify the NPT until Euratom had concluded an agreement with the International Atomic Energy Agency (IAEA) about inspecting all nuclear facilities in the territory of the Euratom member countries. The negotiation, however, dragged on for almost three years. An agreement was finally signed on April 5, 1973. It was a substantial diplomatic victory for the European countries, as it granted Euratom what many critics saw as basically a right to self-inspection. Euratom was recognized "as a party to the application of Article 3 of the NPT," while the IAEA was granted "a right (but not an obligation) to visit some facilities in Euratom territory, when invited to do so by the Europeans."[52] In the following months, the Benelux countries ratified both the safeguards agreement and the NPT. West Germany and Italy, however, seemed to be taking a more cautious approach.

In February 1974, in particular, an interministerial meeting in Rome decided to keep parliamentary actions on the safeguards agreement separated from the ratification of the NPT. The Italian ambassador in Washington, Egidio Ortona, explained to ACDA director Fred Iklé that the decision was made because the government felt that the NPT ratification was a "highly-charged political question," while the safeguards agreement was a relatively easy technical issue. The latter issue was also, Ortona added, a more urgent one as it affected the supply of nuclear materials and it was of great interest for the other Euratom countries.[53]

"When the United States can't bomb and won't negotiate, it runs the risk of acquiescing to a continued North Korean buildup."

The Italian decision to split the parliamentary debates about the two issues concealed an implicit gambit, which was made clear a few weeks later by the Foreign Ministry's director general for political affairs, Roberto Ducci, in a conversation with the American deputy chief of mission in Rome. By ratifying the IAEA-Euratom safeguards agreement, Ducci argued, Italy could be guaranteed all the necessary fuel deliveries and technical assistance for its civilian nuclear program, as such deliveries were covered by the U.S.-Euratom agreement. Ratification of the NPT, by contrast, was of no immediate urgency and Italy intended to take its time, particularly as far as the 1975 NPT review conference was concerned. Ducci openly admitted that he preferred to see what results the conference would produce before Italy joined the nonproliferation regime.[54] These statements raised only a limited alarm in the U.S. Embassy in Rome, which interpreted Ducci's remarks as yet another case of Italian discomfort at being classed with the have-nots. The

U.S. ambassador, therefore, urged nothing more than a frank clarification about the difficulties that the Italian decision might create.

The Italian opponents of the NPT, however, were looking for a way to avoid an immediate ratification, and their perplexities were reinforced by the India's testing of an atomic explosion on May 18, 1974. The test sparked yet another round of vehement discussions, as it seemed in their eyes to confirm the substantial failure of the treaty and the whole nonproliferation regime. Roberto Ducci offered a sample of what was to come in a conversation with his German counterpart, Ministerialdirektor (Undersecretary) Günther van Well: Ducci argued forcefully that there was no formal link between the ratification of the safeguards agreement and of the NPT, nor was there any indication that future U.S. deliveries of fissionable materials would be affected by a delay in the ratification of the latter. As to the risk of missing the opportunity of participating in the first NPT review conference in 1975, Ducci reacted with "scorn," countering that the conference "would not amount to anything, anyway." Upon being informed by a disconcerted van Well, this time the U.S. ambassador cabled the State Department recommending that the United States "now bring to bear all reasonable pressure on the Italians to submit the treaty as soon as possible."[55]

Shortly afterwards, the first public shot against the NPT was fired by no less than the secretary general of the Foreign Ministry, Roberto Gaja, who in June 1974 published editorials under his customary pen name of Roberto Guidi, calling for Italy to reconsider its support for the NPT. Gaja argued that the Indian test showed that the treaty had failed to stop proliferation and to provide adequate guarantees to the nonnuclear states. The logical conclusion that the government should draw, therefore, was that it should try to promote a substantial modification of the treaty. Italy should call for the creation of a third category of states, which he called "nonmilitary nuclear states," namely those countries that had the technological know-how and the industrial infrastructure to quickly weaponize, but that refused to do so—a proposal that casts an interesting light on all the Italian activities described above. The EC, Gaja argued, had the full right to see this status formally recognized, and Italy should work to make it happen. Something, incidentally, which he believed would also have the additional benefit of opening the door to a possible revision of the structure of the United Nations Security Council.[56]

Gaja's article, in short, was an outspoken call for formally recognizing the importance of a status of nuclear latency, and for drawing the political consequences of such a recognition. His plea was reinforced by the publication of another article by Albonetti, who pointed out that in the Mediterranean a large number of countries had neither signed nor ratified the treaty—at the time, the list included Albania, Algeria, France, Israel, Libya, Spain, Portugal and Turkey—an ominous development that he claimed posed an implicit danger for Italy.[57] Other critics joined the fray. Historian Rodolfo Mosca, for instance, argued that by refusing to ratify, Italy would help create an international system that finally would overcome the rigid order created at the end of World War II, as well as strengthening European integration by reestablishing a balance between Italy and the two European nuclear powers, France and Britain.[58]

These nuanced arguments were supplemented by a far more provocative publication in *Politica e strategia*—a magazine that had some dubious connections with extreme right-wing groups. In its September 1974 issue, the magazine published a special section featuring a number of essays which openly discussed the costs of national nuclear options.[59] The two most striking contributions were yet another article by Albonetti¸ "Difesa nazionale e autonomia nucleare" (National defense and nuclear autonomy), and an editorial by the magazine director, Filippo De Jorio, who unmistakably advocated for Italy to develop its own tactical nuclear weapons. In his own article, however, Albonetti simply listed the steps through which Italy could (if desired) develop a bomb, but did not support this choice and instead advocated once again for the creation of a European nuclear force.[60]

The publication unleashed a veritable storm in the Italian media that lasted for several weeks. In the heat of the debate, all the opponents of the ratification were lumped together in an undistinguished group. Both Gaja's and Albonetti's subtleties were totally ignored and they were accused of supporting an Italian way to the bomb, together with all sorts of right-wing conspirators and terrorists.[61] The CAMEN also received special attention from a bizarre left-wing magazine, *Maquis.* In an inquiry aptly titled "Come l'Italia prepara l'atomica" ("How Italy is preparing the atomic bomb"), the magazine argued that the "mysterious" organization was feverishly working on an Italian device. CAMEN director Rear Admiral Avogadro di Valdengo published an interview in which he denied all the accusations, but his subsequent resignation was regarded as an indication that something wrong was afoot.[62]

> "The Indian test had reinforced the overall perception of the fragility of the NPT regime."

The virulent debate continued throughout the fall of 1974, in spite of strong denials repeatedly issued by Andreotti, who had been reinstated in his previous position of minister of defense. Both the United States and Italy's European allies, in the meantime, had begun to seriously worry about the possible repercussions of the Italian vacillations. The Indian test had reinforced the overall perception of the fragility of the NPT regime, and an Italian delay in ratification, not to mention an outright refusal, would be a potential crucial blow to its shaky foundations. The Italian ploy to keep separate the ratification of the IAEA-Euratom agreement from the one of the NPT was a subtle one and difficult to implement at the best of times. As it happened, the Italian government tried to execute it at the worst possible moment. In the summer of 1974, U.S. secretary of state Henry Kissinger and his staff reviewed the consequences of the Indian test and concluded that the United States had to step up its efforts to reinforce the global nonproliferation regime. One crucial step in this direction was to make a number of key countries ratify the treaty. Italy was specifically singled out, as its attitude could in turn set an example for other states, such as Japan or Egypt who were studying Italian behavior carefully.[63]

In West Germany and in Japan, in particular, the NPT had been controversial, and both governments feared that an Italian refusal to join the nonproliferation regime could reopen a veritable can of worms.[64] In short, in the second half of 1974 the Italian vacillations were assuming an importance far broader than the Italian case per se, and they "could cause a very serious problem," as German deputy assistant secretary of state Hellmuth Roth told U.S. counsellor Helmut Sonnenfeldt in October 1974. Both the State Department and the West German Foreign Ministry repeatedly discussed how to coordinate their approaches to put pressure on the Italian government.[65] U.S. diplomats tried to disabuse the Italians of any illusions that the United States would automatically continue its supplies of nuclear materials to Italy even without a full ratification of the NPT.[66] As for the West Germans, they first thought about a joint démarche of all EC members, but then acted either alone or in coordination with the United States and the United Kingdom, pointing out to the Italian government the damage that any further delay would inflict on the Community as well as on West Germany itself.[67] Both Washington and Bonn, however, seemed to have felt uncomfortable in putting pressure on Italy, and often asked each other to take the lead.

Tensions in Italy continued to mount. By late autumn, a number of parliamentarians called for an official inquiry on Albonetti, and eventually 142 of the country's leading physicists, led by such prominent figures as Guido Calogero, Edoardo Amaldi, and Carlo Schaerf, addressed a letter to the Ministry of Foreign Affairs criticizing its vacillations and asking for the immediate ratification of the NPT.[68] Apparently, the combination of both internal and external pressures pushed the opponents of the treaty into a corner. When a new government was formed under the leadership of Aldo Moro, at the end of November 1974, its members seemed to have been "sensitized . . . to some of the unpleasant domestic and international ramifications of further foot dragging on NPT," as the US ambassador John Volpe cabled to Washington. Nevertheless, in the same telegram Volpe added that there were some doubts as to where Moro himself stood on this issue, and concluded that the United States should present its view "with firmness and clarity at the political level," outflanking the main centers of resistance in the Foreign Ministry.[69] As an additional instrument "to hold the Italian government's feet to the fire," the U.S. Embassy also recommended hinting at the fact that without a full ratification of the treaty Italy might not be admitted to the impending First Review Conference of the NPT, not even as an observer.[70]

In the early months of 1975, the new Moro government was submitted to a steady barrage of diplomatic démarches. The State Department concluded that "the Italian question" seemed to be arriving at its critical phase, and that its outcome might have an "overriding impact on the attitude of other states on NPT ratification—above all, Japan."[71] U.S. Ambassador Volpe drove home the U.S. interest for an Italian ratification of both the safeguards agreement and the NPT, first to Gaja in late January and then to the new foreign minister, Mariano Rumor, shortly afterwards; the West German foreign minister Hans-Dietrich Genscher paid a visit to Rumor at the end of February; and a Soviet diplomat confided to an American one that the Soviets were talking to the Italians "all the time" about the treaty. On February 19, a cabinet meeting agreed to forward the NPT to the Italian Parliament for ratification. The text was submitted on March 26, and the ratification procedure began in April. Interestingly, in order to accelerate the procedure, the Moro government also decided to handle the NPT ratification together with that of the safeguards agreement, which had been approved by the Senate but still needed the plenary assent of the Chamber of Deputies. This complete reversal of the previous delaying tactics concluded on April 23, when Italy finally ratified the NPT, albeit with the same list of 12 "observations" that had been deposited at the time of the signing.

One particular reason that may have played a role in the reversal was the promise that Italy would be assigned a "quasi-permanent" seat in the IAEA Board of Governors, a sweetening pill that according to Ducci "more or less compensated" Italy for "accepting the role of a nonnuclear power."[72] Yet this carrot had been accompanied by many more serious sticks. Before making its final decision, in fact, the Moro government had held two important meetings with Australian prime minister Edward Gough Whitlam in late January and with the Canadian one, Pierre Trudeau, in March. One of the key Italian goals had been to obtain a firm commitment from both visitors to supply uranium for its civilian program even if Italy did not ratify the NPT. Both conversations, however, fell short of Italian hopes. Trudeau explicitly linked any future nuclear cooperation between the two countries to the Italian ratification of *both* agreements, and openly mentioned the negative impact of the Indian test on Canadian nuclear exports, which henceforth would be subjected to more rigorous safeguards. Whitlam did not make any explicit linkage, but still failed to conclude an agreement with Italy as his government had not yet established an official policy on the export of Australian uranium ore.[73] These negative results might have persuaded the Italian government to drop its last doubts—in between the two meetings, the U.S. Embassy was still worried that Italy would ratify the treaty with some official reservations, if it did at all, and on February 7 Ducci even told ACDA director Fred Iklé that the ratification process might take as long as another year.[74] Assessing the reasons for the final decision to ratify, an internal Central Intelligence Agency memo noted:

> The Italians probably decided to ratify when it became apparent that they lacked support in the International Atomic Energy Agency for a legal maneuver that would have allowed them to continue receiving nuclear materials by ratifying the safeguards agreement required by the NPT, but not the treaty itself. Continued access to nuclear materials is particularly important to Rome now that it is seriously considering a plan intended to reduce dependence on imported oil through the construction of 20 new nuclear power plants by 1985. Canada, one of Italy's major potential sources for uranium, recently made it known to the Italians that their request for supplies would not be considered until Rome ratified both the NPT and the safeguards agreement. Rome must also have been influenced by its failure to get around the provision making ratification a prerequisite for full participation in the NPT review conference of May 5.[75]

The importance of a regular fuel supply was also admitted by Prime Minister Moro himself a few days later. The Italian ambassador to Tokyo, Perrone Capano, had written Moro a personal plea "not to associate his name with such an unequal, and laden with heavy consequences, treaty such as the NPT." A few days later, Moro replied, listing all the reasons that had persuaded the government to ratify, and concluded:

> Yet another reason is the necessity for Italy to purchase uranium for its civilian atomic energy program. It is a badly felt need, for the present and for the future, also in light of a possible new crisis of oil supplies. On the other hand the Western countries which supply

> our uranium have unmistakably conditioned their deliveries to our ratification of the NPT. Only by doing so, therefore, is it possible to ensure for Italy the development of an advanced know-how and technology, and to avoid being left in a dangerous rearguard position.[76]

Conclusion

What were the goals of the Italian government in delaying the ratification of the NPT? Without broader access to the records of the Italian protagonists and of the institutions involved in this story, it is possible at best to offer a plausible thesis. The documentation from the CAMEN, in particular, would be crucial to conclude whether there was any truth behind the allegations that it was involved in the development of a nuclear test—even if the available sources seem to deny that such an option was ever considered, or that it was never fully explored if it was considered.[77]

Among the possible explanations that the theoretical literature has advanced to clarify a country's ambiguous feelings toward the NPT, two seem particularly helpful to understand the Italian case. Itty Abraham has argued that given the inescapable dual dimension of nuclear programs, their fundamental ambivalence does not necessarily imply a military objective. To look at them from a proliferation perspective, therefore, is fundamentally misleading and narrows the analytical vision. On the contrary, "nuclear programs are best understood as one of a larger family of public technology projects, not all of which are weapons related or have destructive ends." Resisting any form of outside control, therefore, does not necessarily mean a secret military aspiration, but can be explained as the reluctance to accept a serious limitation to "a claim to a form of national modernity that [states] once took pride in and took for granted."[78] Ariel Levite, by contrast, has advanced a thesis that may be closer to capturing the essence of what the Italian government was trying to do.[79] Faced with the unpalatable request of adhering to the NPT and accept its restraints, Levite argued, most states do not suddenly and completely change course. Rather, they gradually probe all the possible options to maintain a critical capacity to move quickly from a civilian to a military program. By doing so, they try to explore if the treaty provisions contain any loophole that may allow them to retain (or acquire, if they do not have it yet) as much as possible of the necessary technical knowledge and expertise, as well as the crucial resources in terms of fissionable material and technological infrastructure. Levite defined this attitude as "nuclear hedging," a national strategy lying somewhere in between nuclear pursuit and nuclear rollback.

Levite's paradigm of a hedging state trying to maximize its capacities may help explain the Italian government's behavior between 1969 and 1975. If one looks for the clear-cut evidence of a national nuclear ambition, of course, his paradigm does not apply. The perspective changes, however, if one assumes that Italy nurtured some slightly different nuclear aspirations, namely to be part of a stronger nuclear Europe inside NATO, or to develop a full-fledged civilian program in order to support the creation of a third category of states inside the NPT regime. If one also takes into account Gaja's suggestion that Italy should strive to introduce into the NPT regime a third category of states that have the technological capacity to weaponize but refuse to do so, the Italian initiatives in the field of uranium enrichment, space research, and nuclear naval propulsion, as well as the delaying tactics in the ratification of the treaty, all may be seen as an attempt to bolster the country's technological status as much as possible in order to provide policymakers with the broadest possible range of options—to acquire, in other words, a latency status and to maximize the political advantages that could be drawn from it.

Endnotes

1 Minutes of the Meeting of December 10, 1960, Archivio Storico Presidenza della Repubblica, Roma, Italia (hereafter ASPR), Verbali delle sedute del Consiglio Supremo di Difesa.

2 Adolfo Alessandrini al ministro degli Esteri, Attilio Piccioni, e al Presidente della Repubblica, Antonio Segni, 23 luglio 1963, ASPR, Ufficio del Consigliere Diplomatico (hereafter UCD), busta (hereafter b.) 94.

3 Minutes of the Meeting of the Supreme Defense Council, December 11, 1957, ASPR, Verbali delle sedute del Consiglio Supremo di Difesa; Aldo Moro to Amintore Fanfani, June 25, 1966, Archivio Aldo Moro (hereafter AM), Archivio Centrale dello Stato, Roma, Italy (hereafter ACS), b. S4, f. NATO, sub folder Questioni generali. I discuss all these issues more in depth in Leopoldo Nuti, "'A Turning Point in Postwar Foreign Policy': Italy and the NPT Negotiations, 1967–1969," in *Negotiating the Nuclear Non-Proliferation Treaty: Origins of the Nuclear Order*, ed. Roland Popp, Liviu Horovitz, and Andreas Wenger (London and New York: Routledge, 2017), 77–96.

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6 John Krige, "The Proliferation Risks of Gas Centrifuge Enrichment at the Dawn of the NPT," *Nonproliferation Review* 19, no. 2 (2012): 219–27, see 223. For more background, see R. Scott Kemp, "The End of Manhattan: How the Gas Centrifuge Changed the Quest for Nuclear Weapons," *Technology and Culture* 53, no. 2 (2012): 272–305.

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8 Susanna Schrafstetter and Stephen Twigge, "Spinning into Europe: Britain, West Germany and the Netherlands: Uranium Enrichment and the Development of the Gas Centrifuge 1964–1970," *Contemporary European History* 11, no. 2 (2002): 253–72, see 256.

9 Daviet, *Eurodif*, 319.

10 Tel. 6869 from AmEmbassy Brussels to the State Dept., June 21, 1967, U.S. National Archives and Records Administration, Washington, DC (hereafter NARA), RG 59, Central Foreign Policy Files (hereafter CFPF) 1967–1969, b. 2897, f. AE 11-2 Euratom. For an analysis of the Commission's role, see Mauro Elli, "Between Industrial and Energy Policy: The Issue of the European Capacity in Uranium Enrichment, 1969–1974," in *The Road Europe Travelled Along: The Evolution of the EEC/EU Institutions and Policies*, ed. Daniela Preda and Daniele Pasquinucci (Bruxelles: Peter Lang, 2010), 383–94.

11 Silvio Labbate, *Il governo dell'energia. L'Italia dal petrolio al nucleare* (1945–1975) [The governance of energy: Italy from petroleum to nuclear, 1945–1975] (Firenze: Le Monnier, 2010), 108–9.

12 Achille Albonetti, "Produrre uranio" [Produce uranium], *L'Europa* 1, no. 5 (October 13–20, 1967).

13 Mario Silvestri, *Il costo della menzogna. Italia nucleare 1945–1968* [The price of mendaciousness: Nuclear Italy, 1945–1968] (Torino: Einaudi, 1968), 379–81.

14 Silvestri, *Il costo*, 376–77; and Steven Jerrold Baker, "Technology and Politics: The Italian Nuclear Program and Political Integration in Western Europe" (Ph.D. diss., University of California at Los Angeles, 1973), 168.

15 Verbale della 136 Riunione della Commissione Direttiva del CNEN, December 15, 1967, Archivio Carlo Salvetti, Università di Roma "La Sapienza," Dipartimento di Fisica.

16 The chairmanship of the new committee was given to Piero Caldirola, one of Italy's foremost physicists. Caldirola was a leading figure at the University of Milan and, since 1961, the scientific director of the research reactor of the CAMEN, the military center for nuclear research (see notes 34 and 35 below).

17 Appunto del Ministero degli Esteri: Arricchimento Uranio, August 3, 1973, AM, ACS, b. 162, f. vertice europeo di Copenhagen.

18 "Italy and the Centrifuge Organization," note by G. P. C. Macartney, August 30, 1972, UK National Archives (hereafter UKNA), FCO 55–933 Participation of Italy in tripartite centrifuge arrangement.

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21 *Appunto* by Achille Albonetti to Giulio Andreotti, November 29, 1973, Archivio Giulio Andreotti, Istituto Luigi Sturzo, Roma, Italia (hereafter AAn), Fondo USA, b. 621, f. Viaggio G. A. dicembre 1973.

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33 S. Cao, G. Rolandi, R. Simonetta, and H. Dworschak, "Italian Experience with Pilot Reprocessing Plants," in *International*

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34 Baker, "Politics and Technology," 191.

35 The story of how a military center could be supplied by the United States with a research reactor without violating the regulations on nuclear exports is fairly complicated. See Memorandum by Algie A. Wells, AEC Division for International Affairs, to Philip Farley, Dept. of State, January 30, 1963, in NARA, RG 59, lot file General Records relating to Atomic Energy Matters 1944–1962, b. 503, f. 21.51 Country file Italy, h. Reactor 1957 & 1962.

36 Amerigo Vaglini, *Il nucleare a Pisa. Quaderno di memorie storiche sul CAMEN, 1955–1985* [Nuclear power at Pisa: Notebook of historical memories on CAME, 1955–1985] (Pisa: ETS, 2009), 55. The information about the feasibility study is in Letter from Admiral Polano to Giulio Andreotti, December 19, 1973, in AAn, serie energia nucleare, b.1225, f. dal 1971.

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Nuclear Latency and Iran

Richard Nephew

Though the debate around the Joint Comprehensive Plan of Action (JCPOA) has many different facets, at its center is an uncomfortable reality. As a result of decades of work, Iran has become a country that could—if it so chose—possess nuclear weapons. The U.S. intelligence community has stated this fact for several years, and Director of National Intelligence Dan Coats reiterated it on May 11, 2018.[1] In light of this assessment, the problem of Iran's nuclear program changed from the denial of a capability to the denial of an opportunity, which is considerably more difficult to manage.

The Strategy of the JCPOA

The JCPOA's inherent solution to Iran's nuclear latency was to delay and to monitor. On the question of delay, the Obama administration focused on the central concern of nuclear-weapon production, that of the nuclear material itself. Because research and development work can be harder to detect, particularly if nuclear material is not involved, the United States prioritized efforts to deny Iran the facilities necessary to quickly produce weapon-usable material and to ensure that the international community knew as much as possible about the status of Iran's program in order to monitor it.

In terms of Iran's access to plutonium, the JCPOA is an unambiguous success in this regard. Iran's only sources of plutonium now are its few research reactors and the Bushehr Nuclear Power Plant. Yet its research reactors are far less of a threat now that the original design of the Arak Heavy Water Research Reactor will be changed to one that does not produce weapon-grade plutonium in normal operations, or in anything less than four years. The Bushehr plant also is less of a threat because both the quality of the resulting plutonium will be poorer. Even though the Bushehr plutonium may still be useable in a weapon if reprocessed, Iran has no spent fuel reprocessing program and is not permitted to engage in any research and development on such a program for 15 years. In an abstract way, plutonium must still be acknowledged as a potential threat for Iranian nuclear weapons, but it is not a realistic path for Iran in anything short of many years.

Enriched uranium is an altogether different situation. Iran demonstrated over the 2002–2015 timeframe that it is more than capable of manufacturing and fielding centrifuges. Its ability to do so again, even using the primitive IR–1 design, is unquestioned. Moreover, though in the early years there was some skepticism that Iran would be able to design a more advanced centrifuge, there is sufficient evidence that Iran is capable of doing so. It is plausible that, with additional time, Iran would be able to field a centrifuge at least four times more powerful than that of the IR–1 and perhaps even beyond that.[2] Iran has enough uranium in its indigenous mines to provide the feedstock for nuclear weapons, though perhaps not for a substantial nuclear power program. The questions surrounding a uranium-based nuclear weapon all center on whether Iran could produce enough such material fast enough to deny the United

States or its partners the ability to attack militarily, not (as in the case of plutonium) whether Iran could produce enough of the nuclear material at all.

It is here that the JCPOA once more intervenes in a threefold manner. Not only does it restrict the size of Iran's uranium enrichment infrastructure and the amount of Iranian enriched uranium, but it also subjects the entire enterprise to monitoring and verification measures beyond the terms of the Comprehensive Safeguards Agreement or the Additional Protocol. These monitoring provisions do not wholly prevent Iran from acquiring nuclear weapons; rather, when combined with the amount of time that would be involved in Iran restarting its enrichment program, they would sound a warning that Iran's nuclear program is once more on the verge of a breakout scenario. All together, these measures do not deny Iran nuclear-weapon latency, but rather manage and control it.

BACK TO THE FUTURE

The nature of the JCPOA set off a chorus of recriminations from opponents across the political spectrum who clamored for "more" across the board—more restrictions, more time, more transparency. JCPOA opponents included *both* the Republican chairman of the Senate Foreign Relations Committee and the Democratic ranking member, as well as *both* the Republican chairman of the House Foreign Affairs Committee and the Democratic ranking member. Former U.S. government officials spoke out against the agreement, citing various provisions as being simply insufficient given the scale of Iran's nuclear program and Iranian duplicity over the course of the 30 years of the history of the Islamic Republic. The JCPOA also became a target for pundits in a variety of venues to argue that the the Obama administration had squandered its sanctions leverage for an agreement that fell short of what was desired.

Some of the concern expressed about the JCPOA arguably has more to do with the nature of the Iranian government than the deal itself. In a speech in September 2017, then U.S. Ambassador to the United Nations Nikki Haley offered a succinct summary of this position when she noted: "Why did we need to prevent the Iranian regime from acquiring nuclear weapons in the first place? The answer has everything to do with the nature of the regime, and the [Iranian Revolutionary Guard Corps'] determination to threaten Iran's neighbors and advance its revolution."[3] Haley's rhetorical question and answer underscores that the problem of latency in the case of Iran, at least for some, has little to do with its nuclear program as an intrinsic matter and far more to do with the nature of the U.S. policy disputes with Iran. If one were to substitute "Japan" or "Germany" for "Iran" in the first sentence of Haley's remark, one could easily arrive at a different answer in the second.

Setting aside the opinions of some of those opposed to the JCPOA on more fundamental grounds, much of the disquiet expressed with the deal stemmed from how it failed to secure Iran's agreement to turn back the clock on its nuclear program to before it had an advanced centrifuge capability or the wherewithal to construct a heavy water reactor. Many members of Congress laid out their concerns with the JCPOA in writing—itself an impressive display of thoughtful debate in 2015 Washington—but Senator Ben Cardin's presentation encapsulated the quandary that the JCPOA created for those concerned about Iran's nuclear future. He noted first that "the JCPOA does contain significant achievements," and spelled out the types of restrictions and transparency requirements it contained. Yet he concluded that he would vote against the agreement because "the JCPOA legitimizes Iran's nuclear program. After 10 to 15 years, it would leave Iran with the option to produce enough enriched fuel for a nuclear weapon in a short time."[4]

This issue of nuclear "sunsets," as they have been dubbed, became a catalyst for U.S. legislation in 2017 that would seek to proscribe aspects of Iran's future nuclear program. Republican senators Bob Corker and Tom Cotton sought to draft a bill that would establish automatic parameters for a U.S. response to any Iranian nuclear development that exceeds triggers or redlines established in Washington. President Donald Trump's decision to withdraw the United States from the JCPOA in May 2018 ended any real consideration of this legislation, but the conceptual underpinning of the exercise was to constrain Iranian nuclear latency by fixating on Iran's physical infrastructure and capabilities. Iran would be refused the ability to expand its nuclear program, with the threat of U.S. sanctions on those who do business with Iran serving as the necessary leverage to keep Iran's nuclear program in check.

AFTER THE SUNSETS

If one assumes that Iran's nuclear program is invariably intended to be the means for Iran to produce nuclear weapons, then the approach taken by many critics of the JCPOA makes some intuitive sense. The goal of any agreement with Iran, in this instance, would be to keep its nuclear-weapon program capped for as long as possible and ensure that an Iranian nuclear restart is met with resounding opposition.

The problem with this approach, however, is that there is neither national consensus regarding the intent of Iran's nuclear program nor international consensus regarding whether Iran's nuclear ambitions must be so constrained out of concerns over proliferation risks. Instead, since the JCPOA was adopted in 2015 there has been a fair amount of comfort internationally with the idea of Iran expanding its nuclear program to its legal limits once the JCPOA's main restrictions expire, as well as open questions regarding Iran's nuclear intent. The result has been a mangled debate over the extent of Iranian latency and whether it can be constrained in any meaningful way.

For the first part, there are varying assessments as to how far Iran had advanced its nuclear-weapon program before abandoning it in 2003–2004. Iran's refusal to acknowledge its past nuclear-weapon ambitions has made it more complicated to make a hard and fast judgment, without the benefit of Iran's own descriptions of what was involved in that program. This has led some JCPOA opponents to underscore the importance of deeper and broader Iranian declarations of work on past nuclear weapons and to condemn the International Atomic Energy Agency's (IAEA's) approach to resolving the possible military dimensions (PMD) of Iran's past nuclear program.[5] Those taking this position have argued that if Iran had given more information on the PMD issue, then the IAEA and rest of the international community would be in a position to more definitively assess how far the Iranian program had progressed.

What these critics miss, however, is that those skeptical of Iran's long-term intentions likely would have treated any Iranian declaration as incomplete. Iran's long history of misleading the international community about its nuclear program, as well as the more fundamental concern with the Iranian government to which Ambassador Haley pointed in September 2017, both suggest this outcome. From this perspective, opponents and proponents of the JCPOA often find themselves arguing from unexpected points of view. Opponents have noted that they wish that Iran's declarations were more thorough, while proponents have noted that past Iranian obfuscation has made them less likely to trust Iran's declarations regardless of their details. In other words, some JCPOA opponents notionally have put more faith in what Iran has to say than some proponents have. This exact debate played out when Israel announced in May 2018 that it had seized a wealth of Iranian nuclear documents in a Mossad operation in January of that year. JCPOA opponents lined up to argue that the wealth of new information—which filled in many previous public gaps in understanding—proved that Iran's nuclear-weapon program was real and remains a serious threat. JCPOA supporters concurred that the document seizure was significant insofar as closing gaps was concerned, but the documents did not indicate an ongoing nuclear-weapon program, and so this revelation underscored the importance of preventing Iran from expanding its current nuclear fuel production capabilities.

A similar confusing debate emerged over meaningful constraints on Iran's nuclear program. Opponents took to attacking the JCPOA in 2015 on the basis that Iran's nuclear program would be free of restraint within 10 to 15 years. They noted, as Senator Cardin did, that Iran's nuclear program would even be free of the notional prohibitions provided for in the United Nations (UN) Security Council resolutions imposed on Iran from 2006 to 2010, which among other things forbade Iran from operating a uranium enrichment plant. Senator Cardin' and other opponents' argument was that the JCPOA "legitimizes" Iran's nuclear program, and would permit it to expand dramatically and possibly dangerously in 10 to 15 years' time. To avoid such an outcome, they claimed to be in favor of dispensing with the JCPOA's actual agreed-upon restraints in order to maintain legal (but completely ignored) prohibitions afforded by the UN Security Council. Proponents, for their part, often have been no less confusing in their arguments. Some have decried the risk of Iran's nuclear program restarting in light of the U.S. withdrawal from the JCPOA, but appear to be completely comfortable with the notion of Iran's nuclear program being free of any restraints, legal or otherwise, in that 10 to 15-year timeframe.

Policy on Iran

All of these perspectives essentially point to a failure to be realistic and practical about the problem of Iranian nuclear latency. Four points ought to guide any practical policymaking about Iran's nuclear program and its latent risk. First, Iran has demonstrated sufficient technological sophistication to indicate that it retains the ability to produce nuclear weapons largely at will. Second, Iran is large enough and well-equipped enough that it could choose to pursue the covert path to nuclear weapons again, bypassing all of its known nuclear facilities. Third, Iran's primary constraints are twofold, involving physical impediments for the production of nuclear material and awareness of the consequences of being caught pursuing nuclear weapons. These constraints are real and sobering, particularly given that Iran has been unsuccessful for much of the past 20 years in keeping its clandestine nuclear pursuits secret. Finally, with respect to the first constraint, the JCPOA successfully checks Iranian opportunism for at least 25 years, but different tools and approaches will be needed to check Iranian policymaker psychology. Each point is worth considering in greater detail.

IRAN'S TECHNOLOGICAL SOPHISTICATION

Over a 20-year period, Iran learned much about the nuclear fuel cycle. It moved beyond a situation in which it was dependent on foreign supply and assistance from A. Q. Khan's Pakistani network to the point where it was able to rely on its own nuclear expertise. The Iranians have begun developing their own uranium centrifuges. They have worked through technological problems, such as those presented by the inferior IR–1 model centrifuge for the production of near-20 percent enriched uranium, by undertaking unique solutions such as the tandem cascade design. They have engineered solutions to other technological problems and, though it has taken time and effort, have been able to overcome many hurdles, not least of which was the dedicated export control system arrayed against it. Though it is difficult to determine how far Iran progressed in its nuclear-warhead design efforts, any problems around them would not be unsolvable technically. After all, Iran knows that nuclear-warhead design can be achieved, as there are more than a few nuclear-armed missiles in existence.

Similarly, the United States has long assessed that even the destruction of Iran's nuclear program would only set back the effort by "a couple of years," as noted by former Chairman of the Joint Chiefs of Staff Martin Dempsey.[6] This suggests that the problems of Iranian nuclear latency are not connected to its existing capabilities, but rather to what Iran has learned and what it could reconstitute at a later point in time. Consequently, U.S. and other policymakers have to assume for purposes of strategy that the problems with Iran acquiring nuclear weapons are not technical but political. Any technical problems that Iran may experience can be solved. The trick is to convince Iran to avoid seeking those solutions.

IRAN'S COVERT PATH

Several times from the late 1980s through 2009, Iran engaged in covert nuclear activities in direct violation of its obligations under the Treaty on the Nonproliferation of Nuclear Weapons (NPT). The November 2004 IAEA report summarizes those nuclear activities through that date, and the November 2011 report does the same for Iran's nuclear-warhead program.[7] Together, these reports demonstrate that Iran has no difficulty in creating a covert nuclear enterprise and running it directly contrary to its international obligations.

The problem, for Iran, is that it also has been caught out on multiple occasions. In 2002, Iran's extensive nuclear construction at Natanz and Arak were revealed. IAEA inspection activities from 2003 to 2004 found out more. U.S. and partner intelligence services were aware of many other Iranian activities of concern, including the covert construction of the uranium enrichment plant at Fordow before it was exposed in September 2009.

Of course, past performance is no guarantee of future success. Even if "anytime, anywhere" inspections were to be required in Iran, there is still no certainty that the United States, the IAEA, or any other international actor would find out about what Iran was up to before it was able to develop a covert capability. Iran simply knows too much and has ample room inside of the country to pursue a covert nuclear program. It is not lacking areas to hide the program nor is it lacking the imagination to invent operational parameters for a covert program.

IRAN'S DUAL CONSTRAINTS

Even though Iranian latency exists in potential, Iran is still subject to two levels of constraint. The first is that a covert nuclear program requires inputs, the most important of which is nuclear material. Iranian uranium supplies are under strict monitoring, including tracking of uranium in the country once it leaves the mines and mills and throughout the nuclear fuel cycle.[8] These restrictions will remain in place for at least 25 years. Shorter restrictions and transparency provisions will also help the IAEA track centrifuge components and similar raw materials for 15 to 20 years. Taken in combination, these steps will make difficult for Iran to mount a parallel program to break out of its obligations.

This is where the second constraint—the risks of being identified as having cheated—comes into play. As noted, Iran has been able to undertake covert nuclear activities in the past, but these activities were detected long before the covert program was in a position to deliver fissile material for a nuclear warhead. There is no indication that Iran is presently engaged in undeclared nuclear activities that would suggest an ongoing covert program. Given that former U.S. secretary of state Rex Tillerson has grudgingly admitted that Iran is in technical compliance with its obligations, from information confirmed through intelligence agencies, this likely remains the position of the U.S. intelligence community today.

For this reason, Iran has every reason to fear that it would be detected in the attempt if it were to begin to pursue clandestine nuclear activities now, not least because it would find it difficult to argue away its illicit conduct. After all, in the past, it refused to adhere to IAEA inspection protocols that would have required early notification of intent to build a nuclear facility (also known as the Modified Code 3.1), but because of the JCPOA this is no longer the case. Also in the past, Iran was not an adherent to the Additional Protocol; thanks to the JCPOA, Iran is now operating under its strictures. Moreover, Iran has staked its international reputation on the fact that it is adhering to the JCPOA's obligations. If it were to go back on those commitments, which include a commitment never to pursue nuclear weapons and some of the technologies that would facilitate their production, then it would find itself in a precarious position. In fact, the Israeli document seizure only underscores the complexity of Iran's challenge in dismissing future weapon-related work, as it would be hard-pressed to convince the international community to forget what it has now learned.

From this perspective, it is worth touching on why Iran gave up nuclear weapons in 2003–2004. Iran may have decided that a nuclear-weapon option was contrary to Shia religious principles, as some in Iran have maintained citing a fatwa from Supreme Leader Ali Khamenei. More likely, Iran knew that IAEA inspector access in Iran could find indications of a weapon program and that possessing such a nascent program could be more dangerous to the regime than its absence, having just witnessed the 2003 U.S. invasion of Iraq and 10 years of crushing international sanctions before then. For much the same reason, even a latent Iran would have to deal with the question of what might happen before it reached the point of having operational nuclear weapons, particularly in an atmosphere in which it is seen as the international outlaw.

IRAN'S LEADERSHIP AND NUCLEAR LATENCY

If we assume that the primary problem is not a near-term Iranian breakout—which even skeptics of the JCPOA have been wont to disregard as a serious threat as compared to the issue of nuclear sunsets—then the question is whether and how to keep Iranian nuclear weapons a latent threat. Nothing short of a complete regime change and occupation of Iran will remove of this latency, but it is enough to ensure that latency is as far as the Iranian nuclear program advances. The key issues, therefore, are how to keep Iran's leaders convinced that the security benefits of nuclear-weapon possession are outweighed by the *likelihood of detection* and the *risks of either nuclear possession or continued ambiguity*.

LIKELIHOOD OF DETECTION

Right now, and throughout the years when the JCPOA's constraints are in place, Iran's leaders appreciate that a decision to break out or to edge out of their present, protracted latency would be detected quickly. They also likely appreciate that their ability to talk their way out of such a crisis would be limited, especially if the activities in which they would be implicated are narrowly confined to nuclear-weapon uses. For this reason, it is reasonable to argue that Iranian latency can be preserved so long as enhanced monitoring remains in place, especially taken together with routine IAEA safeguards activities and the Additional Protocol.

After the sunsets begin, the imperative will fall largely on the IAEA to maintain the Iranian leadership's sense that it is not worth the risk of being caught pursuing covert nuclear activities. This means that the IAEA should continue to utilize its authorities under the Additional Protocol to request access to undeclared sites as well as to insist upon the use of technologies that can enhance its work; the latter effort should be more generalized both because of the inherent advantages that come through use of such technology for cutting costs and reducing inspector presence, as well as for nonproliferation benefits.

Iran also needs to be convinced that the United States and others are continuing to monitor its nuclear activities closely. Iran should continue to figure largely in the annual threat briefings given to the U.S. Congress by the director of national intelligence, but the conversation should go well beyond those standard briefings and included constant, regular updates to Congress and the public. Likewise, the United States should continue to engage in intelligence-sharing arrangements with states in the region and beyond about Iran, and the United States should publicize the existence of these arrangements. Obviously, the information shared should remain compartmented as necessary, but the existence of sharing arrangements and monitoring provisions should not be treated as a state secret. Rather, Iran must understand that, even as restrictions may ebb, its nuclear activities are at the center of U.S. security calculations and concerns.

RISKY BUSINESS

More than anything, though, Iran needs to feel that if it is detected in its pursuit of nuclear weapons, such a violation of international restrictions will be met with a decisive international response; moreover, it should be aware that continued ambiguity is detrimental to its interests.

With respect to Iranian expectations of a firm international response, the key elements for the United States and its partners are credibility, sobriety, and context. With respect to *credibility*, the international community will need to produce serious, evidence-based charges in the event of an Iranian nuclear-weapon breakout attempt or the discovery of activities in support of a future one. U.S. leaders' antipathy toward Iran, combined with the history of U.S. intelligence failures in the Middle East with respect to weapons of mass destruction, creates a confidence vacuum regarding U.S. accusations of Iranian illicit conduct. Any U.S. confrontation with Iran must be informed by awareness of this credibility deficit. In the period 2005–2009, the United States addressed this concern by utilizing information presented by the IAEA to articulate the nature of the Iranian nuclear threat. From 2009 to 2013, the United States utilized President Barack Obama's earnest desire to solve the Iranian nuclear crisis through diplomacy as a way of arguing that the United States was not merely seeking a pretext for international pressure or military action against Iran.

For Iran's nuclear ambitions to be kept merely latent, international actors must believe that the United States can make credible accusations if it confronts Iran over indications that Iran has breached existing agreements. If Iran believes that it will stand a chance of arguing that the United States is merely persisting in its long-term vendetta over the 1979 Iranian hostage crisis or any number of other issues, then it may also believe it has a chance of successfully exploiting its latency.

This consideration underscores the importance of *sobriety* if the United States chooses to engage in a possible future conflict with Iran over its nuclear ambitions. U.S. politicians have made a habit of suggesting that Iran is at the heart of every problem in the Middle East. This sentiment, combined with a refusal to condemn other sources of tension or conflict in the region, has led to concerns that the United States is obsessed with Iran and overstating its significance and threat.[9] Hand-in-hand with a credibility gap, this line of argument helps Iran both deflect attention away from any illicit activities it may pursue and cast aspersion on any such charges from the United States. For a number of reasons, it is important to avoid such overstatements, but the most important of these is that they can dilute the significance of actually questionable Iranian behaviors or activities, which would be highly damaging when dealing with a possessor of latent nuclear weapons.

With respect to managing the *context* of Iranian latency, the issue for the United States after the JCPOA is the wide belief that the Iranian nuclear issue is resolved. Because a number of other states have nuclear fuel cycle capabilities, mere possession of advanced centrifuges or enriched uranium stocks may not seem all that compelling to an international audience, particularly if—as noted with respect to credibility and sobriety—the United States has developed an international reputation for exaggeration and misunderstandings around Iran. For the same reason, Iran can exploit an international context in which the United States is seen as the more provocative party, especially after President Trump decided to withdraw the United States from the JCPOA without having been provoked by Iranian malfeasance. This unsupported unilateral action—as well as the overall pattern of policy in the United States—has contributed to a definite sense that Iran may be a more reliable and coherent international actor. It therefore is in the interest of the United States to maintain an international perspective on Iran that is evidence-based, nuanced, and respectful (rather than dismissive) of U.S. concerns. If Iran feels that it will be in a footrace with the United States, then it may be convinced to maintain its latency. If, however, Iran feels emboldened by its position with regard to the international community, then there are greater risks that it may move from latency to actual weapons.

Of course, it would be better still if Iran would take steps to reduce instead of increase a sense of concern about its nuclear latency. In an absolute sense, Iran's nuclear-weapon latency has been assured by its technological developments over the preceding 30 years, but the Iranians can take certain steps to reduce the immediate threat this latency presents, as well as the stress associated with it. These steps are no mystery, and the JCPOA embraces many of them. By restraining its existing nuclear program, declaring its intentions with respect to its future nuclear program, and accepting monitoring and transparency of this program, Iran has been able to reduce the sense of imminent threat from its nuclear activities even as it has kept its latent possibility intact.

The question becomes: what can keep Iran in that kind of constrained position? As noted earlier, some in the United States have suggested that the threat of a future conflict may be successful in restricting Iran's nuclear ambitions. Indeed, the possibility of a future threat may in fact help motivate Iranian restraint. The problem with advertising that threat now is that, as noted, this also may appear to exaggerate the nature of the present (and future) Iranian nuclear threat. This element of a strategy might be better employed at a later date, particularly in response to actual Iranian steps to expand the nuclear program beyond its present size and scope. Perhaps more successful would be a strategy that leads Iran to decide that a constrained program is more to its advantage. Here two possibilities worth exploring are the threat of latent nuclear *competition* and *incentives*.

With respect to competition, the Iranians presently enjoy a nuclear position that has no real parallel in the Middle East. Though Israel reportedly has nuclear weapons, it lacks the kind of large fuel cycle infrastructure in place in Iran. Moreover, setting Israel aside, the Middle East is largely devoid of nuclear capabilities apart from a small number of power reactors being built in the United Arab Emirates and Saudi Arabia. But, this need not be the case in perpetuity. In fact, Gulf Arab States have already underscored to Iran that they are prepared to match Iranian nuclear developments, if not exactly in kind, then at least in some fashion. In 2006, members of the Gulf Cooperation Council announced that they were exploring a joint nuclear program.[10] Though the Emirati and Saudi nuclear programs have compelling energy security reasons for their existence, the fact that both countries are also pursuing them with international support is not lost on Iran, which before the signing of the JCPOA had been struggling to obtain any international cooperation for its similar efforts. Less positively, current and former Saudi officials have suggested that they would match Iran's nuclear program explicitly, and have hinted at the possible option of acquiring nuclear weapons from Pakistan, though there is little evidence to support this claim.[11]

Iran also faces a real risk in the continued development of nuclear capabilities by other states in the region, even though Iranian officials may not acknowledge this at present. Just as Iran's nuclear program started in the shadow of conflict with Saddam Hussein's Iraq, the Iranians know that their present security situation with respect to Gulf Arab states may have inspired nuclear proliferation (and, at a minimum, latency) on the part of their adversaries. The international community might do well to express this risk of balancing and latency in conversations with the Iranians in order to underscore the proliferation threat of nuclear capabilities on the other shore of the Persian Gulf. Admittedly, there also is an inherent risk in utilizing this kind of argument with the Iranians, in no small part because it may suggest to states in the Middle East that the only way to convince Iran to step back from a dramatic nuclear expansion on the eve of the nuclear sunsets is to undertake similar nuclear fuel cycle development. Yet even as a potential option, this line of argument could be part of early conversations in the region and with Iran about the need for broader regional nonproliferation arrangements. These arrangements ideally would involve both restraints on Iran's part as well as enhanced transparency measures across the board—though, as noted above, the latter are more important for keeping Iran's nuclear program latent.

Threat-mitigating actions such as these would be something positive for Iran, but there also may be calls for additional *incentives* from the United States and its partners, most notably in the form of sanctions relief and access to the international economy. Neither U.S. nor Iranian policymakers believe that they achieved as much as they might have desired from the nuclear agreement. For the United States, these shortcomings fall in the frame of the nuclear sunsets and nonnuclear concerns. For Iran, these deficiencies fall in the frame of continued U.S. sanctions and the impediments they present for the Iranian economy. Prior to President Trump's decision to withdraw the United States from the JCPOA, the United States could have turned this frustration to its advantage by signaling to Iran a willingness to offer extended sanctions relief if nuclear provisions in the JCPOA were to be extended. This would have required the United States to accept that its sanctions relief might not be available to deal with nonnuclear issues, such as terrorism, but that doing so would arrest a potential problem in the making with respect to Iran's nuclear program. This option still exists, but is manifestly harder to execute. To utilize it, the United States would first have to decide to restart negotiations with Iran and, eventually, reaccept the JCPOA as a part of the overall effort. This could be a possible basis for future talks, though such prospects are slim under the current U.S. administration.

Conclusion

Iran is a latent nuclear-weapon possessor. The JCPOA did not enable this state of affairs; years of technical progress on the ground in Iran, and the accretion of knowledge and capabilities, allowed Iran to reach this achievement. In all but the most extreme scenarios, it will not be possible to reverse this status. As the JCPOA shows, it is both feasible and sustainable to manage Iran's nuclear ambitions, though it will require imagination and some acceptance of risk in order to do so. Failing to do so, however, entails risks beyond present imagination, both in terms of Iranian capabilities and the future of the Middle East.

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ORDEM E P

Without Reversal: Brazil as a Latent Nuclear State

Matias Spektor

The notion that Brazil belongs to the category of countries that once tried to build nuclear weapons only to freeze their ambitions and roll them back has gained traction in recent years.[1] According to this view, a phase of exploration starting around 1953 was followed by the pursuit of a weapon option from 1978 to 1990, when the country's nuclear program is thought to have been capped and reversed. Virtually all recent attempts at codifying nuclear latency describe Brazil as a case of "nuclear reversal," although several scholars who have conducted detailed fieldwork in Brazil do not share this view.[2] These contending perspectives differ over how to interpret the available data on the various phases of Brazil's nuclear program over time. In previous work, I have specified the degree to which Brazilian authorities did explore the possibility of nuclear weapons, but argue that the existing evidence does not support the belief that Brazil actually pursued nuclear weapons at some point in the past, even if certain voices within the Brazilian establishment wished to develop the country's nuclear-weapon capabilities.[3]

This chapter considers the issue of Brazil as a case of "nuclear rollback." Can the Brazilian case accurately be described as one where authorities set out to develop or purchase dual-use technologies but at some point opted to cap and reverse their policies for the cumulative process of nuclear technology acquisition? The answers are far from obvious, because the concern with Brazil as an instance of nuclear reversal poses the question of how to identify rollbacks in the first place. The challenge resides in the fact that the metrics of nuclear technology acquisition are highly contested and inherently difficult to ascertain.[4] Because there is no single signpost to mark the existence of a nuclear-weapon program, there is no standard demarcation line between a country's effort to acquire nuclear technologies, the actual pursuit of nuclear weapons, and the process used to effectively and definitively reverse such pursuits. Furthermore, measurements in the field of nuclear policy are highly politicized. Consider, for instance, recent calls to reinterpret the text of the Treaty on the Nonproliferation of Nuclear Weapons (NPT) to the effect that the treaty should prohibit nonnuclear-weapon states not only from acquiring nuclear weapons but also from accumulating significant quantities of fissile materials and facilities that can produce such material.[5] Similar attempts have been made to establish a "nuclear firewall" for nonnuclear-weapon states.[6] It is no wonder that choosing indicators to specify degrees of nuclear latency and detect nuclear reversals carries high analytic and political stakes.[7]

To assess whether Brazil fits into the nuclear reversal category, this chapter draws on the expert literature that sees technical progress and political decisions about technical choices as proxies for nuclear latency to test the evidence on Brazilian nuclear capabilities and intentions. It compares the Brazilian case against the following criteria: nuclear policy decisions by the top leadership, the trajectory of uranium enrichment and plutonium reprocessing, the evolution of rockets and missile policy, the impact of changes in domestic regime types on nuclear policy, and the process through which Brazil's nuclear program came to focus on the development of an indigenous naval nuclear-propulsion capability. Newly available data challenge the common view that Brazil's nuclear ambitions at some point abated. In the past three decades, Brazil moved to acquire and develop ever more sophisticated and complex nuclear industrial capabilities. From uranium mining, milling, and enrichment to nuclear energy production, the medical application of nuclear science, and naval nuclear propulsion, Brazilian authorities at no point abandoned or reversed their quest to master the nuclear fuel cycle and several of its applications. They never had a nuclear-weapon program to dismantle in the first place, and a detailed analysis of the data shows that both investment and ambition in the field over time have grown rather than shrank. To be sure, nuclear policy evolved from a low base and in a stop-and-go fashion in the face of political, managerial, and financial hurdles. Consequently, Brazil presents a story of slow and gradual acquisition of nuclear know-how, but it cannot be accurately described as a case of nuclear rollback.

This chapter answers the question why Brazil is normally taken to be an instance of nuclear reversal. It tests the existing evidence against the abovementioned criteria in order to specify what kind of nuclear latent state Brazil has become, and summarizes the broader implications of the Brazilian case for the literature on nuclear latency.

Codifying Brazil as a Case of Rollback

A superficial glance at Brazilian nuclear history suggests that it is a textbook case of nuclear rollback because the standard chronology seems to be consistent with the predictions of nuclear proliferation and reversal. First, Brazil was a beneficiary of foreign assistance in developing nuclear technology, a predictor of proliferation. It was a top recipient of foreign civilian nuclear assistance under President Dwight D. Eisenhower's Atoms for Peace program in the 1950s, and by the 1960s Brazil was actively trying to purchase enrichment and reprocessing technologies abroad through a string of agreements with the United States and West Germany.[8] Second, when the world denied Brazil what it wanted, Brazilian authorities set out to develop their own capabilities in a program outside the purview of international safeguards. Once Brazilian scientists mastered the nuclear fuel cycle in the mid-1980s, both the technology and the equipment were placed in the hands of the country's navy, thereby militarizing its nuclear policy—yet another common predictor of proliferation. Third, Brazil saw the expansion of a nuclear complex encompassing state and private companies, engineers and metallurgy experts, and basic and applied university-based research in the fields of physics, mathematics, and computer science.[9] Fourth, at the height of Brazil's quest for fuel cycle capabilities, its diplomats were engaged in overt status rivalry and competition with neighboring Argentina, a country which at the time also was seeking to acquire sensitive nuclear technologies through foreign assistance and unsafeguarded indigenous efforts. Many observers feared that the Brazil-Argentina dyad was ripe for triggering a destabilizing security dilemma.[10] Finally, from 1979 onward, as Argentina risked war against Chile and then went on to lose a conventional war against Great Britain over the Falklands/Malvinas islands in 1982, Brazil became the principal regional power in South America—yet another a powerful predictor of proliferation, according to the specialized literature.[11]

"Once Brazilian scientists mastered the nuclear fuel cycle in the mid-1980s, both the technology and the equipment were placed in the hands of the country's navy, thereby militarizing its nuclear policy."

By 1987, when the Brazilian authorities publicly announced that they had managed to indigenously enrich uranium, Brazil faced none of the factors that the theoretical literature lists as dissuading a nuclear aspirant from proliferating.[12] For starters, Brazil was not in a tight alliance with a nuclear-weapon state; the bilateral relationship with the United States in particular was at a historical low, with constant friction over trade, human rights, and nuclear proliferation. Nor was Brazil a member of the NPT, which its authorities denounced as an unequal treaty set up by industrialized countries to keep developing states ensconced in their technological backwardness. Furthermore, although both the United States and the Soviet Union worried about Brazil's nuclear-technology acquisition, neither ever credibly committed to coercing Brasília to stop its policy. For all their differences in approach, the Nixon, Ford, Carter, and Reagan administrations accommodated Brazil's transition to nuclear latent status.[13] And, as Brazil joined the exclusive club of uranium-enriching states, its centrifuges were kept under the tight control of the navy. This factor was still another predictor of proliferation, according to conceptual literatures that shows how professional military organizations (as opposed to elected politicians and other government agencies) favor offensive nuclear strategies.[14]

Yet the acquisition of uranium-enrichment capability coincided with the onset of the country's financial decay. By the mid-1980s, the Brazilian nuclear program was in dire straits. Budgets for nuclear power-related activities dwindled and the program went into a state of hibernation as economic recession and hyperinflation eroded the political base of a dictatorial regime that had been on the decline for years. With the first democratic presidential elections in a generation planned for 1989, the room for a nuclear program under exclusive military control shrank. The new democratic constitution adopted in 1988 banned nonpeaceful uses of nuclear energy, and the first administration to come out of the ballot box appointed a civilian with no military ties to lead the Comissão Nacional de Energia Nuclear (National Nuclear Energy Commission). Nevertheless, the know-how, capabilities, and laboratory infrastructure built under cover in the early 1980s were never dismantled, abandoned, or reversed. Instead, the new democratic authorities kept all of the elements the old authoritarian regime had developed, and moved fast to normalize Brazil's position in the global nonproliferation regime by adhering to a range of international norms. At the United Nations (UN) General Assembly in 1990, Brazil formally renounced so-called peaceful nuclear explosions, and one year later it established mutual inspections with Argentina under a formal joint institution, the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC). That same year, the two countries and ABACC signed a formal agreement with the International Atomic Energy Agency (IAEA) for the application of full-scope safeguards, which entered into force in 1994. Brazil also established civilian control over its missile program, creating the Agência Espacial Brasileira (Brazilian Space Agency). Additionally, the Brazilian Congress passed legislation placing export controls on missile-related goods and services. Brazil officially renounced sales of long-range missiles for military use, and terminated a series of ballistic-missile projects, including one with Iraq. In turn, the Bill Clinton administration waived existing trade restrictions and consented to Brazilian membership in the Missile Technology Control Regime (MTCR). Brazil also ratified the Treaty Tlatelolco, which bans nuclear weapons from Latin America. In 1996, Brazil became a member of the Nuclear Suppliers Group (NSG), and two years later it signed and ratified the NPT.

Given this historical trajectory, it is perhaps no wonder that many observers should confuse the Brazilian experience for a case of nuclear rollback, even if the evidence points to the gradual acquisition of ever more sophisticated and complex nuclear technology systems. Yet the rollback narrative as it is applied to Brazil misses important aspects that should be integral to any analysis of intentions and capabilities intended to properly codify and place Brazil in the wider picture of global nuclear politics.

Capabilities and Intentions: Reassessing Nuclear Brazil

This section reviews the evidence available today to reassess the evolution of capabilities and intentions by focusing on five core themes from the conceptual literatures: nuclear policy decisions by the top leadership, uranium enrichment and plutonium reprocessing, rockets and missile policy, the impact of regime change on nuclear policy, and investment in naval nuclear propulsion.

NUCLEAR POLICY DECISIONS BY TOP LEADERSHIP

The first official recorded statement by a Brazilian head of government pertaining to the pursuit of nuclear weapons dates from October 1967. President (General) Arthur da Costa e Silva told his National Security Council that "nothing prevents us from conducting research and even developing devices that can explode. We don't have to call it a bomb, but a device that can explode."[15] The background context of his message was the ongoing hardnosed negotiations unfolding in Geneva at the Eighteen Nation Disarmament Commission (ENDC) on a future global nonproliferation agreement. The president was stating the Brazilian position that the door should be open for the commercial use of "peaceful nuclear explosions" (PNEs). Brazil at the time had become a staunch, overt defendant of the legality and legitimacy of PNEs as useful tools in major infrastructure works. At the time, there were PNE programs in the United States, the Soviet Union, and other nations that were participating in the ENDC talks, and the issue became part of the negotiations, but PNEs did not yet have the full associated stigma that would become dominant after India exploded its first nuclear device in 1974.[16]

Costa e Silva did not frame explosives either as deterrents or as tools for geopolitical reassertion, nor was there any mention to threats against which Brazil might have to guard itself with a nuclear device. "We must emphasize peaceful use. I consider this to be the key point," he concluded.[17] There is no record in the archives that the president or his advisers ever followed up on his utterances about a "device that can explode." No documents have been found to date to suggest that after the meeting, the Brazilian government ever conducted studies on the technical, economic, political, or strategic aspects of a domestic nuclear-weapon program. Also, there is no evidence that the government ever commissioned any studies to assess the utility of nuclear explosions for use in large infrastructure works. What the Brazilian government did do was order the drafting of a "National Strategic Concept," which stated that nuclear science and technology were tools to modernize Brazil by taking it out of its peripheral position in world affairs.[18] This is consistent with a detailed 1968 assessment of Brazilian nuclear capabilities by the U.S. embassy, which concluded:

> (A) There is no visible evidence to indicate that Brazil has embarked on or is presently seriously contemplating embarking on a program to build a nuclear device.
> (B) Brazil does not have a significant base in the science and to a lesser degree the technology necessary to mount such a program should a political decision to do so ever be made. (C) There are important gaps in this Brazilian base which would be both costly and time consuming for the country to overcome before a device could be built and tested.[19]

In less than a decade, however, Brazil's position on nuclear-weapon development would go beyond mere discussions of scientific and technological advancement to indicate both specific goals and specific threats.

The second reference in the historical record by top leadership to a Brazilian nuclear device occurred in June 10, 1974, when then President (General) Ernesto Geisel in a meeting with the Armed Forces High Command stated that the option should be kept open in case Argentina were to build a nuclear weapon. Should Argentina weaponize, he said, "we should see if we could possibly develop the technology to produce a nuclear weapon like others do."[20] The meeting occurred in the context of Brazil's negotiations with West Germany on nuclear assistance, and participants were debating the potential implications of such an agreement. More specifically, Geisel was replying to a comment by General Hugo Abreu, chief of the Military Cabinet of the presidency, who overtly argued that the agreement with Bonn should help Brazil keep its nuclear-weapon option open for the future. Although Geisel was framing the agreement with West Germany as the acquisition of dual-use technologies that might serve a military purpose in case of the emergence of a regional threat, none of the leaders offered any estimates that such a scenario (i.e., Argentina developing nuclear weapons) might come to pass in the near future.

Going through the swathes of secret official documents from that period that are now available for research, it seems clear that the majority of Brazil's top-ranking generals, admirals, and brigadiers understood the momentous decision involved in going nuclear, and with rare exceptions they strongly inclined to abstain from doing so. Oral history work on the Geisel administration (1974–1979) also has shown that there was no significant pro-bomb lobby in Brazil, and the idea of an indigenous nuclear-weapon program struck most of the country's leadership as absurd. They thought nuclear weapons to be dangerous, costly, and in the end unnecessary.[21] What appears instead is an obsessive concern on the part of the Brazilians with acquiring nuclear technological self-sufficiency in a global nuclear order that they found to be both unstable and exclusionary to their detriment—at that time,

> "...it seems clear that the majority of Brazil's top-ranking generals, admirals, and brigadiers understood the momentous decision involved in going nuclear..."

their chief concern was with the emerging international rules and practices being imposed to prevent nonnuclear-weapon states from mastering the nuclear fuel cycle.[22] Provided the technological foundations for nuclear autonomy were in place, however, the issue of weaponization could be dealt with if and when international security conditions required it.

As it turned out, however, the BrazilianWest German agreement did not in the end entail the transference of any enrichment or reprocessing technologies.[23] U.S. pressure on both Bonn and Brasília helped to stop the technology transfer, domestic political change within West Germany turned the government against the agreement, and the onset of a massive financial crisis undercut Brazil's ability to invest in nuclear development.[24] The absence of a policy directive mandating the pursuit of nuclear weapons, however, did not derail successive Brazilian leaders from achieving technological progress in nuclear science, and in particular its applications for uranium enrichment.

URANIUM ENRICHMENT (AND PLUTONIUM REPROCESSING)

In 1978, Geisel authorized the navy to start research and development of an indigenous, unsafeguarded program for the centrifuge method of uranium enrichment. In the aftermath of West Germany's decision to transfer enrichment and reprocessing technology to Brazil, a group of navy officials convinced the president that they could deliver enrichment within years at a small, laboratory scale. From the outset, they framed the project not as a nuclear-weapon capability, but in terms of nuclear naval propulsion, which explicitly precluded any work on reprocessing.[25] Navy officials involved in the program were openly and privately critical of any talk of weaponization, because pursuing a nuclear-weapon option would take away invaluable financial and human resources from their force's ultimate goal of building a nuclear-propelled submarine. If the executive branch were to authorize the nuclear submarine project, the navy would be at the helm of the nuclear program, and it also would secure long-term budgets and other privileges with regard to the army and the air force. A nuclear device, on the contrary, would suck up budgets, invite inordinate amounts of international hostility and pressure, and ultimately weaken the navy's hand.[26] This is crucial in understanding the scarcity of significant support for a Brazilian bomb: the navy was the one "island of excellency" that had the human resources and managerial prerequisites in place to conduct work on uranium enrichment, and its organizational priority was to move toward nuclear naval propulsion at the expense of any other dual-use technologies.

Contrary to the quantitative literature, General Geisel was not the embodiment of the pro-bomb lobby.[27] Rather, by supporting the navy's quest for uranium enrichment, he was throwing his weight explicitly behind the nuclear-propulsion option. But Geisel's authority—indeed, the legitimacy of the dictatorial regime—rested on cooperation among the three armed forces. In authorizing the navy to pursue a uranium-enrichment capability, he also made it a point to channel funds for the army and the air force to explore alternatives to prevent infighting among the forces whose support he needed to remain in office. Oral history interviews suggest that at the time, nobody in the president's circle ever expected serious technological progress from the army or the air force—channeling funds was a preemptive measure by a military president who did not want trouble in the barracks. The navy delivered on its promise in 1987 by enriching a few milligrams of uranium in a laboratory. This was all there was to Brazilian enrichment until the licensing of the first commercial enrichment facility at Resende in 2004. Resende is a small commercial plant licensed to enrich uranium up to 5 percent to fuel Brazil's three nuclear-powered reactors (two under operation and one under construction as of writing). The navy retains its own enrichment plant in Aramar, where its keeps the cascades that will enrich uranium for naval nuclear propulsion. The uranium enrichment program under the purview of the navy is therefore directed at fueling nuclear power plants for energy generation and, in the future, nuclear-powered submarines.[28] In the 1990s, both Resende and Aramar came under IAEA safeguards, and have remained under such safeguards since.

In the period Brazil is claimed to have been pursuing nuclear weapons, then, there is no evidence that it stockpiled highly enriched uranium or even significant amounts of low-enriched uranium. The technical configuration of the navy's centrifuge enrichment program suggests the chief purpose of the policy was not to build atomic explosives. It took Brazil 17 years to get from the mastery of the enrichment process in a laboratory to the commissioning of a commercial enrichment plant, and when commercial applications started the country produced enriched uranium at levels far lower from those needed for weapons. The slow rate of growth of Brazil's uranium enrichment capabilities is incompatible with the notion of a regime determined to acquire weapons. But the fact that such capabilities have grown over time also suggests this is not a reversal in technology acquisition. It is instead a case of slow, protracted movement toward greater (not smaller) levels of nuclear-related activity.

ROCKETS AND MISSILES

In 1979, Brazil started to design and build indigenous satellites, a rocket to deploy them to a low earth orbit (Veículo Lançador de Satélites/VLS–1), and a launching site in the northern air force base of Alcântara.[29] Two years earlier, it had begun constructing its own solid propellants. The technology for the VLS1 was derived from a civilian space assistance program with the United States that in the 1960s had led to the development of Sonda sounding rockets.[30] Governance for the rocket and missile program remained with the military, although Brazilian private companies played key roles in establishing international contacts and collaboration.[31] Reports at the time suggested that Brazilian engineers were assisting Iraq in extending the range of Scud–B ballistic missiles purchased from the Soviet Union and providing replacement parts for them. Brazilian company Avibras sold Astros II multiple rocket launcher systems to Iraq during its war with Iran, and there were accounts of missile technology cooperation with Libya. Brazil soon found itself at the receiving end of an embargo imposed by the newly created MTCR, which cut it off from foreign technologies. By 1992, the U.S. Department of Commerce had listed two of Brazil's Sonda rockets plus the VLS–1 and other ballistic missiles as projects of concern.[32]

> "...throughout the 1980s and early 1990s, U.S. officials treated Brazil's space program as a smokescreen for the production of ballistic missiles..."

Brazil's rocket and missile projects raised eyebrows in the international community because they signaled an apparent interest in potential delivery systems. Indeed, throughout the 1980s and early 1990s, U.S. officials treated Brazil's space program as a smokescreen for the production of ballistic missiles, and the development of VLS–1 as a maneuver to divert space technology to a secret missile program.[33] It is not only that ballistic missiles are the primary delivery vehicles for nuclear weapons, but they also are highly complex technological operations that can function as a proxy for technical prowess. To many, a state's acquisition of missile technology is closely correlated with its development of nuclear technology.[34] In testimony to the U.S. House Committee on Government Operations, a nonproliferation expert stated in September 1990: "As a missile the [Brazilian] VLS will have a range of over 2000 miles with a payload of 500 kilograms, the presumed weight of a first-generation nuclear missile warhead."[35]

Such perceptions, however, misread the realities of the Brazilian space program on the ground. Brazil's investment in space technology went to a satellite launch vehicle without inertial guidance systems. The lack of a guidance system indicates the Brazilian vehicle would have no use as a military rocket. Furthermore, space technological projects were bedeviled by intense intrabureaucratic competition and disarray, and recurrent tension between scientists and the military. The story of Brazil's space exploration is one of missed deadlines, scarce budgets, and frustrated ambitions, largely caused by internal divisions.[36] There were attempts to launch the VLS on three separate occasions (in 1997, 1999, and 2003). None of them worked.

NUCLEAR POLICY AFTER REGIME CHANGE

The existing literature points to the transition to democracy in the 1980s as the period when Brazil's new regime capped and rolled back the nuclear ambitions of the old regime. In effect, as pointed out above, many of the nuclear policy flagship projects built under the authoritarian rulers underwent a period of financial duress as recession and hyperinflation curtailed the new regime's ability to finance nuclear development activities. Also, the end of dictatorial rule brought greater levels of transparency to the nuclear program. But the view that this should be equated with the capping and reversal of either capabilities or ambitions does not stand up to close scrutiny. As soon as the economy began to recover from 1995 onward, budgets were put in place for initiatives that expanded and deepened the development of nuclear-technology capabilities. The government revived plans to enrich uranium and renewed deliberations on developing nuclear propulsion for submarines. The Fernando Henrique Cardoso administration (1994–2002) resumed work on the Angra 2 power plant. Upon taking office in January 2003, Luiz Inácio Lula da Silva further expanded the nuclear program. His administration moved ahead with the construction of the Resende plant, which was inaugurated in May 2006. This facility falls under international inspections, but the Lula administration insisted on the proviso that IAEA inspectors be denied full visual access to the centrifuges, arguing that proprietary technology had to be protected from industrial espionage. The conflict with the IAEA over access to Resende was resolved in October 2004 after difficult negotiations, in which the Brazilian government agreed to allow IAEA inspectors to install cameras in the ceiling of the facility to facilitate observation of containers of uranium hexafluoride, but allowing for only partial visual access to the actual centrifuge cascades. This revived talk about Brazil's growing nuclear ambitions. Brazil also resisted external pressure to negotiate an IAEA Additional Protocol to its existing safeguards agreement. The Lula government also moved ahead with ambitious plans to build a nuclear-propelled submarine in cooperation with the Naval Group from France.

Such expansion and deepening of Brazilian nuclear capabilities and intentions coincided with greater transparency and the acceptance of important nonproliferation commitments. Brazil's new constitution mandated that nuclear energy be used for peaceful purposes only (1988), and joined the ABACC, the MTCR, the NSG, and the NPT. Greater transparency, accountability, and controls naturally were consistent with the global expansion of nonproliferation norms at the end of the Cold War and greater economic integration with the West.[37] But they did not lead to the dismantling of Brazil's existing nuclear capabilities or a reversal in its ambition to master the nuclear fuel cycle and eventually work toward an indigenously built nuclear-powered submarine.

NUCLEAR PROPULSION

Brazil's commitment to the development of indigenous technology for naval nuclear propulsion dates back four decades. Since then, the pace of progress has been both slow and uneven, but plans picked up significant speed from 2008 onward, when the government placed the construction of a nuclear-propelled submarine at the forefront of Brazil's defense strategy.[38] This became a major enterprise in cooperation with France, which provided technical assistance in the nonnuclear components of the sub. At the time of writing, Brazil expects to be able to commission a nuclear-propelled submarine around 2029, although past experience suggests that schedules may well be postponed. Three types of hurdles complicate Brazil's ability to swiftly move toward a nuclear-propelled submarine capability. First, economic recession exposed the fiscal frailty of the Brazilian state, and steep cuts affected budgets across the board, casting a long shadow over the program's viability. Although the submarine program has not lost qualified personnel, anecdotal evidence suggests that scarce human resources remain a major concern. The official date for completion has been postponed several times thus far. Second, to further complicate matters, in 2017 a corruption scandal broke involving allegations that government officials involved in the nuclear submarine program had colluded with construction companies to generate kickbacks worth some €70 million. Although investigations are still unfolding, and it is too early to assess any long-term damage, it is not inconceivable that legal challenges against core parts of the program will emerge in coming years, further delaying progress and tarnishing the entire submarine enterprise in the court of public opinion.[39] The scandal may also generate new demands for project transparency, financial accountability, and nuclear safety and security that may retard progress further. Third, technical difficulties remain an obstacle to progress. Even if Brazilian officials have signaled that they will power their submarine with low-enriched uranium, the degree of enrichment that will be adopted in the reactor core remains unclear. Brazil's former National Nuclear Energy

> "...in 2017 a corruption scandal broke involving allegations that government officials involved in the nuclear submarine program had colluded with construction companies to generate kickbacks worth some €70 million..."

Commission president Odair Gonçalves and others point to 18 to 19 percent.[40] Others have suggested that Brazil will follow the French model by using less than 10 percent U–235.[41] Brazil built a land-based prototype for the first reactor core using uranium oxide rods with uranium enriched to 4.3 percent. Whether this prototype can withstand battle shocks and other extreme conditions deep underwater remains to be seen.[42]

High costs coupled with declining budgets, corruption allegations, and technical difficulties are complicating factors for the Brazilian Navy. But what is important is the fact that the evolution of Brazilian capabilities is a story of cumulative (if slow) progress. When it comes to naval nuclear propulsion, Brazil has expanded and deepened its technological acumen, rather than the opposite.

Conclusion and Implications for Proliferation Studies

This chapter sought to puncture the current dominance of the rollback assumption as it applies to Brazil. If technical progress and the top leadership decisions on technical choices are proxies for nuclear latency, then over time Brazil has become more latent, not less.

The Brazilian case presented here has four implications for the study of nuclear latency. First, it highlights the importance of distinguishing between two types of phenomena: the development of nuclear capabilities and the pursuit of a nuclear-weapon program. Brazil's story speaks to the cumulative expansion in nuclear nonweapon capabilities as a central feature of nuclear latency. Second, attention-grabbing lists of capabilities do not help build sound analysis of the politics behind nuclear latency in a given country. Classifying countries on the basis of the surface capability—whether they can enrich uranium or whether they can launch missiles into the sky—tells us little about what is really going on in domestic nuclear politics. Global proliferation experts should focus less on the capabilities themselves and more on the attitude of national leaders, the political context within which authorities make decisions, and the various political uses they make of the capabilities they acquire. The key question to ask about how nuclear latency plays out in key countries is what political functions do nuclear technology capabilities perform in the context of national politics?

Third, in assessing nuclear capabilities and intentions, both policy and scholarly communities tend to airbrush away the crucial details and treat specific cases as proliferation challenges that need to be resolved. This approach, however, biases the analysis from the outset and blinds the analysts to alternative hypotheses. A better posture would be to adopt an attitude of genuine curiosity about the case's specificity, returning to the culture of inquiry and open-mindedness that was the hallmark of proliferation studies some 40 years ago and that has produced some of the most powerful insights in the field.

Finally, if Brazil is not a case of nuclear rollback, then what in fact is it? After all, if Brazilian authorities never wanted nuclear weapons, the real question is why they went through the political and financial ordeal of pushing for sensitive technological development in the face of international pressure and domestic disagreement. One hypothesis might draw on the insight that countries sometimes pause at the threshold of technology acquisition and delay or forgo exercising the nuclear-weapon option provided by their nuclear fuel capabilities because they use nuclear technology to bargain for concessions. According to this view, Brazil might be an illustration of nuclear hedging. Yet this conceptual framework hardly applies to the specifics of the case. There is no evidence to date that any Brazilian governments used nuclear capabilities to push, cajole, threaten, or pressure third parties in international bargaining, or set out to trade their level of technological capacity for side payments from more powerful nations.[43] The generic term "hedging" does not seem to fully account for Brazil's nuclear policy.

Much work remains to be done in unpacking nuclear Brazil. But by establishing that this is not a case of nuclear reversal, the door is now open to probe additional questions about the connection between capability and intent. Understanding the precise constellation of factors that allowed successive Brazilian administrations to chase nuclear technologies without ever setting up a nuclear-weapon program will provide greater insights from this particular case to learn about self-restraint in a nuclear world. The hope is that mapping the kinds of behaviors that states deploy to live with nuclear technology will place the international community in a superior position to grasp the precise causal factors that might trigger some countries to actually go for the bomb.

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International Nuclear Cooperation and Nuclear-Weapon Potential: Japan's Reprocessing Capability Development in the 1950s and 1960s

Akira Kurosaki

By the late 1960s, when nuclear proliferation had become a major issue of concern in the international community, Japan was acquiring the technological capability that would enable it to produce nuclear weapons through civilian nuclear energy development. Since the mid-1950s, Japan had assiduously pursued peaceful uses of nuclear energy with broad domestic support. Under the Atomic Energy Basic Law, which came into effect in January 1956, nuclear energy within Japan could be used only for peaceful purposes. Japan accordingly had no military nuclear program, and refrain from developing and possessing nuclear weapons. However,

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Left: President Truman signs the Atomic Energy Act into law on August 1, 1946.

through civilian nuclear energy development, Japan had been gathering nuclear materials and technology capable of producing weapons. In 1968, a study on Japan's nuclear policy sponsored by the Cabinet Research Office (CRO) of the Prime Minister's Office produced a confidential report on Japan's nuclear-weapon capability. This report examined the military potential of Japan's civilian nuclear program and concluded that Japan would acquire the technology to produce nuclear weapons as early as 1972.[1]

At that time, the key element of Japan's nuclear-weapon capability was its reprocessing technology, derived from its civilian nuclear power development program.[2] Broadly speaking, nuclear bombs can be categorized into two types by the kind of nuclear fissile materials used as explosives: the uranium bomb (highly enriched uranium) and the plutonium bomb (plutonium). Fissile material production requires the dual-use technology originally developed for military purposes: uranium enrichment technology for highly enriched uranium and reprocessing technology for plutonium. In the late 1960s, the Institute of Physical and Chemical Research (IPCR) and the Japan Atomic Fuel Cooperation (JAFC) and its successor organization, the Power Reactor and Nuclear Fuel Development Corporation (PNC) conducted uranium enrichment research, but it was understood that Japan was unlikely to obtain uranium enrichment capability in the near future.[3] In the late 1950s, however, the Japan Atomic Energy Research Institute (JAERI) had begun to research and develop reprocessing technology, and by the late 1960s the JAFC was constructing Japan's first reprocessing plant in Tokai-Mura, Ibaraki Prefecture.[4] Those who were familiar with nuclear technology expected that once the Tokai-Mura plant was completed, by 1972 at the earliest, Japan would have a reprocessing capability that could produce plutonium for military purposes. The 1968 CRO report, for instance, assessed that if Japan were to produce nuclear weapons, its most likely weapon of choice in the foreseeable future would be a plutonium bomb.[5]

How then did Japan develop its reprocessing capability? This chapter focuses on the impact of international nuclear cooperation on Japan's reprocessing capability development in the 1950s and 1960s. In the mid-1950s, the United States sought to use its position as the West's leader in advanced nuclear technology to promote international cooperation on peaceful uses of nuclear energy. President Dwight D. Eisenhower's Atoms for Peace initiative heightened interest in peaceful nuclear power throughout the world, triggering an expansion of international cooperation in the field. Through this initiative, countries with advanced nuclear technology, including the United States, began releasing extensive information on reprocessing technology. In this climate of scientific information-sharing, Japan began to research and develop reprocessing technology, and in the late 1960s it received British and French assistance in designing its first reprocessing plant.[6] Yet other international factors, such as the dissemination of technical information on reprocessing and foreign nuclear assistance, also influenced the development of Japan's reprocessing capability.

This investigation is intended to fill some gaps in previous studies. A number of historical studies have examined the proliferation of uranium enrichment technology, which the U.S. government guarded with secrecy.[7] In contrast, historians have paid relatively little attention to the dissemination of reprocessing technology during that time period.[8] This is understandable, because starting the mid-1950s information on reprocessing technology gradually was declassified and made available to many countries. Yet by the 1970s, especially after India conducted its first nuclear explosion test in 1974, the risk of nuclear proliferation involved in reprocessing technology attracted greater attention and the international community began to take more of an interest in controlling the spread of reprocessing technology.[9] In this situation, in 1977, the U.S. government under President Jimmy Carter tried to put a hold on the Japanese government's decision to start the operation of the reprocessing plant in Tokai-Mura, creating a confrontation between the two countries. This Japan-U.S. dispute over the Tokai reprocessing plant has been the subject of historical studies.[10] However, the existing literature does not explain how international factors influenced Japan's reprocessing capability development before the 1970s. This chapter will shed new light on the link between international nuclear cooperation and the proliferation of reprocessing technology before the 1970s, as well as Japan's development of its potential nuclear-weapon capability through civilian nuclear energy development.

The Dissemination of Technical Information on Reprocessing

Reprocessing technology was originally developed to produce plutonium for military purposes first in the Manhattan Project, the U.S.-led effort to develop atomic bombs during World War II. After the war, the United States sought to maintain its monopoly of nuclear weapons, classifying information on nuclear science and technology under the Atomic Energy Act enacted in 1946. Under the law, the newly established civilian agency, the U.S. Atomic Energy Commission (U.S. AEC), controlled nuclear materials and technology. Consequently, technical information on reprocessing was hidden behind the veil of secrecy until the mid-1950s.[11]

By then, however, effectiveness of the U.S. policy had become highly questionable. In 1949, the Soviet Union succeeded in the first nuclear test to put an end to the United States' nuclear monopoly. Three years later, the United Kingdom also independently developed nuclear weapons, drawing on the technological expertise it had acquired as a partner in the Manhattan Project. Moreover, after the war, countries with or without nuclear weapons began engaging in research and development of nuclear energy for nonmilitary purposes. In the United States, technological developments had generated broad interest in nuclear power in Congress as well as industry, creating political pressure for liberalizing industry's access to nuclear materials and technology held by the government.[12]

Under President Dwight D. Eisenhower, the United States departed from the policy of nuclear secrecy. On December 8, 1953, Eisenhower gave the so-called "Atoms for Peace" address to the United Nations (UN) General Assembly, calling for international cooperation for peaceful uses of nuclear energy. After that, in response to the request of the Eisenhower administration, Congress approved an amendment to the Atomic Energy Act of 1946 in 1954. Under the Atomic Energy Act of 1954, the United States began releasing hitherto classified information on nuclear technology for fostering U.S. nuclear industry and offering nuclear assistance to allies and friendly countries of the United States. In accordance with the law, the United States concluded bilateral agreements for civilian nuclear cooperation with many countries in the late 1950s. In this vein, the United States took the lead in establishing the International Atomic Energy Agency (IAEA) in 1957.[13]

> "Under the Atomic Energy Act of 1954, the United States began releasing hitherto classified information on nuclear technology for fostering U.S. nuclear industry and offering nuclear assistance to allies and friendly countries of the United States."

After Eisenhower's Atoms for Peace address, international cooperation for peaceful uses of nuclear energy expanded, and various countries began engaging in civilian nuclear power development. At that time, reprocessing was considered necessary for the effective utilization of nuclear fuel because of a perceived scarcity of uranium. But reprocessing alone had limited effects on saving resources unless it was combined with the use of breeder reactor technology, "which transmutes non-fissionable uranium into fissionable plutonium and thus produces more fuel than consumed."[14] Thus, countries with or without nuclear weapons were developing reprocessing technology as well as breeder reactor technology for civilian nuclear power, which created a demand for countries to release and exchange information on reprocessing technologies.

In this context, hitherto classified technical information on reprocessing became available for civilian purposes. In August 1955, the International Conference on the Peaceful Uses of Atomic Energy was held in Geneva under UN auspices. Against the background of growing interest in peaceful nuclear energy uses throughout the world, extensive technical information regarding civilian nuclear energy was made public at this conference, which later would be known as "the first Geneva conference."[15] During the conference, two sessions were devoted to "Chemical Processing of Irradiated Fuel Elements." Twenty-two papers were given during these sessions by scientists from centers for nuclear research and development in France, Sweden, the United Kingdom, and the United States.[16] The UN published the conference proceedings the following year.[17]

The release of technical information on reprocessing continued after the Geneva conference. The United States, for instance, provided technical information on reprocessing at the symposium on fuel reprocessing held in Brussels, Belgium, in May 1957 in support of the decision by the member states of the Organization for European Economic Cooperation (OEEC) to establish the European Company for the Chemical Reprocessing of Irradiated Fuel (Eurochemic) as a joint venture.[18] Then, the U.S. AEC organized a symposium on reprocessing in Richmond, Washington, in October 1959, to provide technical information on reprocessing to assist U.S. industry.[19] In the late 1950s and the 1960s, U.S. reprocessing policy was directed to the privatization of commercial reprocessing services.[20]

Bilateral channels also helped disseminate information on reprocessing technology. In the Western world, the United States, the United Kingdom, and France opened their training facilities to scientists and technicians from their allies and friendly countries. These facilities were located at the U.S. national laboratories in Argonne, Illinois, and Oak Ridge, Tennessee; the British Atomic Energy Research Establishment in Harwell; and the center of the French Atomic Energy Commission (Commissariat à l'énergie atomique; CEA) in Saclay, France. These courses featured practical training with experimental reactors in nuclear laboratories, and included training on the chemical technology of irradiated fuel reprocessing of plutonium extraction.[21] These three countries were competing with each other to provide technical assistance to potential customers of their nuclear fuel and reactor technology.

The Beginning of Japan's Civilian Nuclear Energy Development

Against the backdrop of the growing interest in peaceful nuclear power throughout the world, Japan embarked on civilian nuclear energy development in the mid-1950s. During World War II, the Imperial Army and Navy conducted atomic bomb research in Japan. After the war, the defeated country experienced denuclearization by coercion; under the Allied occupation, almost all nuclear study was prohibited in Japan. The end of the occupation in the early 1950s finally lifted the ban on nuclear research, and at the initiative of a small group of conservative politicians, in March 1954 the Japanese national legislature (Diet) approved the first budget for nuclear development. After that, politicians, bureaucrats, and industries began actively exploring how to proceed with nuclear energy development in Japan.[22]

Coincidentally, in Japan, public sentiment against nuclear weapons arose and grew into a "national sentiment" in the years after 1954. In March 1954, a U.S. hydrogen bomb test exposed a Japanese tuna fishing boat, *Daigo Fukuryu Maru* (Lucky Dragon No. 5), to nuclear fallout. This tragic incident had a profound influence on the Japanese people's perception of nuclear weapons. It fomented negative feelings towards these weapons, which resonated with people's fears against involvement in war, as well as their sense of nationalism. This national antinuclear sentiment was expressed though a surging grassroots movement to ban atomic and hydrogen bombs. In 1955, the Japan Council Against Atomic and Hydrogen Bombs (Gensuibaku Kinshi Nihon Kyogikai) was launched as a nationwide umbrella organization, and it grew into a national campaign transcending the boundaries of political camps.[23]

Under this circumstances, the Japanese people desired nuclear energy to be used only for peaceful ends and the Diet approved a series of legislative measures for launching civilian nuclear energy development in Japan. On December 16, 1955, the Diet passed the so-called Three Atomic Power Acts, which become effective on January 1, 1956. These were the Atomic Energy Basic Law, the Establishment of Atomic Energy Commission Law and an amendment for the Office of the Prime Minister to create the Atomic Energy Bureau. Of them, the Atomic Energy Basic Law limited the development and utilization of nuclear energy to peaceful purposes. Subsequently, the Diet approved an act establishing the Science and Technology Agency on March 1, 1956, and acts to establish the Japan Atomic Energy Research Institute and the Atomic Fuel Corporation both on April 30, 1956.[24]

These legislative actions were quickly followed by the emergence of various bureaucracies and research and development facilities. On January 1, 1956, the Japan Atomic Energy Commission (JAEC) was established within the Prime Minister's Office, taking the responsibility for making policy decisions regarding nuclear energy development issues. The prime minister was expected to respect the decisions made by the JAEC, whose chairman was a minister of state. After its foundation in May 1956, the Science and Technology Agency (STA) became the center of the government's nuclear energy administration, incorporating the Atomic Energy Bureau, which initially had been created within the Prime Minister's Office. From that point on, the STA director served as the JAEC chairman.[25]

Two organizations that played key roles in Japan's reprocessing capability development in the late 1950s and 1960s were also established: JAERI in June 1956, and JAFC in August of the same year. The JAERI operated under the auspices of the STA, as a statutory corporation responsible for general research on nuclear power and the design, construction, and operation of nuclear reactors. All research and development concerning nuclear fuel was delegated to the JAFC, another special statutory corporation.[26]

As Japan explored a comprehensive program to promote civilian nuclear energy development, it welcomed international cooperation for peaceful nuclear power and began seeking assistance. In January 1955, the Japanese government received an offer from the U.S. government under President Eisenhower to provide enriched uranium and technical assistance to construct research reactors. In response to this U.S. proposal, in May, the Japanese government decided to negotiate a civilian nuclear cooperation agreement with the U.S. government. The two governments then started the negotiations on June 2 and reached a provisional agreement on the 21st of that month. After Tokyo and Washington signed the bilateral nuclear cooperation agreement on November 14, the Diet approved it on the 27th of that month. Consequently, Japan received enriched uranium and two research reactors from the United States. These reactors named Japan Research Reactor No. 1 (JRR–1) and No. 2 (JRR–2) were constructed at the JAERI site in Tokai-Mura.[27]

The Formation of Japan's Nuclear Fuel Policy and Reprocessing

Under the circumstances, Japan's nuclear fuel policy was formulated based on the assumption that as the Japanese economy grows and the population increases, the demand for electric power also will increase. Moreover, because Japan has scant natural resources, it was recognized that it would have to import more energy sources to meet its increased demand for power. Japan, however, was suffering a chronic trade deficit and needed to conserve foreign currency reserves. In this situation, nuclear energy was regarded as a promising energy source for Japan, because it seemed possible for Japan to achieve the self-sufficiency of nuclear fuel for power and decrease the overall dependence on foreign energy supply.[28]

In September 1956, the JAEC approved the first "Long-Term Program for Development and Utilization of Atomic Energy," in which the JAEC set the basic goal of Japan's nuclear fuel development policy:

> We should aim to develop, to the greatest extent possible, a domestic supply of nuclear fuel. Research and development of local resources should be conducted in earnest and the efforts of the private sector should be encouraged towards these ends. Any deficiency should be met by overseas imports. In order for our country to establish an adequate nuclear fuel cycle in the future, the development of a breeder reactor and spent fuel reprocessing technology is necessary.[29]

In other words, the JAEC considered that Japan initially would have to rely on foreign nuclear fuel supply and nuclear reactor technology, but that it must develop uranium resources at home for domestic nuclear fuel production and pursue the development of reprocessing and breeder reactor technologies for the effective utilization of nuclear fuel and the establishment of the nuclear fuel cycle.

Regarding the development of reprocessing technology, the JAEC adopted a policy of indigenous development. The 1956 Long-Term Program stated:

> [i]t is our basic policy to conduct reprocessing using domestic technology as much as possible and this will be exclusively done by the Japan Atomic Fuel Corporation. Initially, the Japan Atomic Energy Research Institute conduct reprocessing research. Then, reprocessing will be performed exclusively by the Japan Atomic Fuel Corporation to prevent the dispersion of nuclear fuel materials and to ensure safety.[30]

Accordingly, the JAERI and the JAFC sought to fulfill their respective responsibilities in reprocessing technology development thereafter.

In formulating and implementing the policy of indigenous development, the Japanese could learn technical information on reprocessing disseminated through various channels. Soon after the 1955 Geneva conference on peaceful nuclear energy, for example, a member of the Japanese delegation and chemical engineer, Yagi Sakae, contributed articles to scientific journals that explained reprocessing technology based on the conference's materials.[31] The Japanese government also sent government officials, scientists, and technicians to learn reprocessing technology at the International School of Nuclear Science and Engineering at the Argonne National Laboratory in the United States from 1955 and the Harwell Reactor School at the Atomic Energy Research Establishment in the United Kingdom from 1956.[32]

The JAERI seemed to benefit from the continued dissemination of technical information on reprocessing. After 1957, the JAERI conducted various basic studies and developmental research on reprocessing testing devices. In 1959, it succeeded in the separation of micrograms of plutonium, and then designed a reprocessing testing facility that began construction in 1961.[33]

According to Shimamura Takehisa, who served as the Atomic Energy Bureau chief of the STA in the early 1960s, the JAERI relied on materials from the Brussels reprocessing symposium for designing the facility.[34] The JAERI also purchased technical information on Purex and Thorex methods of reprocessing plutonium and thorium, respectively, from a U.S. firm, Kaiser Engineers.[35]

In the meantime, Japan concluded bilateral civilian nuclear cooperation agreements with the United States and the United Kingdom in June 1958. For Japan, the main purpose of these agreements was to obtain nuclear reactors and fuel to expedite the introduction of nuclear power generation. Under the 1958 Japan–U.S. agreement, Japan received enriched uranium for nuclear reactors and a demonstration power reactor named the Japan Power Demonstration Reactor from the United States. Under the 1958 Japan–UK agreement, Japan received a power reactor and natural uranium for its fuel from the United Kingdom. The British-made reactor was an Advanced Calder Hall–type reactor fueled by natural uranium and moderated by graphite.[36] Notably, each of the bilateral agreements stipulated that Japan would reprocess the spent fuel originally provided by the United States and the United Kingdom. Moreover, the Japan–UK agreement included a provision providing British assistance to help Japan develop reprocessing technology.

The Japan–U.S. nuclear cooperation agreement of 1958, which superseded the 1955 bilateral agreement, aimed at promoting cooperation in various ways such as the exchange of information between the two countries in the civilian nuclear power field. The scope of cooperation covered the development and utilization of nuclear reactors and related issues. Thus, although the Japan–U.S. agreement of 1958 did not specify bilateral cooperation concerning reprocessing, the U.S. government occasionally conveyed messages to the Japanese government and industry that it would provide U.S. technical assistance to Japan's reprocessing program in the late 1950s and the early 1960s.[37] In this relation, then, the new agreement stipulated how to reprocess the spent fuel originally provided by the United States to Japan and produced in nuclear reactors in Japan as follows: "such reprocessing shall be performed at the discretion of the United States [Atomic Energy] Commission in either United States Commission facilities or facilities acceptable to the United States Commission, on terms and conditions to be later agreed."[38] In contrast to the 1955 agreement, which prescribed that spent fuel originally provided by the United States to Japan should be returned to the provider (the U.S. AEC), the 1958 agreement permitted Japan to perform reprocessing in the future without specifically referring to it.[39] Nevertheless, the U.S. monopoly over the right to choose facilities for reprocessing constituted its veto power over Japan's reprocessing of U.S.-origin spent fuel.

The scope of cooperation under the Japan–UK agreement of 1958 was broader than that under the Japan–U.S. agreement of 1958. The most notable difference is that, the former specifically mentioned British assistance to Japan's reprocessing capability development as follows: "The [UK Atomic Energy] Authority shall provide to the Government of Japan or to persons authorized by that Government, on commercial terms, assistance in the design, construction and operation of facilities for the manufacture of fuel in Japan and for the processing of used fuel in Japan, or shall facilitate the procurement by the Government of Japan or by persons authorized by that Government of such assistance."[40] Moreover, under the Japan–UK agreement, the two governments agreed that "[t]he Authority shall process used fuel from research and power reactors operating in Japan, to such an extent and on such commercial terms as may be agreed, or shall assist the Government of Japan or persons authorized by that Government in arranging for such processing in the United Kingdom."[41] The Japan–UK agreement thus established the option for Japan to rely on reprocessing services in the United Kingdom.

From Indigenous Development to Foreign Technology Imports

By the end of the 1950s, the JAEC began examining its policy on developing reprocessing technology in connection with the formulation of the next long-term program on nuclear- energy development. In June 1959, the JAEC set up the Reprocessing Special Committee (RSC), and instructed it to conduct substantial studies on the issue. During the investigation, an RSC member from the JAFC, Imai Yoshiki, reported his participation in the U.S. AEC Symposium on reprocessing at the meeting of the committee on November 10, 1959. On May 27, 1960, the RSC submitted the intermediate report, in which it advised the JAEC to construct a pilot plant with a reprocessing capacity of approximately 350 kilograms of spent nuclear fuel per day.[42]

The RSC's advice was reflected on the second "Long-Term Program for Development and Utilization of Atomic Energy," which the JAEC adopted on February 8, 1961. Regarding spent fuel, the JAEC announced the policy that spent fuel produced in reactors should be disposed in accordance with international agreements, and, as the production of nuclear power increased, reprocessing should be performed in Japan. Then, the JAEC set the goal that the JAFC complete the construction of the reprocessing pilot plant in the latter half of the 1960s, with no reference to foreign technical assistance for the project. The JAEC upheld the policy of indigenous development of reprocessing capability in its 1961 long-term program.[43]

However, this plan was abandoned shortly afterward, out of an expectation that Japan would soon have more spent fuel that required reprocessing. As noted earlier, Japan purchased an Advanced Calder Hall-type rector and its nuclear fuel from the United Kingdom, and the Japan Atomic Power Company (JAPC) established by nine electric power companies and the Electric Power Co. (Dengen Kaihatsu) in November 1957 became the operator of the nuclear power plant constructed in Tokai-Mura, in which the British-made reactor was installed. The Tokai nuclear power plant went into operation in 1966.[44] Independently of the JAPC, in the early 1960s, private power utilities were planning to build nuclear power plants.[45] Thus, it was expected that as more nuclear power plants went into operation, Japan would have more spent fuel that required reprocessing.

Around this time, the United States and some European countries had made progress in industrializing spent fuel reprocessing. In the United States, the U.S. AEC was seeking to privatize its reprocessing services, and the Industrial Reprocessing Group of six private firms was looking into constructing a reprocessing plant. In the United Kingdom, the UKAEA had operated a reprocessing plant in Windscale, and was constructing the second plant there. In France, the first reprocessing plant in Marcoule had been in operation since 1958. Moreover, the Eurochemic company was planning to construct a reprocessing pilot plant.[46] These developments in the United States and Europe persuaded Japan to expedite its reprocessing capability development.

> "...Japan purchased an Advanced Calder Hall-type rector and its nuclear fuel from the United Kingdom, and the Japan Atomic Power Company (JAPC) established by nine electric power companies and the Electric Power Co. in November 1957..."

In this situation, after the submission of the intermediate report, the RSC continued extensive investigation on Japan's policy to develop its reprocessing capability. From April to May 1961, it dispatched an investigating team overseas to visit reprocessing facilities in the United States and European countries. As a result of the investigation, the RSC concluded that nuclear fuel reprocessing technologies had already reached the stage of practical application. On April 11, 1962, it submitted its final report to the JAEC, recommending that Japan import foreign technology to construct a commercial reprocessing plant. The facility was intended to have a reprocessing capacity of 0.7 to 1 ton per day and be completed by 1968. The committee also suggested the preliminary design of the plant to be commenced between April 1962 and March 1963.[47]

The JAEC officially approved this policy in 1964. Along with the committee's final report, on June 15, 1964, the JAEC issued a paper entitled "Regarding Policies for Domestic Nuclear Fuel Reprocessing and Plutonium Procurement." This paper indicated its policy to commence the operation of a plant with a reprocessing capacity of 0.7 ton per day (or 210 tons per year) from as early as 1970. However, because the JAEC lacked confidence in commercially run reprocessing undertakings, it also proposed that the government fund both the reprocessing plant construction and the plutonium procurement. The Ministry of Finance strongly disapproved of this proposition, and the JAEC decided to construct the plant on borrowed capital and to abandon the idea of government-procured plutonium. However, Japanese government would finance the plant design.[48]

Even before the JAEC officially adopted the RSC's advice, the JAFC had taken steps to construct the reprocessing plant in line with the committee's recommendations.[49] First, the JAFC sought technical assistance for the preliminary design of the reprocessing plant. According to Shimamura, right after the submission of the RSC's final report, the JAFC contacted 10 firms in the United States, the United Kingdom, and France to submit cost estimates of the preliminary plant design. Among them, six firms responded to the bid, resulting in the JAFC to sign a contract with a British firm, Nuclear Chemical Plant

Co. (NCP), in October 1963. The JAFC also chose a U.S. firm, Weinrich & Dart, as a design consultant.[50]

Before the preliminary plant design was completed at the end of 1964, the JAFC called for tenders of the detailed plant design in August 1964. In response to this call, NCP and a French firm, Saint-Gobain Nouvelles (SGN) provided cost estimates. SGN had built the Eurochemic reprocessing plant and helped construct a reprocessing plant in Israel.[51] As the main contractor of the preliminary plant design, NCP had the advantage over SGN for the bid. Nevertheless, SGN offered a much lower price than NCP did. NCP's cost estimate was over 7 billion yen (roughly $19 million at the exchange rate at that time), which was six times as large as the budget prepared for the detailed plant design.[52] British foreign minister Michael Stewart lobbied for NCP at his meeting with Prime Minister Sato Eisaku in Tokyo in October 1965.[53] However, with Sato's approval, the JAFC chose SGN above NCP, entering into a contract with the former in February 1966.[54]

The groundwork for French assistance to Japan's reprocessing plant construction project had been made without a formal nuclear cooperation agreement between the two governments in the early 1960s, when nuclear cooperation dialogues between Japan and France had started. In November 1962, the first Japan–France conference on nuclear technology was held in Tokyo, hosted by the Japan Atomic Industry Forum. The French delegation included 47 members in public and private sectors. The second conference was held in Paris in April 1964. In between these conferences, two sides had been discussing concrete issues for Japan–France cooperation, including the introduction of technology from France for the construction of a reprocessing plant in Japan.[55] Pursuing their economic interest in civilian nuclear cooperation with Japan, the French competed with the British in providing technical assistance to Japan's reprocessing plant construction project.[56]

Toward the Construction of the Reprocessing Plant

As the JAFC was working with SNG to complete the detailed plant design, the JAEC adopted the "Long-Term Program for Development and Utilization of Atomic Energy" on April 13, 1967. The program clearly stated the goal that Japan should be the one to reprocess the spent nuclear fuel. Regarding the provider of reprocessing services, the program announced that at first the JAFC would be responsible for the reprocessing, but eventually it would be carried out by private enterprises.[57]

Soon after, however, the JAFC was abolished and incorporated into a public corporation, the PNC. The Power Reactor and Nuclear Fuel Development Establishment Law was passed in the upper and lower houses of the Diet in July 1967. Three months later, on October 2, 1967, the PNC formally began operating. From then on, the PNC oversaw the government nuclear-development project for the next quarter of a century, and became the organization that controlled not only the development of the power reactors but also the development of nuclear fuel following its merger with the AFC.[58] Therefore, the PNC took the responsibility for the reprocessing plant construction project.

While the PNC worked on for the construction of the reprocessing plan, the JAERI ended its research and development into reprocessing technology. After the completion of the reprocessing testing facility, the JAERI conducted cold tests, and finally began a hot test of its reprocessing testing facility on March 26, 1968—though it extracted only 208 grams of refined plutonium by the end of the test period, March 25, 1969. However, this was the peak of the JAERI's research and development activities. Its reprocessing testing facility, which also was used to train JAFC personnel, closed in 1970.[59]

Meanwhile, in the late 1960s, Japan was becoming more dependent on the United States for its nuclear reactor technology and nuclear fuel supply. During that time period, the U.S.-designed light water reactor (LWR) was considered to be economically competitive enough to be used for commercial power generation, enjoying a boom around the world. Thus, the JAPC chose a U.S.-designed LWR for the second commercial power plant in 1966, and private power companies followed by introducing U.S.-designed LWRs for commercial power production.[60] In view of these developments, the Japanese government negotiated with the U.S. government to revise the 1958 nuclear cooperation agreement, which was set to expire in 1968. For Japan, the primary objective was to secure the U.S. supply of enriched uranium used as the fuel for U.S.-designed LWRs. At that time, only the United States had the ability to provide Western countries with enriched uranium for civilian uses. In February 1968, the Japan–U.S. negotiations resulted in a new atomic energy cooperation agreement, under which Japan was able to purchase U.S.-designed LWRs and the United States agreed to provide Japan with enriched uranium as nuclear fuel for 30 years. Consequently, in Japan, all commercial power reactors constructed and run after the Tokai power reactor have been LWRs.[61] This also meant that, as more nuclear power plants equipped with the U.S.-designed LWR went into operation, the amount of spent fuel produced in power reactors and originally provided from the United States would increase in Japan.

The United States was not opposed to Japanese reprocessing of U.S.-origin spent fuel on its soil. At the JAEC councilors' meeting on January 18, 1967, the STA Atomic Energy Bureau chief reported that the Japanese side had conveyed to the U.S. side that it desired to conduct reprocessing of U.S.-origin spent fuel at the JAFC's reprocessing plant, and had obtained U.S. consent.[62] Based upon this understanding, in the negotiations to revise the Japan–U.S. nuclear cooperation agreement of 1958, Japanese negotiators sought to specify Japan's option to perform domestic reprocessing in the superseding agreement.[63] As a result of the negotiations, Article VIII of the Japan–U.S.

nuclear cooperation agreement of 1968 provided that reprocessing "may be performed in Japanese facilities upon a joint determination of the Parties that the provisions of Article XI may be effectively applied."[64] The provisions of Article XI stipulated safeguards.[65] Thus, even though the U.S. government conceded Japan's option to conduct domestic reprocessing of U.S.-origin spent fuel under the new agreement, it maintained its veto power over such reprocessing in Japan to prevent Japan from diverting its reprocessing capability for military purposes.[66] The U.S. government was well aware that once the construction of the reprocessing plant was completed, Japan would be able to produce weapon-grade plutonium.[67] As its response to Japan's reprocessing program illustrates, Washington did not oppose the construction of reprocessing facilities or even plutonium stockpiling for peaceful purposes under effective safeguards, though it recognized the proliferation risk of nuclear latency.[68]

"What made the location issue more complicated and enhanced local concerns was the existence of the U.S.-owned Mito air-raid firing range in Katsuta City (currently Hitachinaka City) adjoining Tokai-Mura."

The construction of the first Japanese reprocessing plant finally started, behind schedule, in 1971. SGN completed the detailed plant design on January 15, 1969, but it took another two-and-a-half years before starting the plant construction. A major cause of the delay was strong resistance to the location of the plant. Although the Japanese government sought to construct the reprocessing plant in Tokai-Mura, local residents and governments opposed the project out of safety concerns. What made the location issue more complicated and enhanced local concerns was the existence of the U.S.-owned Mito air-raid firing range in Katsuta City (currently Hitachinaka City) adjoining Tokai-Mura. After many twists and turns, however, the

Japanese government managed to obtain a local government consent on plant construction in the spring of 1970. After that, in preparation for plant construction, the PNC signed contracts with SGN and its Japanese subcontractor, the Japan Gasoline Co., Ltd. (Nihon Kihatsuyu, abbreviated as Nikki) on December 10, 1970, and plant construction began on June 11, 1971.[69] Accordingly, the Tokai reprocessing plant was built with French technical assistance.

Conclusion

In the 1950s and the 1960s, Japan developed its reprocessing capability as a part of its civilian nuclear power program. Since the beginning of its civilian nuclear energy development in the mid-1950s, Japan sought to establish control over its nuclear fuel cycle as an ultimate goal for its energy security and related economic considerations. The development of reprocessing technology, combined with that of breeder reactor technology, was considered indispensable to achieve that goal. In Japan, there was a national consensus to promote the development and utilization of nuclear power for peaceful purposes, and the goal to develop its reprocessing capability gained broad political support. Moreover, against the backdrop of expanding international cooperation for peaceful uses of nuclear energy, Japan could receive nuclear assistance from advanced nuclear power countries such as the United States and the United Kingdom to expedite the introduction of nuclear power production, which resulted in a growing amount of spent fuel that requiring reprocessing in Japan.

Under the circumstances, international nuclear cooperation significantly influenced Japan's development of reprocessing capability. First, the dissemination of technical information on reprocessing since the mid-1950s created opportunities for Japanese to learn advanced reprocessing technology through bilateral and multilateral channels, increasing their interest in developing the domestic reprocessing capability. The JAERI's research and development efforts seemed to benefit from released information on reprocessing technology. It is not clear if and how its results and experience were utilized in the reprocessing plant construction project of the JAFC and later the PNC. However, through various channels the Japanese learned technical information on reprocessing, which they could use to formulate JAEC policy for developing reprocessing capabilities.

Foreign technical assistance made it possible for Japan to adopt a foreign technology import strategy for reprocessing plant construction. Western countries with advanced nuclear technology did not oppose Japanese efforts to develop reprocessing capability, and the United Kingdom and France were willing to provide technical assistance to construct Japan's first reprocessing plant. In view of the slow pace of progress in the JAERI research and development project, French technical assistance for the plant design undoubtedly helped Japan begin to construct its reprocessing plant sooner than otherwise would have been possible. The United States did not actively assist Japanese efforts to develop a reprocessing capability, but the U.S. government approved Japan's domestic reprocessing of U.S.-origin spent fuel under effective safeguards, when such spent fuel was expected to increase in Japan. Consequently, Japan could establish its reprocessing infrastructure before the diffusion of reprocessing technology emerged as a serious proliferation concern in the 1970s.

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53 Oa kyoku Eirenpo ka, "Sato sori to Sutuwato Eigaisho tono kaidan kiroku," October 20, 1965, Nihon Eikoku kan gaiko, Nichi-Ei teiki kyogi kankei, dai 4 kai kankei, kaidan kankei, A'.1.3.1.1-4-4-1, The Diplomatic Archives of the Ministry of Foreign Affairs of Japan (hereafter DAJ), Tokyo.

54 Shimamura, *Shimamura Takehisa*, 57; Mori, *Gensan hanseiki*, 29; and Yoshioka, "The Development of Nuclear Fuel-Cycle Technology," 235–36.

55 Yoneho Tabata, "Nichi-Futsu genshiryoku bunya ni okeru kyoryoku no yoake," in Genshiryoku Shisutemu Konwa Kai, *Genshiryoku kaihatsu*, 114–15.

56 According to a cable from US Embassy in Paris to Washington, "CEA heavily involved in SGN–AFC contract negotiations since CEA owns patent rights on reprocessing processes. Apparently high royalties sought by CEA was sticky matter during negotiations." Telegram, Paris to Secretary of State, Safeguards–Japanese chemical reprocessing plant, January 5, 1966, JAPAN AE13: Safeguards 1965 1966, Box 2, U.S. Mission to the International Atomic Energy Agency, Classified Country Files, 1960–1970, Record Group (hereafter RG) 84, U.S. National Archives and Records Administration, College Park, MD (hereafter NACP).

57 Skolnikoff, Suzuki, and Oye, "International Responses to Japanese Plutonium Programs," 2–3; and "Genshiryoku kaihatsu riyo choki kihon keikaku [soron]," *GIG* 12, no. 4 (April 1967).

58 Yoshioka, "The Development and Utilization of Nuclear Reactors," 232.

59 Yoshioka, "The Development of Nuclear Fuel-Cycle Technology," 236–37.

60 Yoshioka, "The Development and Utilization of Nuclear Reactors," 226–28.

61 Ibid., 228–29; and Kurosaki, "Nuclear Energy and Nuclear-Weapon Potential," 61–62.

62 Kokusai rengo kyoku kagaku ka, "Genshiryoku Iinkai Sanyokai giji hokoku," January 18, 1967, Genshiryoku no heiwateki riyo ni okeru kyoryoku no tameno Nichi-Bei kan kyotei, 1 Kyosho keii, B'5.1.0.J/U 22, DAJ.

63 Kagaku gijutsu cho genshiryoku kyoku, "Nichi-Bei genshiryoku kyotei kaitei no kihon hoshin [an] ni tsuite," January 25, 1967, ibid.

64 Agreement for Cooperation between the Government of the United States and the Government of Japan Concerning the Civil Uses of Atomic Energy, Atomic energy (cooperation for civil uses) 19 U.S.T. 5214 (1968).

65 Ibid.

66 Kurosaki, "Nuclear Energy and Nuclear-Weapon Potential," 62–63.

67 Ibid. 54–56.

68 At the meeting with an Italian Embassy official on July 5, 1967, the U.S. Arms Control and Disarmament Agency chief of political affairs, Robert H. Kranich, explained that, under the then-negotiated Nuclear Nonproliferation Treaty (NPT), its parties would be permitted "to possess power reactors and to stockpile plutonium," and safeguards were intended only to ensure that nuclear materials would not be diverted to weapons production. Memorandum of Conversation, Petrignani and Kranich, Italian Proposal for Modification of Withdrawal Provision in the NPT, July 5, 1967, DEF 18-6 7/1/67, Box 1733, Subject Numeric File 1967-1969, RG 59, NACP. The author owes this reference to William Burr at the National Security Archive (Washington, DC).

69 Yoshioka, "The Development of Nuclear Fuel-Cycle Technology," 236.

International Nuclear Bluff and Bluster: South Korea's Nuclear Latency in the 1970s

Lyong Choi

Introduction

Under Park Chung-hee's leadership, the Republic of Korea (ROK; South Korea) developed a clandestine nuclear-weapon program in the early 1970s. The program was suspended in 1976 but revitalized in the late 1970s, and it ended after Park's death in 1979. Because of the dual-use nature of nuclear technology, the intensive competitiveness of the nuclear industry's international market, and different perspectives on nuclear proliferation, South Korea was able to secure the skills and technologies for potential nuclear armament. Today, South Korea is one of the most advanced states in nuclear technology, and it would not have any technological difficulties in building a nuclear arsenal.[1] However, regarding its nuclear latency, South Korea's nuclear program and denuclearization in the 1970s and 1980s have produced many rumors and theories that often exaggerate the level of its nuclear capability. The potential and impact of Park Chung-hee's nuclear program are often discussed, especially when South Korea is threatened by North Korean nuclear weapons. However, despite the popularity of this issue, the research on the exact picture of

South Korea's nuclear program has been limited mainly by the lack of archival records and of access to sensitive records.

Using newly declassified Korean and American archival records, this chapter briefly chronicles South Korea's efforts to pursue nuclear armament and latency in 1970s. Under the pressure of Koreanization and North Korean threat, the Park Chung-hee government pushed ahead with its ambitious nuclear program. This research examines the level of South Korea's nuclear technology and its diplomatic efforts to secure the requirements for nuclear arms in the 1970s. Especially, this research highlights the milestones of South Korea's nuclear history, ROK-Canada discussions on the introduction of Canada Deuterium Uranium (CANDU) reactors in South Korea, the contracts between South Korea and France for reprocessing technology in 1974, the suspension of South Korea's nuclear program by American pressure in 1976, and the efforts to revitalize the nuclear program from 1977 to 1979.

Historical Background

The South Korean nuclear program began during the Cold War's détente era, as the United States began to ease relations with the People's Republic of China and the Soviet Union and, under the logic of the Nixon Doctrine, reduce its military support for South Korea. Until his assassination in October 1979, South Korea's president Park Chung-hee made a number of decisions and actions related to South Korea's development of nuclear arms. After Park's demise, however, the new military regime under Chun Doo-hwan ceased and discarded the nuclear program.[2] Revelations of North Korea's nuclear program in the early and mid-1990s—and Pyongyang's major strides in developing nuclear weapons since—have shocked South Korean society. In light the North Korean nuclear threat, academics and policymakers alike have reevaluated Park's efforts to obtain nuclear arms. During and after the first North

Korean nuclear crisis in June 1994, the popularity of South Korea's putative nuclear program was demonstrated in a series of former policymakers' testimonies in political magazines that recounted information on Park's nuclear decision-making, as well as in an alternative historical novel that assumed that South Korea had succeeded in its nuclear aims.[3] Interestingly, many of these witnesses of Park's nuclear program viewed nuclear war as an ultimate weapon that could resolve almost all of South Korea's problems, from the North Korean threat to American pressure on South Korean leadership to the road to becoming a strong regional power in East Asia. They frequently expressed frustration that Park's death had ended South Korea's nuclear effort. Their testimonies often began with statements along the lines of "One day, President Park said to me that South Korea will be one of the nuclear powers within 'N' years (or 'N' months)" and ended with the fact that he was killed not long after, before completing the nuclear program.[4]

The witnesses and novelists seeking to defend Park Chung-hee's nuclear gamble have conveniently ignored the many obstacles that stood in the way of the program, and even overlooked Park's diplomatic efforts to use his fledgling nuclear-weapon program to secure an American commitment to South Korea's national security. One of the biggest obstacles was Washington itself, on which Seoul relied for its national security and economic development, and the nonproliferation efforts of U.S. policymakers.[5] Indeed, in the early 1970s South Korea entered into negotiations with France—which was willing to sell reprocessing facilities and technologies to South Korea in 1973—and was determined to secure the core technologies for plutonium useable in nuclear weapons. However, India's nuclear test in 1974 alarmed the White House, and frustrated Park Chung-hee's plans to obtain nuclear weapons. Because the United States rejected nuclear proliferation as an option for its allies in East Asia, South Korea could not have realized its nuclear ambitions without damaging its relations with the United States. First and foremost, Seoul would have had to conduct nuclear tests if it wanted to have effective warheads. Considering American intelligence capabilities on South Korean territory, it is highly unlikely that a nuclear test could have been conducted secretly. Second, as the former policymakers themselves admitted, South Korea still needed to secure reprocessing plants and technologies from abroad in order to produce nuclear weapons within a few years.[6] Seoul's diplomatic efforts for the plants, however, regularly ran into opposition from the White House. Even if South Korea could have indigenously developed reprocessing facilities, it would have faced the even more difficult challenge of constructing them without being detected. Finally, even if one were to ignore all of these operational difficulties, South Korea probably would not ultimately have taken the political risks involved in becoming a nuclear power because of the severe economic hardships it suffered in the late 1970s and early 1980s following the second oil shock of 1979.[7] Simply put, South Korea was not in a strong position to develop nuclear weapons, even though it had the latent expertise to produce these weapons. After realizing that American pressure had made nuclear-weapon development impossible, the Park government negotiated with the United States on the American commitment to South Korean national security by using its latent nuclear-weapon program as leverage.

Declassified government records available in the South Korean and U.S. archives clearly demonstrate these political challenges to Park Chung-hee's nuclear program. Although Park's sudden death in 1979 prevented him from ever offering a full account of his motives and the anxieties behind the program, many documents he penned or commented on offer valuable evidence from which to assess his nuclear aspirations. This evidence can help put to rest the revisionist accounts of, and myths surrounding, South Korea's nuclear program that have proliferated in recent years.

The Two-Track Diplomatic Approach for the Plutonium Bomb

Beginning in 1972, the Blue House examined the potential for scientific and technical cooperation with countries possessing nuclear capabilities.[8] According to Oh Won-cheol, who took charge of the South Korean defense industry in the 1970s, Seoul decided to build plutonium warheads rather than highly enriched uranium ones mainly because of the country's level of nuclear technology and time considerations.[9] The Blue House attempted to secure the required technologies and facilities from Canada and France. South Korea negotiated with Canada in order to import a CANDU reactor and a National Research Experimental Research Reactor (NRX), and spoke to France about reprocessing facilities beginning in 1973.

CANDU AND NRX CONTRACT

To maximize the production of plutonium from spent nuclear fuel without facing inspections from the United States, South Korea's nuclear experts determined that they needed to secure CANDU and NRX reactors, which use heavy water as a moderator.[10] South Korea easily concealed its intention to pursue nuclear armament under the cover of a civil program, claiming that its growing economy increasingly required new sources of electricity to meet domestic demands. Moreover, Canada often found it difficult to secure potential customers for CANDU reactors because light water reactors dominated the international market. In August 1973, Canada and South Korea reached an agreement for the export of CANDU and NRX as a package. However, in 1974, India conducted a nuclear test with plutonium it had produced through a NRX. Following the Indian nuclear test, Canada cancelled this package deal and decided to export CANDU only.[11] Furthermore, Canada demanded that the South Korean government ratify the Treaty on the Nonproliferation of Nuclear Weapons (NPT), which the latter had signed in 1968 but had not formally ratified.

ROK-FRANCE AGREEMENT ON PLUTONIUM REPROCESSING FACILITIES, 1974

France offered the most favorable reaction to South Korea's interest in acquiring reprocessing plants and technologies. After South Korean science and technology minister Choi Hyeong-seop visited Paris in May 1972, the ROK Ministry of Science and Technology and France's Commissariat a l'energie atomique (Atomic Energy Commission) entered negotiations for the transfer of plutonium reprocessing facilities and technologies from France to South Korea and the establishment of a pilot plant for research. In 1974, the South Korean and French governments furthered their cooperation when they exchanged a Memorandum of Understanding (MOU) for the Peaceful Uses of Nuclear Energy. This MOU, which recently was declassified by the South Korean Ministry of Foreign Affairs, explained how and why the Korean and French governments made such an agreement. This document contains some suspicious passage; for instance, it keeps referring to "nuclear materials for special interest" without defining the special interest.[12] According to the agreement reached in Paris in October 1974, South Korea demanded that France supply technologies for forming and reprocessing fuel rods. These technologies, nominally intended for nuclear energy, also can be used to develop weapon-useable plutonium. The ROK-France MOU repeatedly emphasized the peaceful uses of nuclear energy, but it its stipulations it did consider the technologies for weapon-grade useable plutonium and ways to avoid the IAEA inspections of this technical cooperation. Based on this information, it is highly likely that South Korea attempted to introduce the essential technologies and facilities for producing nuclear warheads from France, which was less reluctant than the United States to provide reprocessing technologies to South Korea.

ROK-U.S. Agreement on Nuclear Energy Technologies, 1976

In the aftermath of the agreement between Seoul and Paris on nuclear technologies, the U.S. government under President Gerald Ford began to investigate and tried to constrict South Korea's nuclear program. Once India conducted its nuclear test in 1974, Secretary of State Henry Kissinger began to pay attention to the ROK-France and ROK-Canada negotiations for nuclear technologies.[13] Kissinger and Canadian foreign minister Allan J. MacEachen discussed South Korea's intentions and potential for nuclear development, and Canada demanded that South Korea join the NPT. On January 6, 1975, MacEachen sent a letter to his South Korean counterpart Kim Dong-jo, stating that Canada would only export CANDU on the condition that South Korea would sign the NPT and give up nuclear weapons and other military explosives.[14] On January 17, 1975, President Park received a cable from Kim Young-ju, the ROK ambassador to Canada. Kim reported that South Korea would be able to build three to six nuclear weapons a year if it introduced a CANDU reactor. However, he did not consider it possible, stating, "if [the United States] restricts uranium supply, it is impossible to secretly produce nuclear weapons."[15] Seoul voted to ratify the NPT in March 1975 and officially denied accusations about its nuclear-weapon program.[16]

In contrast to Canada, France did not cancel its contract with South Korea on reprocessing technologies, even in the face of American pressure. Serious opposition to nuclear proliferation in Northeast Asia and pressure from Washington prevented the actual transfer of reprocessing technologies from France to South Korea. Franco-American discord on the past French nuclear program and European politics, however, prompted France to strongly resist U.S. pressure to cancel the contract with South Korea. Considering the influence of France on Europe, Washington refrained from worsening its relationship with Paris. Instead, the Ford administration strongly pushed

South Korea to break the contract.[17] The situation was not totally negative for Seoul. Despite France's stubborn stance, the Blue House demanded that, in exchange for heeding the contract, the White House provide reassurances of its commitment to South Korea, transfer American nuclear technologies, and provide economic support for that transfer.[18] Further, the Blue House even requested that the White House pay the cancellation fee for breaking the contract with France.[19]

In January 1976, South Korea began to reconsider its contract with France and intended to freeze its nuclear program. Minister Choi Hyung-seob and the U.S. Atomic Energy Commission's assistant general manager for international activities, Myron Kratzer, had an unofficial meeting and discussed the terms and conditions for the ROK-U.S. nuclear partnership. The two men also agreed to have a plenary meeting in June 1976 and to establish a joint standing committee for the ROK-U.S. nuclear partnership. The U.S. government expressed its appreciation of the ROK decision to reconsider the acquisition of the reprocessing facility, and indicated that a decision not to proceed with this project, if taken, would strengthen cooperation with the ROK government in the peaceful uses of nuclear energy. In September 1976, South Korea cancelled its contract with France and officially stopped its nuclear program. Nuclear plants in South Korea started to be constructed based on American support and technology. In return, the United States reinforced safety regulations and monitoring for nuclear energy in order to prevent the South Koreans from reviving their nuclear-weapon program. The United States supplied and monitored these nuclear facilities, and new U.S. regulations banned the import of uranium for nuclear weapons.[20]

Reconsidering South Korea's Nuclear Deterrence and Latency, 1977–79

Barely a few months after the conclusion of the ROK-U.S.

agreement on South Korea's nuclear program, Seoul regretted its fast decision to cancel the French deal. In contrast to Park's expectation, his trustworthy partner, Gerald Ford, lost the 1976 U.S. presidential election to Jimmy Carter. The new president withdrew Ford's decision on security commitment to South Korea and announced that the U.S. land forces also would be removed. Carter also pushed Park to reconsider his authoritarian rule in South Korea, often referring to human rights issues in South Korea. The Park government resisted the pressure from Washington, and in 1977 it revealed to the press its intention to revive its nuclear-weapon program.[21] Nevertheless, U.S. monitoring made it difficult for South Korea to develop nuclear-weapon technologies. Even worse, the route for international partnership, primarily with France, also was well known, and the White House frustrated a second round of negotiations with France was frustrated. Instead, South Korea made indirect but threatening gestures in front of U.S. officials related to development of nuclear arms, such as developing theoretical ideas for weapon-grade plutonium in the Korea Atomic Energy Research Institute, planning to develop South Korea's own reactor model, and testing ballistic missiles that could deliver nuclear warheads.[22] In addition, it also took new diplomatic measures to find a new international routes for acquiring reprocessing technologies, including through Pakistan.

Diplomatic Approaches to the Third World for Nuclear Latency

In 1977, Seoul started to pay keen attention to Pakistan, which was attempting to develop nuclear weapons because of its conflict with India. From 1976 to 1978, Pakistan, like South Korea, negotiated with France for the introduction of French reprocessing facilities and technologies. Although the United States hamstrung these negotiations as well, the Pakistani government persisted in the development of nuclear weapons, even after Prime Minister Zulfikar Ali Bhutto (a key instigator of the country's nuclear program) was deposed, tried for authorizing the murder of a political rival, and executed in 1979.[23] The determined position of Bhutto and his successors likely impressed Park. The South Korean government had observed the Franco-Pakistan discussions about the transfer of reprocessing technologies, and considered Pakistan's potential for being a nuclear-weapon state. The ROK Ministry of Foreign Affairs reported the history and strategy of the Pakistani nuclear program to the Blue House. To be specific, the report indicated that Pakistan had constructed reprocessing facilities with the technological support from France mainly because of India's nuclear threat to Pakistan and American reluctance to sell the A–7 Corsair II light attack aircraft to Pakistan. It also stated that Prime Minister Bhutto had warded off American pressure to cancel a nuclear plant order with France by utilizing the rhetoric of nuclear sovereignty for developing states.[24]

South Korea had accelerated its talks with Pakistan to develop diplomatic ties since 1977, when both countries revealed their intentions to develop weapon programs and experienced political tension with the United States. Although these two states established a consular relationship in 1968, their negotiations for full diplomatic relations were delayed for about

South Korean Army parade at Armed Forces Day in 1973. A huge Card stunt which is honoring Park Chung-hee is being performed.

North Korea and Pakistan in the Nonaligned Movement.[25] However, regarding Park's tensions with Jimmy Carter and his interest in the Pakistani nuclear program, it is highly likely that South Korea considered the partnership with Pakistan to involve nuclear weapons.

Conclusion

In 1979, before the assassination of President Park Chung-hee, South Korea developed the potential to become a nuclear-weapon state by establishing its own model reactor and testing ballistic missiles. Although the Park government was confident that its nuclear program could succeed in theory, almost every required element for the program—from nuclear tests to reprocessing fuel rods, and from the production of weapon-grade plutonium to importing uranium from abroad—was frustrated by Washington. Seoul made a number of diplomatic efforts to overcome these limits by approaching France and Pakistan, but in the late 1970s there was no state, including those two states, that could supply the required facilities and technologies to South Korea and risk pressure from the United States and an international community increasingly focused on nonproliferation. Had South Korea cut its ties with the United States, it could have processed its nuclear program through its own capabilities. Yet considering South Korea's heavy reliance on international trade and its economic hardships in 1979, as a result of the second oil shock, this option might have isolated South Korea and destroyed its economy.

As the archival documents reveal, when Park started to develop a nuclear-weapon program in early 1970s, he did not face a strong challenge from the United States and talked with France and Canada about the transfer of nuclear technologies and facilities without clear American opposition. However, once Washington started to pay more attention to nuclear proliferation in Asia, South Korea used its nuclear program as a card to prevent a complete American withdrawal from its soil. The Park government continuously boasted that it already had approached the technological level for becoming a nuclear-weapon state, but it neither constructed reprocessing facilities nor conducted a nuclear test. Simply put, it kept threatening Ford and Carter with missile tests and diplomatic gestures. In this sense, there is a need to review the political limits on South Korea's nuclear program more carefully in order to get a more exact picture of South Korea's nuclear history.

The biggest problem with the witnesses of the South Korean nuclear program is that they could not or did not consider the impacts of international relations and political restriction on South Korea's pursuit of nuclear arms. Even before the American invasion of Afghanistan after the terrorist attacks of September 11, 2001, North Korea and Pakistan suffered severe economic hardships as a result of international sanctions on them once they revealed their nuclear intentions. Iran entered nuclear negotiations with Western powers and agreed to the Joint Comprehensive Plan of Action because of its concerns about its present and future economy. In some sense, for countries trying to possess nuclear weapons, international political restrictions are the toughest obstacle on their road to nuclear armament. The South Korean experience suggests that the keys to nuclear armament are avoiding detection of nuclear activities and overcoming the pressure from nonproliferation efforts in the international community.

Endnotes

1 As the political openness of South Korea's democratic regime has reduced possible government support for secret military efforts, it is not realistic to consider that South Korea will redevelop its clandestine nuclear-weapon program in the near future.

2 For details of denuclearization in South Korea, see Seung Young

Kim, "Security, Nationalism and the Pursuit of Nuclear Weapons and Missiles: The South Korean Case, 1970–82," *Diplomacy & Statecraft* 12, no. 4 (2001): 53–80; Jonathan D. Pollack and Mitchell B. Reiss, "South Korea: The Tyranny of Geography and the Vexations of History," in *The Nuclear Tipping Point: Why States Reconsider Their Nuclear Choices*, ed. Kurt M. Campbell, Robert J. Einhorn, and Mitchell B. Reiss (Washington, DC: Brookings Institution Press, 2004), 254–92; and Daniel A. Pinkston, "South Korea's Nuclear Experiments," Center for Nonproliferation Studies, November 9, 2004, http://cns.miis.edu/pubs/week/041109.html.

3 For example, Oh Won-cheol, who took charge of the ROK defense industry in the 1970s, published a series of his memoir regarding the nuclear-weapons project under the guidance of Park Chung-hee in the 1970s. See Oh Won-cheol, "Oh Won-cheol hoegorok" [Oh Won Cheol's memoir], *Monthly Chosun*, June 1, 1994, 458–98; One of the most popular and famous novels in South Korea in the wake of the 1994 North Korean nuclear crisis was Kim Jin Myeong's *Mugunghwa kkoch i p'iossumnida* [Althaea flowers have blossomed] (Seoul: Haenaem, 1993). In this novel, the author suggests an alternative history in which South Korea developed nuclear weapons and became a superpower in East Asia.

4 For instance, Kang Chang-seong, the former security commander of South Korea in 1970s, claimed that Park told him in 1978 that South Korea would be able to produce its own nuclear weapons by 1981. See Kim Ha-yeong, "Suspicion to South Korea's Nuclear Weapon Program," *Bi-weekly Dahamkke*, September 17, 2004, 39.

5 Memorandum for the Assistant President for National Security Affairs from Robert S. Ingersoll of Department of State, "Approach to South Korea on Reprocessing," Department of State, July 2, 1975, Gerald R. Ford Library, Ann Arbor, MI (hereafter, Ford Library).

6 Oh Won-cheol, *Park Chung-hee neun uduke gyeongje gangguk mandleotna* [How Park Chung-hee could build a strong economy] (Seoul: Dongsu Munhwasa, 2009), 393–96.

7 Because of these economic hardships, democratic resistance against the South Korean government grew. Park Chung-hee's regime collapsed after he was killed by the director of the Korean Central Intelligence Agency, Kim Jae-gyu. See Bruce Cumings, *Korea's Place in the Sun* (New York: W.W. Norton & Company, 2005), 379.

8 South Korea ratified NPT in 1975 upon Canada's request, as part of the terms and conditions of the CANDU deal.

9 Oh, "Oh Won-cheol hoegorok."

10 Sung Gul-ong, "The Search for Deterrence: Park's Nuclear Option," in *The Park Chung Hee Era: The Transformation of South Korea*, ed. Byung-Kook Kim and Ezra F. Vogel (Cambridge, MA: Harvard University Press, 2011), 492; and Constance D. Hunt, "Canadian Policy and the Export of Nuclear Energy," *University of Toronto Law Journal* 27, no. 1 (1977): 69–104.

11 See "Agreement between ROK and Canada for peaceful nuclear development and application, 1975–77," Class No. 761.64 CN, ROK Diplomatic Archives, Seoul.

12 Ibid.

13 In 1974, before the India's nuclear test, South Korea also promoted the agreement on the technical cooperation for peaceful uses of nuclear energy with India. After India's nuclear test, however, Seoul stopped the diplomatic actions for the agreement with India out of concern that continued activity could be interpreted as support for India's nuclear program. For details, See "Negotiation for agreement for peaceful uses of nuclear powers between the ROK and India, 1974," Class No. 741.61ID, ROK Diplomatic Archives, Seoul.

14 "Agreement between ROK and Canada for peaceful nuclear development and application, 1975–77." The South Korean government considered that MacEachen's decision had been influenced by the Americans.

15 Ibid.

16 Ibid.

17 For instance, when Secretary of Defense Donald Rumsfeld visited Seoul in May 1976, he confirmed Washington's determination to review its support for Seoul unless Park gave up his quest for a reprocessing plant. For detail, see Information Memorandum from the Acting Assistant Secretary for International Security Affairs in the Department of Defense (Bergold) to Secretary of Defense Rumsfeld, Washington, DC, March 16, 1976, OSD Files: FRC 330–79–0049, Korea, 092, 1976, U.S. National Archives and Records Administration.

18 Memorandum of Conversation, "Meeting between President Park and Secretary Schlesinger, 26 August, 1975," Seoul, August 27, 1975, Korea 11, Box 9, Presidential Country Files for East Asia and the Pacific, National Security Adviser, Ford Library; and Cho Cheol-ho, "Park Chung-hee'eui Jaju Gukbang'gwa Haekgyebal" [President Park Chung-hee's national defense policy of self-reliance and the development of nuclear weapons], *Yeoksa bipyeong* 80 (2007): 13.

19 Memorandum of Conversation of Brent Scowcroft, Richard Sneider, William Gleysteen, September 15, 1976, Korea 19, Box 10, Presidential Country Files for East Asia and the Pacific, National Security Adviser, Ford Library. Gleysteen sent the memorandum of the conversation to Scowcroft, recommending his approval, under a covering memorandum on September 17, which Scowcroft initialed. For details of French, U.S., and South Korean discussions on the Franco-ROK nuclear contract, see Lyong Choi, "The First Nuclear Crisis in the Korean Peninsula, 1975–76," *Cold War History* 14, no. 1 (2014): 71–90.

20 "The implementation of the ROK-US Joint Standing Committee on nuclear and atomic energy technology matters in 1976. Safeguard for non-proliferation in Korea, especially for the reprocessing plant issue," Class No. 763.62US; 763.631US, ROK Diplomatic Archives, Seoul.

21 "Korean Intensify Discussion of Nuclear Option," June 17, 1977, Carter Withdrawal of US Troops from Korea – Dep. Of State Documents, Box 1, Oberdorfer Korea Collection, National Security Archive, George Washington, University, Washington, DC.

22 Peter Hayes and Chung-in Moon, "Park Chung Hee, the CIA & the Bomb," *Global Asia* 6, no. 3 (Fall 2011), https://www.globalasia.org/v6no3/feature/park-chung-hee-the-cia-&-the-bomb_peter-hayes; and Kim, "Security, Nationalism and the Pursuit of Nuclear Weapons and Missiles."

23 "US Lobbied to Stop Pakistan Nuclear Drive: Documents," *Dawn*, July 27, 2011, http://www.dawn.com/2011/07/27/us-lobbied-to-stop-pakistan-nuclear-drive-documents.html.

24 "Pakistan's plan for development of nuclear fuel, 1976-78"; and "Relations between North Korea and Pakistan, 1982," Class No. 763.61, ROK Diplomatic Archives, Seoul.

25 "Establishment of diplomatic relations between the ROK-Pakistan, 1960–1983," Class No. 722.2, ROK Diplomatic Archives, Seoul.

Policy Implications of Nuclear Hedging: Observations on East Asia

Toby Dalton

Western analysts have long identified South Korea and Japan as likely cases of future nuclear-weapon proliferation. Recent scholarship on the region backs up this concern, and with obvious reason.[1] In light of increasing nuclear threats from North Korea, and the fact that both Japan and South Korea have advanced nuclear-energy programs, both of the latter states have the motive and means to develop nuclear weapons. Yet, until now, leaders of both states have eschewed decisions to develop nuclear weapons, and have not taken other preliminary steps that would translate nuclear latency into more active hedging. Why is this the case? What does this imply for the study of nuclear latency and hedging? And what are possible policy implications for states seeking to manage nuclear latency among advanced nuclear-energy powers?

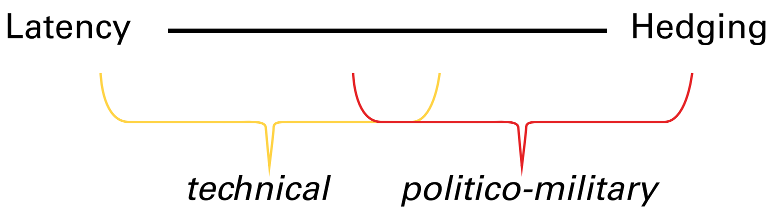
Left: An underwater test-firing of a strategic submarine ballistic missile is seen in this undated photo released by North Korea's Korean Central News Agency (KCNA) on April 24, 2016
Source: Reuters

Broadening the Definition of Latency

Nuclear latency is most often understood and assessed in terms of technical phenomena, whereas nuclear hedging is seen more as having a political impetus. For many nuclear analysts, particularly those with scientific backgrounds, a technical approach to assessing latency is comforting. Technology is concrete. In many cases it can be quantified. Latency can be measured and tracked through formal models.[2] The results can even be measured in "breakout time"—how long it would take to manufacture and assemble a nuclear weapon—which became an important point of contention about Iran's nuclear program and the temporal constraints resulting from the 2015 Joint Comprehensive Plan of Action (JCPOA).[3]

Much of the concern about nuclear latency in South Korea and Japan follows from such technically driven analysis. Japan has been working on developing a closed fuel cycle for decades. It has accumulated a substantial stockpile of plutonium reprocessed from spent nuclear power reactor fuel. South Korea more recently began to investigate a type of reprocessing called pyroprocessing and is engaged in a 10-year joint study with the United States on its commercial feasibility. Japan has an established space-launch program from which it might derive ballistic missiles. South Korea possesses ballistic and cruise missiles capable of carrying nuclear weapons. Breakout time for the two states is popularly estimated as a few months for Japan and six months to a year for South Korea, though these figures are debatable.[4] Both states thus have a high degree of nuclear latency. There is much greater uncertainty about whether, when, and why this latency might evolve into nuclear hedging. Here, some technical indicators may be useful for analysis, such as if states begin to develop important nonnuclear-enabling capabilities. But other nontechnical indicators are also needed to understand whether states are beginning to lay the political and military groundwork for a nuclear-weapon capability, signifying a shift from latency toward hedging (Figure 11.1).

FIGURE 11.1: THE LATENCY-HEDGING SPECTRUM



The dominant technical approach to analysis of nuclear latency is important and useful.[5] However, it tends to obscure or diminish the weight of other indicators, drivers, mediators, and constraints on nuclear latency and hedging. As the historical cases presented in this volume make abundantly clear, decisions on nuclear latency and even more so on hedging involve multiple overlapping systems: normative, political, bureaucratic, military, and of course, technical. This complexity has critical effects on governmental policies that aim to manage or influence nuclear latency and hedging in third states. An analytic focus drawing primarily on technical factors misses these other potential indicators. More importantly, efforts to conceptualize nuclear latency in broader terms may help develop a more inclusive set of potential policy tools.[6]

In particular, one interesting common thread in the historical cases in this volume is the importance of charismatic leaders or policy entrepreneurs central to the achievements of the nuclear programs of each state. This rich historiography challenges policy analysts to consider how to incorporate the role of individuals as variables in models of latency and hedging—a profoundly difficult task, because people are not always predictable, their interactions within political and professional networks make potential influence diffuse and subject to any number of possible constraints, and their views can change over time. As these cases also show, it is hard to make sui generis claims about the various roles played by such individuals and prove why they were so important to each program. Yet it is imperative for analysts to understand how the important nuclear policy influencers in a given state—whether scientists, military officers, or politicians—relate to decisions about nuclear latency and hedging, what power they have, and what constraints they face in advancing a nuclear-weapon program.

In the context of a broader definition of nuclear latency and hedging, it is also useful to consider various types of latency and hedging and how these may relate to policy options. A number of plausible taxonomies of nuclear latency and hedging break down the differences based on regime type, state of economic development, or nuclear technology pathway, to give a few possible examples. For the United States, an important distinction from a policy perspective is whether the nuclear program in question is being undertaken by a U.S. ally or by a state not under a U.S. security umbrella. A range of scholarship on the nuclear programs of U.S. allies identifies security bargaining as a strong motivation for hedging behavior.[7] In these cases, the credibility or feasibility of the actions contemplated to signal hedging may have been more important than specific technical choices that could contribute to latency, because the states were seeking primarily to extract security concessions from the United States. Policy options to manage latency and hedging among allies, for whom fear of abandonment is a central issue, would necessarily differ from those used to manage this challenge among other nonallied states.

In this regard, the broader policy community must correctly interpret the signals presented by its allies' nuclear latency. Does South Korea's persistent interest in reprocessing represent the entrenched interests and aspirations of the nuclear science community, a silver-bullet technopolitical solution to the looming challenge of dealing with spent nuclear fuel, or a long-term hedge to acquire the capability to quickly produce plutonium for nuclear weapons? Or could it be all three of these simultaneously, and still other plausible rationales as well? There is evidence to support all of these explanations, but Washington's ability to sift and interpret that evidence will inform how it prioritizes its own policy objectives and tools for managing Seoul's nuclear ambitions.

Lastly, even though historical studies of nuclear programs make an important contribution to the literature on latency and hedging, the limitations of temporal extrapolation also must be kept in mind. Again, in considering past cases of allied hedging and bargaining, the technological, security, political, economic, and energy policy contexts are considerably different today, and those differences could change how signals might be sent and interpreted. Stated another way, indicators of latency or hedging that might have been important in the 1970s—for instance, the construction of a low-power natural uranium research reactor (which could be used to produce plutonium) or a state's refusal to the sign the Nuclear Nonproliferation Treaty (NPT)—look different today. Many states have sufficient nuclear technology and credible means of delivering nuclear weapons; today, there are relatively few barriers to indigenous development of such technologies. However, with the near-universality of the NPT and International Atomic Energy Agency (IAEA) safeguards, other kinds of indicators may have greater significance. In South Korea, for instance, a more apt indicator of hedging today might be elite opinion on nuclear weapons, whereas in Japan such indicators might include the government's approach to managing the politics of its retention of fissile material stocks and production capability in the face of public opposition to nuclear power, the absence of a credible nuclear waste disposition pathway, and a shrinking nuclear-energy infrastructure.[8]

Assessing Nuclear Latency in Contemporary Japan and South Korea

Keeping a broader definition of nuclear latency and hedging in mind, what indicators should analysts focus on regarding

Japan and South Korea? How much weight should be accorded technical factors relating to nuclear capability versus broader political-security issues tied to possible proliferation intent? Historical context is important, of course. The Japanese government on several occasions has ordered studies on the question of nuclear acquisition. Public reporting on these studies suggests that in each instance, there has been no decision to pursue the matter further.[9] Meanwhile, South Korea had active ambitions and even plans to develop nuclear weapons in the 1970s.[10] By the early 1980s, U.S. pressure and issues surrounding the change of regimes had stopped these efforts, but subsequent revelations of unsafeguarded research on plutonium and highly enriched uranium in the 1990s and early 2000s, respectively, created suspicions that Seoul's nuclear-weapon interest had never gone away entirely.[11] Nevertheless, both countries are signatories to the NPT and are in compliance with their myriad institutional and treaty obligations. Japan remains committed to operating a closed nuclear fuel cycle, while South Korea continues work to develop an industrial reprocessing capability, all under integrated IAEA safeguards. They are also active participants in numerous international efforts to promote effective nonproliferation, nuclear security, and nuclear safety practices. Yet, as noted at the outset, both states' technical capabilities and the difficult security environment in East Asia drives regular speculation and even prognostication that one of them may transition its nuclear program toward weapon hedging or even outright acquisition. The reasons for such speculation are many and varied, but are worth exploring in some detail.

JAPAN

Japan's high degree of technical latency increases the importance of nontechnical indicators of nuclear hedging, not least of which being its domestic political struggle over its postwar national identity. Japan is undergoing a slow transition, shepherded by a series of conservative governments, toward a more traditional military posture. Mounting threats from China and North Korea and concerns about the credibility of U.S. alliance commitments provide the backdrop for this transition, but the impetus has more to do with a desire on the part of some Japanese to move beyond the "antimilitarism" that has characterized Japanese security policy after World War II and become a "normal" state with a standing military.[12] This proposed change is hugely controversial in Japan (and in the region), given the symbolic importance of military restraint to Japan's postwar identity construction based on a so-called "pacifist" constitution.

The legal centerpiece of this transition is a proposed amendment of Article 9 of Japan's constitution—which bans the establishment of armed forces but has been interpreted to allow for a self-defense force—to permit a standing military. Prime Minister Shinzo Abe has targeted the year 2020 to amend the constitution and will use the intervening period to build public and parliamentary support for this initiative.[13] Practically speaking, the mission and force posture implications of this change may at first be fairly limited, given that the Japanese Self-Defense Forces are already well-equipped and capable. Yet from a political perspective, such a shift would constitute a major change in the security environment, both within Japan and the region. Japan's neighbors sustain historical grievances about abuses by Japanese occupational authorities before and during World War II, and Japan's reversion to a nation with standing military services undoubtedly would deepen these tensions, particularly with China and South Korea.

The specific effects of this broader normative evolution on potential Japanese considerations about nuclear weapons are debatable, but a revision of the Japanese constitution would cue analysts to consider other indicators of nuclear hedging in a new light. For example, one of the few technical domains in which Japan would need to undertake additional work to develop nuclear weapons is in the area of delivery platforms, in particular ballistic and cruise missiles. At present, Japan has only limited strike capabilities, focused on defense of outer islands in the Japanese archipelago—a position consistent with the status quo defense posture, and one that looks less like nuclear hedging. Future acquisition of capabilities with range and payloads exceeding, say, 1,500 kilometers and 500 kilograms, in the context of a general rearmament could be seen more as contributing to a nuclear hedge.[14]

In addition to Japan's debate on amending its constitution, another contextual element important to assessments of the evolution of nuclear latency toward hedging is the state of the U.S.-Japan alliance, and in particular Japanese perceptions of the credibility of the U.S. extended nuclear deterrence. Elite and popular opinions are deeply divided on these questions. The Japanese defense community, which anecdotally seems in favor of acquiring conventional strike capabilities, also remains strongly wedded to the extended nuclear deterrence provided through the U.S.-Japan alliance out of a belief that a security partnership with the United States is far preferable to trying to balance China alone.[15] Notably, it was this community that pressured the administration of Barack Obama to temper some of its aspirations to reduce the salience of nuclear deterrence. For example, some Japanese defense officials opposed proposals that the United States adopt a no-first-use policy, and some reportedly were angered by the U.S. decision to retire the nuclear-armed Tomahawk cruise missile.[16] Thus, so long as the U.S. nuclear arsenal provides reliable extended deterrence, this constituency is unlikely to see the need for an independent Japanese nuclear-weapon capability.

At the same time, Japanese civil society remains profoundly antinuclear—not merely against nuclear weapons but also against nuclear energy, in the wake of the 2011 Tohoku earthquake and the resulting disaster at the Fukushima-Daiichi nuclear power plant.[17] Prodisarmament groups from Hiroshima and Nagasaki, which draw on the experience and moral standing of the hibakusha (survivors of the 1945 atomic bombings), are particularly active in Japanese politics. These groups played a crucial and visible role in promoting the negotiation of the Treaty on the Prohibition of Nuclear Weapons at the United Nations, and the Nobel committee recognized the Japanese groups' efforts in their awarding of the 2017 Peace Prize to the International Campaign to Abolish Nuclear Weapons. They are pressuring the Japanese government to sign the treaty and promote progress on disarmament. It is also noteworthy that the Japanese scientific community, from which technical expertise would be drawn to support a nuclear-weapon effort, seems to share some similar views. For instance, in March 2017, the 850,000 members of the Science Council of Japan released a statement calling on Japanese scientists, universities, and research organizations not to accept funding from the government for military-related research and development.[18]

These civil society groups exert sufficient influence in Japanese politics to force the government into an uncomfortable tightrope act: simultaneously promoting nuclear disarmament while sustaining U.S. extended nuclear deterrence. In this context, Japanese officials recognize the strength of the opposition they would face from the Japanese public and scientific community if they sought to develop nuclear weapons. Thus, the domestic political and normative environment in Japan contains important indicators to monitor even as key actors and popular opinion within Japan modulate potential nuclear hedging.

SOUTH KOREA

The picture in South Korea is in several respects the inverse of Japan, especially with regard to domestic politics. South Korean public opinion polls demonstrate strong and consistent support for nuclear weapons, ranging from 60 percent to 70 percent, which some experts cite as evidence of a weak nonproliferation norm.[19] The primary drivers of such significant support for nuclear weapons are the growing nuclear threat from North Korea—which seems to be felt more acutely in South Korea than in Japan, given the history of North Korean military aggression toward the South—and concerns about the credibility of U.S. extended nuclear deterrence. On the surface, the logic for nuclear weapons at the level of public opinion seems simplistic: to protect South Korea from North Korean nuclear weapons. Yet several other underlying indicators of potential relevance to hedging deserve greater attention.

Though the South Korean public has voiced relatively consistent support for nuclear weapons over time, elite opinion as measured by the number of politicians and media figures openly stating support for nuclear weapons rose substantially only in 2016 and 2017.[20] Together, these two trends seem to indicate a general erosion of a political taboo for promoting acquisition of nuclear weapons, or at least a mainstreaming of the political acceptability of discussing nuclear proliferation. Previously, only a few conservative politicians made public arguments about South Korea's need for nuclear weapons, but early in 2017, the few lonely voices became a veritable chorus. In August 2017, in the context of North Korea's test launch of an intercontinental ballistic missile (ICBM) and claimed test of a thermonuclear weapon design, the main opposition conservative Liberty Party announced that it had adopted the return of U.S. tactical nuclear weapons—which had been withdrawn from the Korean Peninsula in 1991 on the orders of President George H. W. Bush—as a party platform.[21] Conservative media outlets also regularly published editorials calling for nuclear weapons, and lending support to a long-term nuclear hedge. Notwithstanding such public and political support, both the conservative government of President Park Geun-hye and the subsequent progressive government of President Moon Jae-in consistently rejected a nuclear-weapon option.

Much of the stated popular and elite support for nuclear weapons in South Korea tends to gloss over an important distinction between possession of an independent nuclear arsenal and the restationing of U.S. tactical nuclear weapons.[22] From a hedging point of view, this is an analytically crucial difference, especially in terms of how the United States might interpret these signals and assess policy options. Some South Korean nuclear proponents explicitly link hedging to the return of U.S. nuclear weapons, suggesting a bargaining strategy. In an October 2017 speech in Washington, for example, Liberty Party chairman Hong Joon-pyo stated: "If the redeployment of American nuclear weapons in Korea does not work out, we would be left with little choice but to strive for independent nuclear armament."[23] Others, however, argue that North Korea's development of an ICBM that can target the U.S. mainland can decouple the alliance by forcing the United States to consider whether it is willing to defend Seoul if it means sacrificing Los Angeles, and therefore South Korea must have its own nuclear weapons.[24] This sentiment instead suggests a more fundamental alliance credibility problem that would not necessarily be resolved by return of U.S. nuclear weapons.

Most of the outspoken political support for nuclear weapons comes from conservatives, whereas South Korean progressives, like their Japanese counterparts, skew more antinuclear. Indeed, all five of the left-wing party candidates in the May 9, 2017, special presidential election signed a pledge to phase out nuclear power. The winner of that election, Moon Jae-in, announced on October 22 that he would carry out this pledge, albeit over several decades as operating reactors reach the end of their initial licenses. Until the election, public opinion in South Korea showed majority support for maintaining nuclear power even with rising concerns about nuclear safety.[25] If South Korea does carry through on Moon's plan and proceeds to get out of the nuclear-energy business, it also eventually will begin to reduce nuclear-weapon latency.

Other, more fragmented indications of policy incoherence further complicate assessments of South Korean latency and hedging. For instance, the coexistence of majority pronuclear weapons and antinuclear power views raises some interesting questions that bear on the normative environment, and whether a country could pursue both policies simultaneously. Can politicians articulate separately a security rationale for nuclear weapons and a safety rational against nuclear power, when the consequences of an accident involving either would have manifest humanitarian and environmental consequences? One clear example of the tension in South Korea's nuclear policy is President Moon's nuclear-energy phaseout and his interest in developing a nuclear-powered submarine for deterrence purposes.[26] Another underlying phenomenon that seems prevalent in South Korea is the "not-in-my-backyard" (NIMBY) opposition to anything that might be perceived as dangerous. In several cases, localities have opposed proposed nuclear power plants in their areas, for example when residents of the eastern coastal city of Samcheok voted against nuclear power in a 2014 referendum.[27] Similarly, in 2016, residents of the agricultural Seongju County strongly opposed the deployment of a missile defense system there, even in the midst of heightened threats from North Korea.[28] It seems likely that any facility or site earmarked for nuclear-weapon-related work would attract determined and perhaps even violent local and regional opposition. As in Japan, South Korean leaders' ability to reconcile these tensions in politics, public opinion, and NIMBYism will be fundamental to a successful hedging strategy.

Analytic Implications of East Asian Nuclear Latency

What do the Japanese and South Korean cases contribute to the study of nuclear latency and hedging? Arguably, for cases of states featuring a high degree of technical latency, other nontechnical indicators may well be more important in assessing the potential transition from latency to hedging, or even outright pursuit of nuclear weapons. In both of the East

Asian cases, the political and normative environments are greater constraints than any specifically technical barrier to hedging. These cases also point to a few issues that deserve further consideration and analysis in the latency discourse.

First, changes in the global political context—namely, the rise of populist and nativist political movements—may yield more cases of nuclear latency or hedging in the future. Nationalism is well documented as an important determinant of nuclear-weapon programs historically, such as those in France and India.[29] But the particularly nativist strain of nationalism that has flourished in the 21st century in reaction to globalization could create a newfound interest in nuclear weapons among leaders seeking to harness populist appeal on security and sovereignty grounds. Some evidence for this trend already exists. For example, a few conservative politicians contesting the spring 2016 parliamentary elections in South Korea appear to have tried to drum up fears of North Korea and simultaneously argue for nuclear weapons as a way to gain support at the ballot box, though without much success.[30] Similarly, though not in the context of an election, in February 2017 the chairman of Poland's right-wing ruling Law and Justice Party argued publicly that Europe ought to become a "nuclear superpower" to rival Russia.[31]

A related issue is the political health of the nonproliferation norm, embodied in the NPT—specifically, the extent to which the norm continues to make public advocacy of nuclear weapons essentially taboo, consigning it to the political fringe. In Japan, the norm remains strong, to the point that mainstream political discourse focuses on nuclear disarmament. Even conventional military rearmament, let alone nuclear-weapon development, is hugely controversial. In South Korea, by contrast, the taboo on public advocacy for nuclear weapons, which seems to have existed until the mid to late-2000s, has been eroded. Until then, politicians mainly used the coded term "nuclear sovereignty" to hint at the potential acquisition of an independent nuclear capability.[32] But following successive nuclear tests by North Korea, South Korean politicians began to actively discuss the acquisition of nuclear weapons, media outlets broadcast it as regular news, and defense researchers (including several prominent former officials) validated it.[33] The government did not publicly censure the mainly conservative politicians voicing such views, though left-leaning politicians did criticize them, in at least one instance arguing that such views "brought disgrace" on South Korea.[34] Similarly, a nascent nuclear "debate" in Germany may indicate a weakening of the taboo there.[35] One important mediator or indicator of the taboo is the extent to which politicians, media, and civil society actors are rewarded, tolerated, or punished for such advocacy. In Germany, the backlash against the politicians who sought to raise the nuclear option was swift, and they were forced to back down, whereas in South Korea politicians have not faced significant penalties for their advocacy, even if their stances on the issue have not translated into domestic political gains.

A second vital issue affecting the study of nuclear latency and hedging is the relationship between nonproliferation norms and public opinion. Analysis of South Korea's nuclear proliferation potential often starts with an exegesis of public opinion polls that reveal consistent majority support for acquisition of nuclear weapons. Polling in Japan that shows the opposite result is similarly cited in support of arguments about the low likelihood of proliferation there. But to what extent do these opinion polls reflect the state of health of a nonproliferation norm—an clear contextual indicator for nuclear hedging—in either country?

The scholarly literature on norms indicates that public opinion tends to be most important during the phase of norm emergence and consolidation. Social movements or norm entrepreneurs seek to mobilize public opinion to put pressure on governing elites to adopt the norm in question.[36] In contrast, elite opinion tends to be more important in the process of internalizing norms—when they are written into national or international law, for instance, and then enforced through various mechanisms. Arguably, then, for states that have adopted nonproliferation norms and instituted strong nonproliferation practices, public opinion should have little bearing on whether that norm endures. Indeed, public support for nuclear acquisition may be more accurately understood as a matter of nationalism, rather than the health of nonproliferation norms.[37] Elite opinion, however, may be a more relevant indicator, insofar as such individuals possess more influence over questions of norm enforcement and violation.[38]

In conversations with Japanese and South Korean defense experts, it is not uncommon to hear dismissal of public opinion on nuclear weapons as uninformed and unimportant. Some Japanese experts argue (privately, of course) that public opinion would not be a constraint if the government decided it needed to develop nuclear weapons; some Japanese prime ministers apparently held similar beliefs.[39] And in South Korea, high levels of public support for nuclear acquisition do not seem to be tempered by any consideration of the potential costs of violating international commitments. That said, Mark Fitzpatrick cites a recent unreleased poll sponsored by the South Korean Ministry of Foreign Affairs that showed support for nuclearization dropping below 50 percent once respondents were informed of potential economic sanctions or other consequences.[40]

There are two elite groups whose opinions undoubtedly matter more than the public's, but which are much harder to measure: scientists and military officers. The historical cases in this volume make clear that in order to understand how nuclear programs might evolve from latency to hedging or beyond, one must understand the military and scientific communities from which charismatic leaders of nuclear-weapon efforts emerge. Support from prominent individuals in both communities seems necessary for a state to realize a nuclear-weapon effort. Indeed, these communities also may have bureaucratic vetoes on nuclear-weapon development, as some studies have argued.[41] But relatively few indicators can gauge the extent to which these groups internalize nonproliferation norms, save from statements like that from the Science Council of Japan eschewing military-funded research. Anecdotally, military leaders seem more likely to support nuclear acquisition and to underestimate the potential consequences.[42] But most such views, whether from the military or scientific communities, tend to be shared only in private. In South Korea, only a bare handful of retired military officers and scientists have provided on-the-record support for an independent nuclear arsenal.[43]

A third analytic issue highlighted by the East Asian cases is how potential consequences of a shift toward hedging or breakout are perceived and evaluated. Here, too, the issue of the credibility of the U.S. alliance commitment is a key mediator. South Korean and Japanese leaders might assess that if their security was threatened to the point that nuclear weapons were deemed necessary to deter existential threats, the United States and others in the international community would be unlikely to sanction them for proliferation. Given periodic public statements by U.S. officials that appear to give some "understanding" about these countries' putative decisions to develop nuclear weapons, one could understand that Japanese and South Korean leaders might calculate this to be an acceptable risk.[44]

Short of an obvious existential threat, these states must calibrate hedging against potential consequences in less grave circumstances. Under U.S. law, breaking peaceful-uses commitments on U.S.-obligated nuclear material or U.S.-supplied technology could result in a range of penalties pursuant to the Atomic Energy Act and the Glenn Amendment to the Arms Export Control Act, from cessation of export of material to restrictions on trade and military assistance. Other countries with which Japan and South Korea have nuclear trade relationships could apply similar penalties. Both states have scarce energy resources and are heavily dependent on imports. Nuclear-energy-related penalties could be especially punitive on South Korea, since it generates about 30 percent of its electricity through nuclear power. Japan's nuclear-energy sector has yet to recover from the 2011 Fukushima-Daiichi accident and the subsequent closure or suspension of its entire nuclear-power infrastructure—which is only gradually being restarted—and thus nuclear-energy penalties would have relatively less bite. But any possible energy or economic sanctions could have deep impacts on the economies of both. As such, energy and economic security considerations may constrain either state's propensity to seek a nuclear hedge.

At the same time, security bargaining considerations might encourage both states to skirt the boundaries of U.S. law in order to make the hedge credible enough to extract concessions rather than prompt penalties from Washington. If most penalties would be triggered by illicit work on fissile material, then it seems reasonable to expect that Japan or South Korea might work on other dual-use aspects of nuclear-weapon development, such as design and testing of implosion systems. In these areas, plausible scientific inquiry could obscure the weapon-oriented nature of the work yet still signal possible interest in developing a hedging posture. It is an open question how Washington might react to such activity, given that it falls into areas where U.S. law is not clear cut and on which the NPT is silent. For analysts, then, the question is how to evaluate the credibility of hedging signals and the potential cost of those signals for a state as it moves toward a nuclear-weapon capability.

Policy Implications for Managing Latency and Hedging

Through incremental adaptation of legal and policy mechanisms since the 1970s, including the formation of international technology control regimes, the United States has sought to manage nuclear latency among its nuclear trading partners. These efforts have not fundamentally closed the "loophole" in the NPT, under which states are permitted to acquire the fuel cycle infrastructure necessary to produce nuclear weapons. But by establishing incentives and disincentives for certain technologies or practices, especially those related to the fuel cycle, these mechanisms kept some states at the lower end of the nuclear latency spectrum. Over the same period, using alliances and defense relationships, the United States also sought to manipulate the political environment such that states would be less likely to seek nuclear technology for hedging purposes. These two approaches—technical and political—to managing latency and hedging helped ensure that there were far fewer cases of proliferation than many analysts had predicted in the early days of the nuclear age.

The incentive structure that helped to manage latency and hedging in the past, however, is showing signs of strain. Some of this strain results from using different tools for different states, and the challenge of maintaining uniform standards or benchmarks. For example, South Korea, wanting to receive the same consideration that Japan received several decades ago, has demanded that the United States give it programmatic consent for reprocessing. North Korea demands recognition by the international community as a state with nuclear weapons, similar in some ways to the same treatment accorded India through the 2008 decision of the Nuclear Suppliers Group to permit nuclear cooperation with Delhi, notwithstanding its nuclear-weapon program and non-NPT status. Other states in the future may also demand the capability to enrich uranium, given that the JCPOA essentially ratified Iran's enrichment program. Meanwhile, the rejection of U.S. proposals to the Nuclear Suppliers Group to ban the further spread of enrichment and reprocessing technology indicate general supplier discomfort with more stringent technology controls. All of these developments have created the potential for perception of double standards that complicate nonproliferation diplomacy and nuclear trade.

In the case of U.S. allies, in particular Japan and South Korea, some tools for managing technical latency still exist, such as maintaining a cooperative approach with Korea on reprocessing and encouraging Japan to scale its plutonium stockpile to reasonable commercial needs. Managing the potential for nuclear hedging is more a question of utilizing the alliance framework. Defense and security cooperation can be used to respond to attempted nuclear bargaining and to mitigate security concerns that might drive political support for hedging or acquisition. But there is a slippery slope inherent in this use of the alliance, which the United States has experienced with South Korea since North Korea's nuclear-weapon effort gained steam in the late 2000s. As the nuclear threat from North Korea materialized, South Korean leaders sought specifically to increase (in content and visibility) the nuclear element of the alliance. But Washington quickly exhausted the low-hanging fruit of symbolic use nuclear weapons for assurance. The half-life of signals demonstrating nuclear resolve, such as flying U.S. strategic bombers during joint military exercises, turned out to be rather short. Many South Korean politicians then began to openly demand a return of U.S. tactical nuclear weapons to the peninsula or to adopt a nuclear-sharing arrangement like that in NATO. If the United States ultimately opts not to accede to these demands, then the limits of using the alliance to manage South Korea's hedging may be reached. What might South Korea do at that point? Would it really create a breakout nuclear-weapon capability, even at the expense of the alliance and in the face of a potential security vacuum? These are questions that U.S. policymakers decidedly wish to avoid.

Another policy implication from the East Asian cases is the need to consider ways to inoculate nonproliferation norms, whether from external security pressures or from nationalist politics. The erosion of the taboo on advocacy for nuclear weapons in South Korea is a cautionary tale for policymakers. Arguably, the United States (together with the South Korean government) did not do enough to create effective counterarguments to nuclear-weapon proponents. Policy efforts in this regard must at some level involve strategic communication targeted at the public and key elite groups, both to assure them about the credibility of the alliance but also to make clear in a sensitive way the potential consequences of overtly pursuing nuclear weapons. Though it will be hard to correct this trend in South Korea, it is not too late to have an impact in other states in which nuclear nationalism is likely.

Finally, and following from the utility of a broader definition of latency and hedging, developing shared understanding among policy shapers from generally like-minded states would be immensely useful. Common tools for assessment, especially ones that incorporate both technical and political indicators, could help facilitate sharing of comparative analysis of nuclear programs and coordination of policy responses. Experts from the Carnegie Endowment for International Peace have worked on one such model, which they termed a "nuclear firewall."[45] The objective of such common assessment tools is to strengthen the existing bilateral and multilateral toolset, such as trade practices instituted by the Nuclear Suppliers Group or IAEA safeguards. In particular, given high levels of technical latency in several states as well as the slow spread of fuel cycle technologies and nuclear-capable delivery vehicles, it is imperative that latency assessment tools focus more on evaluating nonfissile-material aspects of latency, such as nuclear-weapon design, as well as political indicators of hedging.

Conclusion

South Korea and Japan face security threats that lead many to predict that they ultimately may seek the protection of nuclear weapons. As such, these states are perhaps the most important test case for the continued viability of the nuclear nonproliferation regime. If they opt to remain nonnuclear-weapon states, then it will demonstrate that even the most threatened states can be made to feel secure within the NPT. But if they decide to withdraw from the NPT and build nuclear weapons, it will be a critical blow to the nonproliferation regime.

Probably neither state will opt to develop nuclear weapons, at least not all at once. The more likely possibility is that South Korea and Japan will edge toward a hedging posture through work on nonnuclear capabilities that could enable them to complete nuclear weapons. For analysts, understanding the possible forms that the transition from latency to hedging might take, and the most important indicators of that transition, is a critical task. Typical models of latency, which tend to overrely on fuel cycle indicators, are unlikely to provide much analytic leverage. Instead, models that situate latency and hedging in a broader political, normative, and technical context will be necessary.

The policy challenge, which falls primarily on the United States as a provider of extended nuclear deterrence, is how to manage the potential for an evolution toward hedging. Here, the question is whether the existing alliance structure, in which the United States provides strategic deterrence from afar backed by forward-deployed conventional military forces, will suffice to manage the security demands from Japan and South Korea that would motivate hedging. But just as important from the perspective of long-term regime viability, however, is to manage potential hedging in a way that does not establish new precedents that other states might seek to exploit, and does not exacerbate regional security challenges in East Asia. There are no simple solutions, meaning that the attendant political costs will be tough for American policymakers to swallow.

Endnote

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Left: North Korean leader Kim Jong-un at the launch of a new ballistic missile in this undated photo released by North Korea's Korean Central News Agency (KCNA) on March 4, 2016.
Source: Reuters/KCNA

Nuclear Latency, Deterrence, Nonproliferation, and Disarmament

Joseph F. Pilat

Although there is no agreed definition of the term *nuclear latency*, it can be viewed as the possession of some or all of the technologies, facilities, materials, expertise (including tacit knowledge), resources, and other capabilities necessary for the development of nuclear weapons, without full operational weaponization. Nuclear latency has technical and historical dimensions, and like other forms of strategic latency, it can result in strategic surprise.

The question of Iran's nuclear program has generated increased interest in nuclear latency from a nonproliferation perspective. Likewise, the arguments of the "Gang of Four" (Henry Kissinger, Sam Nunn, William Perry, and George Schulz) and the policies of the Obama administration have underscored the potential importance of nuclear latency from a disarmament perspective. At both ends of the continuum, the reality of nuclear latency can have an impact on deterrence. Yet the relation between latency and deterrence, including cross-domain deterrence capability to counter or mitigate threats from another, is complex and difficult

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Left: Arak IR-40 Heavy Water Reactor, Iran.

to address. Even the most fundamental elements of cross-domain deterrence are not well understood or characterized. The relationship of cross-domain deterrence to nuclear (and other) latency is even more elusive, but latency must be taken into account and brought into the deterrence discussion, not least because of the important connection between latency and strategic surprise.

Both the nonproliferation and disarmament narratives recognize the potential deterrence effects of latent capabilities either as a security threat that must be addressed (namely, through nonproliferation) or as a hedge capability that allows bolder steps toward disarmament. In each case, the arguments go beyond nuclear deterrence and have cross-domain dimensions. In the Iran case specifically and in the broader nonproliferation debate, a latent proliferant program is argued to have real or potential deterrent value against a range of threats, even if there is no weaponization, in part because of the ambiguity that such latency creates. In the disarmament debate, the latency that remains even if disarmament efforts succeed is nonetheless seen as reducing the vulnerabilities created by deep reductions in real or potential nuclear stockpiles, and deterring potential threats across a number of domains while still allowing a reversibility that mitigates the risks attendant on moving toward zero. That said, this degree of reversibility inherent in nuclear latency poses its own threat to the objective of disarmament.

Neither debate has been based on, or contributed to, the systematic analysis of these assumptions. Moreover, in this context, latency's relation to deterrence, especially to cross-domain deterrence, may have critical dimensions in the nuclear arena, and possibly in the cyber and other technology arenas as well. This chapter focuses on the nuclear issues.

Latency Deterrence and Proliferation: Iran and

Beyond

On July 14, 2015, U.S. president Barack Obama announced an historic deal on Iran's nuclear program, the Joint Comprehensive Plan of Action (JCPOA).[1] Following more than a decade of growth in Iranian capabilities, on-and-off negotiations, increasingly tight sanctions, reported cyberattacks (the Stuxnet computer worm) and threats of military action, this agreement was designed to reduce proliferation risks at key Iranian facilities—particularly the uranium enrichment sites of Natanz and Fordow, and the nuclear reactor at Arak—in return for sanctions relief for Iran. Although the JCPOA limited or scaled back important parts of Iran's program, it nonetheless recognized and reinforced Iranian latency.

The debate over the JCPOA has been contentious in both the United States and Iran, and the Trump administration withdrew from the agreement in 2018. The future of the JCPOA is unclear at present. If it does not survive, Iran may move to restore its pre-JCPOA capabilities and continue its pursuit of nuclear weapons. However the fate of the JCPOA evolves, the negotiations demonstrated that Iran could not readily be pressured into foregoing nuclear capacity. Moreover, the deal did not require Iran to give up its nuclear latency, which some critics saw as a fundamental flaw in the agreement. From this perspective, the critics have argued that weaponization is unnecessary, and that Iranian interests can be achieved with latency.

In any case, Iran was already a latent nuclear power in 2015. Not even the entire removal of the country's nuclear infrastructure would have eliminated this reality. As the Iran case highlights, latency is a reality for many nonnuclear-weapon states today, primarily as a result of spreading nuclear energy technologies and programs. Latency has already provided some level of virtual nuclear-weapon capabilities as nuclear energy technologies and programs have spread. These widespread nuclear capabilities will only increase with the growth of nuclear power programs worldwide, especially those that involve direct-use nuclear materials such as plutonium and highly enriched uranium (HEU). States, weaponization, delivery, and support capabilities are also critical and provide an indicator of intent, albeit one with low visibility and high ambiguity.

As appears to be the case for Iran, latency can be a strategy for some states, including those who find in ambiguity an optimal security response that may avoid negative international reactions from diplomatic isolation to sanctions and embargoes to military options. In this case, nuclear latency allows a state to hedge against a deteriorating regional or global security environment and even to respond to it if required, although the time needed for an effective response is unclear and may not be sufficient. In general, latent capacity is regarded as under the threshold of military responses, even if it could have consequences that include sanctions.

As the limited impact of sanctions and other responses suggest, and the negotiations reinforced, Iran always was highly unlikely to give up a significant degree of nuclear latency, despite complex domestic politics in which not all factions supported going nuclear. Of course, breakout—the time required to go from latency to the possession of enough fissile material for a nuclear weapon—is the overarching concern. Both before and after the JCPOA was concluded, international attention focused on breakout times for Iran, and whether agreement would increase breakout time. Yet the assumption that Iran would need to weaponize its capability to pose a threat has itself been questioned. As suggested, some observers have argued that weaponization is unnecessary, and draw different conclusions from this point of reference. Another question that has been raised is whether Iran can use latent capacity to deter conventional and other attacks. As suggested, ambiguity could serve Iran well, and it is possible that Iranian interests can be achieved with latency alone. The widespread belief that a kinetic or nonkinetic strike could only delay, not destroy, the Iranian nuclear program reinforces this point.

The issue is whether, and with what impact, latency can serve as a deterrent. Many believe that the deterrent effects of latency are credible, and necessary for regime survival. This is the lesson drawn by some observers—and is a position touted by North Korean and Iranian officials—from the cases of Iraq, Libya, and Ukraine over the past two decades. It has been asserted that states that give up their nuclear weapons or programs became vulnerable to interference, attacks, and even regime change as a consequence. In actuality, these cases are all different and do not incontrovertibly support the view that decisions to forego nuclear arms increase a state's vulnerability.

In any case, Iran is not likely to threaten or use nuclear weapons against other states. Overt nuclear threats to Israel, the United States, or other states might provoke renewed sanctions, diplomatic isolation, or even military action. A small, emerging arsenal might be especially vulnerable to countermeasures. If regime survival is a critical objective, this strategy may appear far too risky. Instead, the most serious threat that a

Left: President Barack Obama meets with, left to right, former Defense Secretary William Perry; former Sen. Sam Nunn (D-Georgia); former Secretary of State George P. Shultz; and former Secretary of State Henry Kissinger in the Oval Office, to discuss the U.S. non-proliferation policy, May 19, 2009. (Official White House photo by Pete Souza) nuclear-capable or latent Iran poses is the prospect that latency would enhance Iran's ability to pursue regional hegemony and low-level destabilizing conflict, including increased support for subversion, terrorism, and interference in the affairs of other regional states. Iran already has shown evidence of its willingness to use low-level pressures and efforts to exploit sectarian issues in Gulf Cooperation Council states, and nuclear capacity or weapons are not likely to change the situation dramatically. However, under the cover of its nuclear arms, it is widely believed that Iran could undertake such actions with greater impunity. The use of latency in this fashion would raise fundamental questions about the international nuclear nonproliferation regime and reduce the prospects for nonproliferation solutions, which will be seen to have failed even though the Treaty on the Nonproliferation of Nuclear Weapons (NPT) does not address latency.[2]

One response to Iran's use of latency, which also has risks for the NPT and the regime, would be for regional states to hedge. The limited capability in the region means that it might well take decades for the regional rivals to hedge, and hedging would likely be a long-term prospect. Over time, however, the region may be expected to become heavily hedged, laying the foundations for a nuclear arms race. Hedging will be a key part of the response of the Gulf states and other regional states. The Saudi Arabian discussion of "deterrence by capability" suggests that it intends to follow the logic of cascades, and intend to match Iran's latent capabilities but not to escalate to weapons themselves. This potential response is not desirable, and raises issues of crisis instability, but it may be seen as preferable to a full-blown regional nuclear arms race.

In the near and medium-terms, beyond nonproliferation and possibly counterproliferation measures, it is difficult to see how this Iranian strategy could be addressed through traditional extended deterrence. For military and political reasons, it may not be possible to extend nuclear deterrence formally to the Gulf states and others, even though there have been longstanding and increasing efforts to enhance the capabilities of and the cooperation among these regional allies. Moreover, as is the case in other regions, classical deterrence threats could be escalatory, and possibly drive Iran to nuclear weapons if it has not already decided on this objective. The threats themselves may not be credible, in part because they are likely to be seen as unjustified and disproportional acts of aggression by the international community.

Can cross-domain deterrence offer a credible means to deter a latent nuclear state? From acquisition? From threats? From use? Cross-domain deterrence offers, in principle, a credible response to latency, against which a nuclear threat may not be viewed as appropriate or proportional and therefore not credible. Economic threats designed to freeze or degrade the latent capability through sanctions, or cyberthreats to destroy the latent capability of computer systems and infrastructure, have appeared as credible, attractive options. Yet the record of their use in Iran in the past decade indicates that they did not achieve the results expected in the logic of cross-domain deterrence. Sanctions may have brought Iran to the negotiating table, but did little to affect Iran's commitment to a growing program. Reports on Stuxnet, which has been described as a secret program with a significant but limited impact, suggest that such an approach may be difficult, controversial, and less effective than needed.

Even if these measures had been used in an explicit cross-domain strategy, there is no reason to believe the results would have been different. The logic of cross-domain deterrence, for that matter, could undermine responses by taking otherwise credible responses off the table out of fear of reprisal or escalation. Nuclear attacks have never been in play, but conventional military strikes may not appear as attractive as these other cross-domain options, whatever the record, even though they might be better tailored to achieve the desired deterrence objectives.

Although the cross-domain element may have only a limited impact on deterrence (and compellence) in this case and possibly others, it may be useful in broadening the options for responses to Iran. Cross-domain deterrence may be more attractive (and possibly effective) in deterring threats and use, and cyber, conventional, and other cross-domain responses could be deescalatory in this case. Iran might at least to some degree be affected by cross-domain responses that did not provoke it to move from a latent to an operationalized nuclear weapon.

Latency, Deterrence, and Disarmament

Despite the stalemate in arms control today and no realistic prospects for progress in the foreseeable future, the disarmament debate in recent years has raised a number of other interesting issues related to the nexus of latency, deterrence, and disarmament, both in the 1990s after the end of the Cold War and in last decade. Nuclear weapons cannot be uninvented. Nuclear-weapon programs that have been shut down can be reconstituted. The realities of latency in Japan, and in the cases of South Africa's unilateral disarmament and rollback cases in Iraq, Libya, and three post-Soviet successor states (Belarus, Kazakhstan, and Ukraine), as well as the best outcome of the JCPOA, all remind us that that latency will exist as nuclear forces are reduced and even in the case of the achievement of a nuclear-weapon-free world.

The reality of nuclear latency, seen through the prism of the disarmament debate, can offer a reduced risk of accidental or unauthorized use while at the same time allowing a high level of crisis instability and the prospect of disarmament being rapidly reversed. Moreover, the explicit (or more often the implicit) assumption put forward in the debate is that latent capabilities enable disarmament and nuclear-weapon states can choose whether or not to rely on these capabilities as a hedge against the risks that disarmament poses. Whatever one's view of disarmament, this argument has problems and uncertainties. More specifically, the point in question is whether the latent capabilities that existed during reductions and remained after disarmament would deter in and of themselves. The argument is based on the reality of enduring latent capacity in a hypothetical nuclear-weapon-free world. Capabilities can enhance deterrence based on forces in being and, in principle allow further reductions in those forces. There is a sound basis for such reasoning, although this approach raises issues of balance and sufficiency. However, there is nothing to support the view that virtual nuclear deterrence would provide sufficient inducements for extant nuclear-weapon states to pursue disarmament.

Although some states pursuing nuclear-weapon capabilities may determine that their latency provides them an acceptable level of deterrence, and perhaps view this as optimal and preferable to weaponization, the situation is likely to look quite different to states with nuclear arms. The issue involves the perceived and real differences between seeking and giving up nuclear weapons, and divergent risk calculations (both assessments and acceptance of risk), especially for the United States, which extends deterrence to allies. In this context, the perception that latency will have a positive deterrent effect without forces in being appears neither clear nor compelling for extant weapon states. At any point short of a global zero, most nuclear powers would view reliance on latent capabilities as posing unacceptable risks. Even in a nuclear-weapon-free world, politicians and bureaucracies would be resistant to any regime without a developed protocol that precisely delineated prohibited capabilities and ensured that allowed capacity was not asymmetric and could be fully resourced and exercised. At least some aspects of such an arrangement would be essentially unverifiable, and would have to be addressed as a cooperative or confidence-building measure if at all possible. In practice, such an agreement could merely recognize these capabilities, or sanction and preserve them, or proscribe and dismantle them to the extent possible. If virtual capabilities (without forces in being) are to serve as a hedge—albeit one of uncertain value—they require, among other things, human capital and facilities that cannot just be mothballed and will need to be exercised. This state of affairs may appear threatening, and raises questions about stability. Of course, the potential for both crisis and arms race instability as numbers are reduced, to low numbers and to zero, has long been recognized. However, latency increases the potential for instability.

The potential for breakout during a crisis has been considered as far back as the landmark Acheson-Lilienthal Report of 1946 (formally known as the *Report on the International Control of Atomic Energy*). As the reality in East Asia and the prospects for a heavily hedged Middle East indicate, the global and regional stability issues raised by the report remain as valid as they were more than seven decades ago. Latency at either level creates the potential for breakout; unless the risks are managed properly, and there is a liable option to counter breakout scenarios in response, a nuclear-weapon-free world will be plagued with intrinsic and worrisome instability.

Aside from these critical stability issues, it is difficult to assess any deterrence offered by latency. The manner in which a state—whether Japan, Germany or a disarmed nuclear-weapon state—might attempt to use latent capabilities for deterrence and compellence and the effects are unclear. In spite of the oft-mentioned hope that latency will provide a level of deterrence, and bolder arguments that science by itself will be the basis for a virtual deterrent, the limits and problems of U.S. Stockpile Stewardship Program and current and anticipated future funding levels make it highly unlikely that such aspirational scenarios would come to fruition. In any case, this approach may not appear to meet the objectives of disarmament, and face criticism from abolitionists and their allies.

If latency alone does not appear to be credible as a hedge to enable disarmament, would cross-domain deterrence affect this calculus? In the West, conventional forces and ballistic missile defenses (BMD) appear to serve this hedging function in a world whether the number of weapons has been reduced or in a nuclear-weapon-free world. However, Russia and China have criticized these forces for a host of reasons, including the argument that they preserve U.S. military superiority and allow the maintenance of a level of deterrence in a nuclear-weapon -free world. There is no reason to believe that Russia and China would eliminate their nuclear arsenals if U.S. superiority in conventional forces, BMD, and other areas somehow were not addressed, or if international relations had not been somehow transformed or if general and complete disarmament were not achieved. It remains to be seen precisely how any of these possibilities could be realized, if in fact they could be achieved in the first place.

Even if the asymmetry between U.S. and other states' nonnuclear military capabilities somehow could be addressed as nuclear forces were drawn down, conventional forces, defenses and other capabilities, including cyber, would exist in a denuclearized world (assuming that general and complete disarmament had not been achieved). These capabilities could be used to deter breakout from nuclear latency or a virtual weapon status, and in principle they could reduce the risks of a successful breakout and effectively take the threat of one or a few covert weapons off the table. However, their ability to achieve this objective is unclear and uncertain. Moreover, in scenarios where breakout is a real possibility, significant cross-domain threats could be destabilizing and escalate crises. Could nonnuclear deterrence threats across a variety of domains end the disarmament process or provoke a nuclear breakout if a nuclear-weapons-free world had been achieved? Could these threats encourage arms races in and across nonnuclear domains? What are the prospects of crisis and arms race instabilities?

Conclusion

Since the end of World War II the United States has engaged in long-term effort to avoid strategic technological surprise and increase early warning in the nuclear and other national security realms. Intelligence was at the forefront, but the role of deterrence, nonproliferation and arms control were also important. From this perspective, the emerging challenges of latency and cross-domain deterrence may be more daunting than those that the world has confronted in the past, reinforcing the need to better understand these concepts and the relationships among them.

To do so, the international community as a whole will need to consider and better understand several critical issues, including the following:

- Will latent capabilities allow the holder to deter the United States, allies, and friends?
- Can nuclear or other strategic latent capabilities be deterred or otherwise countered by cross-domain threats? Conventional? BMD? Cyber?
- Will any cross-domain deterrence effects on latent capabilities differ from those on forces in being, especially in terms of escalation and crisis stability?
- How do traditional criteria for stable deterrence relationships, especially symmetry of force capabilities, affect latent capabilities? Are there differences in this regard with forces in being?
- Is a framework for understanding the interrelations and interactions between domains in deterrence possible? Desirable? For the United States and allies? For the United States and adversaries? For both?
- Does latency make this problem more difficult and necessary to address?

- Would such a framework enhance predictability and reduce the prospects for miscalculation and inadvertent escalation?
- How would latency affect this calculus?Are norms, standards, and even treaties and institutions possible?

These and other questions that may be derived from them comprise a rich and challenging research agenda. Analyses based on them are absolutely needed if we are to more fully understand the relations of latency and hedging to deterrence, nonproliferation, arms control, and disarmament.

Endnotes

1 For a fuller discussion of the JCPOA, from which its treatment in this case study is largely derived, see Nathan E. Busch and Joseph F. Pilat, *The Politics of Weapon Inspections: Assessing WMD Monitoring and Verification Regimes* (Palo Alto, CA: Stanford University Press, 2017).

2 In the nuclear nonproliferation and arms reductions efforts that have been pursued since the Acheson-Lilienthal report, the issue of latency received insufficient attention or analysis. More importantly, in the intervening decades there have been no direct efforts to address latency in any bilateral or multilateral nonproliferation, arms control, and disarmament agreements. The NPT did not proscribe latency; in fact, it fostered the role of the treaty in creating latent capability through the promotion of peaceful uses of nuclear power. Moreover, nothing in the treaty limits research and development or the pursuit of knowledge and experience relevant to nuclear weapons. This is evident in the language and negotiating histories of key provisions of the treaty, including the definition of "manufacture" in Article II, the limits of safeguards coverage in Article III, and the meaning of Article IV. For a fuller discussion, see Joseph F. Pilat, "Nuclear Latency, Arms Control and Disarmament," Los Alamos National Laboratory White Paper, 2013.

Explaining the Proliferation of Latent Nuclear Capabilities

Matthew Fuhrmann

Many scholars and policymakers have considered the drivers and strategic effects of nuclear-weapon proliferation.[1] There is growing recognition in scholarship that nuclear programs may be consequential even if they do not produce nuclear bombs.[2] Having the capacity to make nuclear weapons—a condition often referred to as "nuclear latency"—can shape peace and stability in important and sometimes underappreciated ways. Nuclear latency might allow countries to deter military conflict or extract political concessions with greater ease. The spread of latent nuclear capabilities could also invite instability by providing incentives for preventive military conflict, as the 2003 Iraq War suggests.

More than 30 countries have sought sensitive dual-use nuclear technology since Enrico Fermi and his research team generated the first nuclear chain reaction in a rackets court beneath the football field at the University of Chicago in December 1942.

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Left: Nuclear power generation fukui prefecture japan. Courtesy of shutterstock.com

Countries continue to express an interest in obtaining latent nuclear capabilities today. Saudi Arabia, for instance, has asserted that it will develop uranium enrichment technology that could provide the foundation for a bomb program in response to the Iranian program.[3] This chapter addresses a simple question: what explains the global spread of latent nuclear capabilities? Put differently, what motivates countries to develop nuclear latency? There is no single driver of nuclear technology diffusion. Instead, multiple considerations combine to shed light on dual-use nuclear technology diffusion. This chapter focuses on six historically significant factors: commercial incentives, nuclear arsenals and hedging, latent nuclear deterrence, arms races, prestige, and international risks and constraints. Before going into detail about these motivations, the chapter discusses an effort to collect comprehensive data on the spread of sensitive nuclear technology and comments on global trends in nuclear latency.

Measuring Nuclear Latency and Global Trends

Nuclear latency is fundamentally about how quickly a country could build nuclear weapons following a political decision to proliferate. Analysts have measured this concept in several ways, and each measurement strategy can produce varying conclusions about the spread of latent nuclear capabilities in world politics.[4]

One approach is to consider any country with a civilian nuclear program to be a latent nuclear power. In this view, all states that have a research reactor—which generally is the first technology that countries obtain after starting a nuclear program—have the capacity to build nuclear weapons.[5] This is a low threshold that would result in nearly 70 countries, including underdeveloped states such as Jamaica, being labeled as latent nuclear powers. To raise the bar, one might argue that states achieve nuclear latency once they develop their first nuclear power plant.

Yet some states that operate nuclear power plants, such as Armenia and Mexico, lack other capabilities that are critical for building bombs.

The political scientists Dong-Joon Jo and Erik Gartzke—building on earlier work by Stephen Meyer and Richard Stoll—have taken a more sophisticated approach that incorporates multiple requirements for bomb making.[6] Their measures of latent nuclear capacity include the possession of uranium deposits; expertise in metallurgy, chemical engineering, nuclear engineering, physics, chemistry, electronics, and explosives; and the capacity to produce nitric acid and electricity.[7] Based on these capabilities, Jo and Gartzke create an additive index that ranges from 0 to 7, with higher scores indicating greater degrees of latency. Their index assesses countries based on their nuclear potential over a large period of the nuclear age (1938–2001), making it useful for many purposes.

One limitation of Jo and Gartzke's latency measure—as well as the Meyer and Stoll versions on which it is based—is that it does not directly capture a state's ability to produce fissile material. Making fissile material—weapon-grade highly enriched uranium or weapon-grade plutonium—is the most difficult step in building nuclear bombs. For this reason, enrichment and reprocessing (ENR) plants are widely seen as sensitive from a nonproliferation standpoint. By excluding ENR facilities, the Jo and Gartzke index may set the threshold for latent nuclear capacity too low. Colombia, Portugal, and Uzbekistan all receive the maximum possible score on their index even though none of them have sophisticated civilian nuclear programs. These countries could probably build nuclear bombs with adequate time and political determination, but they would have to start largely from scratch. States such as Japan that already possess the means to make fissile material, by contrast, could assemble nuclear warheads more rapidly. Jo and Gartzke's index does not fully distinguish countries with the most advanced nuclear capabilities from everyone else. It also does not completely capture national interest in having nuclear latency, since some countries that score highly on their index have made little effort to obtain sensitive technologies related to the nuclear fuel cycle.

The Nuclear Latency (NL) dataset provides an alternative measure of a country's latent nuclear capacity based on its existing ENR technology.[8] This dataset identifies every country's laboratory, pilot-scale, and commercial ENR activities from 1939 to 2012. It contains information on 253 ENR sites globally. For each of these sites, the NL dataset identifies details such as the construction and operation dates, the military dimensions of the facility, whether it operated under regional or international safeguards, and the countries that provided assistance in building the plant.

One could construct at least two ENR-based indicators of nuclear latency using this dataset. First, any country that has an active ENR program could be classified as a latent nuclear power. This measure would uniquely identify all states that have some capacity to produce fissile material. However, countries with laboratory-based ENR activities typically produce only small quantities of highly enriched uranium or plutonium, well short of the amount needed to make at least one nuclear bomb. A second possible measure of latency is based on a higher technological threshold: one could identify a country as a latent nuclear power if it had a pilot-scale or commercial ENR plant in operation.

Based on the NL dataset, a total of 32 countries developed at least laboratory-based ENR programs. Ten of these countries never completed a pilot plant, meaning that 22 countries (69 percent of those that started a laboratory program) developed a more serious bomb-making capacity from a nonproliferation standpoint. Table 14-1 lists the countries that are classified as latent nuclear powers according to the two thresholds described previously. Algeria, Egypt, South Korea, and other countries that lacked pilot plants could not have obtained nuclear weapons imminently, but nonetheless they acquired significant capabilities that raised concerns internationally about the possible spread of nuclear weapons. The other countries in the table were much closer to a serious bomb-making capacity. Ten of these states (45 percent) eventually went on to build nuclear arsenals. However, 12 have developed latent nuclear capabilities without building warheads.

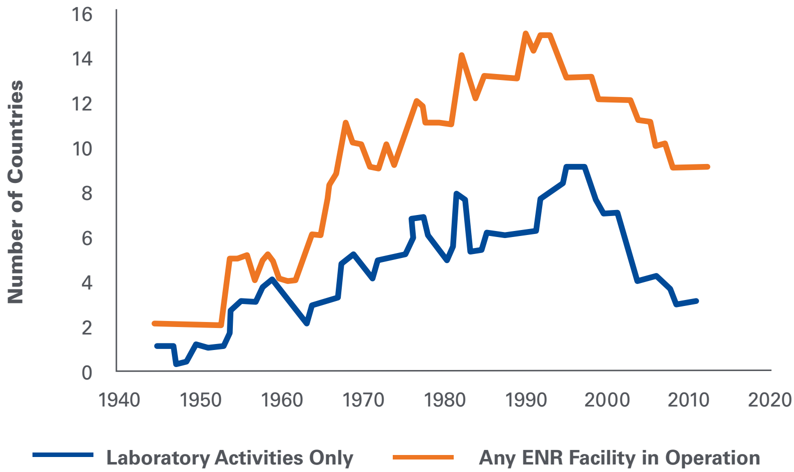
TABLE 14-1. LIST OF LATENT NUCLEAR POWERS

Countries with Laboratory ENR Activities Only	Algeria, Australia, Czechoslovakia, Egypt, Libya, Romania, South Korea, Sweden, Taiwan, Yugoslavia
Countries with Pilot or Commercial Plants	Argentina, Belgium, Brazil, Canada, China, France, Germany, India, Iran, Iraq, Israel, Italy, Japan, North Korea, Norway, Netherlands, Pakistan, Russia, South Africa, Spain, United Kingdom, United States

Source: Fuhrmann and Tkach (2015)

Figure 14-1 summarizes trends in the spread of latent nuclear capabilities over time. It identifies the number of nonnuclear countries that had active laboratory ENR programs or pilot/commercial plants in operation from 1945 to 2012. As the figure shows, the number of states with nuclear latency generally increased during the Cold War. There was a particularly significant spike from 1960 to 1968, when the number of nonnuclear states with ENR capabilities nearly tripled (from 4 to 11). After the Cold War, however, the trend began to reverse. In 2012, nine countries that lacked nuclear arsenals had active ENR programs, compared to 15 in 1990. Some of these states abandoned their programs in the face of external coercion—for example, Iraq—while others shuttered ENR plants largely on their own accord. Some signs indicate that concerns about the Iranian and North Korean nuclear programs could lead to another spike in ENR activities, but such an outcome remains to be seen.

FIGURE 14-1. NONNUCLEAR COUNTRIES WITH ENR CAPABILITIES OVER TIME



Source: Fuhrmann and Tkach (2015)

Why Countries Develop Latent Nuclear Capabilities

What accounts for the previously described global trends? A review of some of the principal motivations for developing latent nuclear capabilities suggest that no single explanation can fully explain why countries seek nuclear latency.[9] Taken together, however, the motives and constraints described below provide a richer understanding of how and why latent nuclear capabilities spread globally.

COMMERCIAL AND ECONOMIC MOTIVATIONS

Sensitive nuclear technology attracts attention from the international community in large part because of its bomb-making potential. Yet ENR plants, like all nuclear technology, have legitimate commercial applications as well. In particular, these facilities provide states with the capacity to produce low-enriched uranium fuel for nuclear power plants. (Plutonium could fuel nuclear reactors but this is generally not done today.)

Countries and private firms may wish to export nuclear fuel to foreign clients. In that case, countries may encourage ENR development to take advantage of potentially lucrative business opportunities. Three firms currently dominate the market in enrichment services: Rosatom (Russia), Urenco (Germany, the Netherlands, and the United Kingdom), and Orano (formerly Areva, France).[10] The United States was a leader in global enrichment services for much of the nuclear age, but it is no longer a major player in this area. The last U.S.-owned enrichment plant, located in Paducah, Kentucky, closed in 2013.[11] The only U.S. firm providing enrichment services, USEC, filed for bankruptcy shortly thereafter.[12] It emerged from Chapter 11 protection under a new name (Centrus Energy), but its financial difficulties continue.[13]

Many states with nuclear power plants rely on international suppliers to meet their fuel needs. However, two economic considerations could motivate states to produce their fuel domestically. First, countries that rely (or expect to rely) heavily on nuclear power to meet their electricity needs might find it more economical to develop their domestic fuel-making capacity. As a country's nuclear fuel needs rise domestically, it becomes easier to justify a capital-intensive investment in ENR technology. Second, countries may worry that geopolitical considerations could lead to disruptions in the market for nuclear fuel. A state that is deeply worried about its energy security may prefer to meet its nuclear fuel needs domestically rather than rely on foreign suppliers, who might raise prices or reduce supplies on short notice. In the United States, some have used the energy security logic to justify continued investment in ENR activities.[14] Concerns about market capriciousness exist, but they should not be overblown. Compared to the oil market, which experienced severe disruptions following the oil embargo of the 1970s, enrichment services have been relatively stable.

Economic and commercial factors have motivated ENR technology development in the past, and this trend could continue in the years to come. Some Australian officials, for instance, have suggested that Canberra should export enriched uranium in order to make economic gains. As John Carlson, the former director general of the Australian Safeguards and Nonproliferation Office, said in 2006, "The Prime Minister [John Howard] has said we have a third of the world's uranium reserves and clearly we need to look at whether we can value-add rather than have the economic advantage of upgrading falling only to other countries."[15] At the same time, economic factors have been the *principal* motivation for achieving latent nuclear capacity in just a few cases. Of the states that developed nuclear latency (see table 14-1), economics clearly played a role for Belgium and the Netherlands. France, Russia, the United Kingdom, and the United States benefited economically from their ENR programs, but these countries exploited their nuclear programs for financial gain after they had built nuclear weapons. Most latent nuclear powers sought ENR technology mostly for noneconomic reasons. To understand their motives, it is helpful to consider strategic and political considerations.

NUCLEAR ARSENALS AND HEDGING

Having nuclear weapons provides countries with political and strategic benefits. The scholarship generally agrees, for example, that countries armed with nuclear arsenals are less likely to be invaded. States may therefore desire nuclear forces to enhance their security, particularly if the risk of external aggression is high and they face conventionally superior adversaries. To build nuclear weapons, countries must first obtain fissile material. Because it is unlikely that countries would be able to acquire sufficient quantities of weapon-grade highly enriched uranium or plutonium on international markets (or as a result of theft), having ENR technology is essentially a prerequisite for proliferating. Some countries obtain nuclear latency simply because it is a necessary stop on the way to obtaining bombs. The United States and the Soviet Union, for instance, sought latent nuclear capabilities because they were determined to build nuclear weapons from the beginning. These countries were latent for a brief period, but it was only a matter of time before they became full-fledged nuclear powers.

However, building nuclear weapons is costly. Aside from the financial and technological burdens of building and maintaining and arsenal, states that proliferate may face international sanctions, especially following the establishment of the Treaty on the Nonproliferation of Nuclear Weapons (NPT) in 1968. Some countries, therefore, may hesitate to fully commit to building nuclear weapons but nonetheless desire some of the benefits that arsenals may provide. These states may seek nuclear latency as part of a hedging strategy.[16] Nuclear hedgers seek ENR technology because they want to shorten the time needed to proliferate in the event of a serious international crisis, even if they are not already determined to build nuclear weapons.

Analysts often point to Japan as a prototypical hedger.[17] Based on this line of thinking, Tokyo did not necessarily have a concerted effort to build bombs. Its pursuit of a vast civilian nuclear program emerged, in part, because of it potentially dangerous security environment. In the event that relations deteriorate quickly with China or North Korea, and the alliance with the United States is deemed to be too unreliable, Japan may decide that it needs an independent nuclear capability in short order. By developing latent nuclear capacity, Japan is well positioned to accomplish this objective. Several other countries listed in table 14-1 may have had hedging-related motives as well. For example, many assume that South Korea had a dedicated nuclear-weapon program under President Park Chung-hee, but a declassified assessment from November 18, 1975 reveals that at least one bureau in the U.S. State Department held a more nuanced view:

> it has to be recognized that there is some ambiguity in our precise knowledge as to what the Koreans are up to in the nuclear military field. It may be likely that the ROK is intent on acquiring a weapon as soon as possible, but it also appears possible that the decision to acquire a weapon may not have been firmly taken and that the ROK is essentially developing a contingent military capability for possible activation at a later time.[18]

Even states that ultimately built nuclear arsenals may have started their ENR programs as part of a hedging strategy. For example, Israeli prime minister Levi Eshkol thought it was critical for his country to have the *capacity* to build nuclear weapons, but it is less clear that he desired an arsenal from the beginning.[19] Egypt's behavior in the lead up to the 1967 Six-Day War presented a serious threat to Israel, and ultimately compelled Eshkol to quickly convert a previously latent capability into a crude nuclear arsenal. In the absence of this conflict, Israel may have been content to remain a latent nuclear power.

LATENT NUCLEAR DETERRENCE

The mere capacity to build nuclear weapons may benefit countries from a foreign policy standpoint. In particular, latent nuclear powers may be able to deter serious military disputes more effectively than their nonlatent counterparts. There are two mechanisms through which latent nuclear deterrence might work. First, latent nuclear powers may be able to carry out delayed nuclear counterattacks. If a state with nuclear latency could deliver a nuclear strike within weeks (or perhaps months) of an attack, it might be able to dissuade invasions as if it were a nuclear power. When this is the case, states are sometimes said to possess "virtual nuclear arsenals."[20] A potential aggressor would have to consider the possibility that the latent state might quickly build a nuclear bomb and use it in conflict following an initial salvo. Latent nuclear deterrence, then, may work like traditional nuclear deterrence, except with a delay between the initial attack and the nuclear response. However, latent nuclear powers may be able to deter conflict even if nuclear weapons are not used in a (delayed) retaliatory attack. The second mechanism involves countries threatening to initiate or accelerate a nuclear-weapon program following an attack. The possibility of fomenting nuclear proliferation might discourage aggressors from mounting attacks even if there is no possibility of nuclear use in the context of the initial conflict. Imagine that State A is considering attacking State B, which is a latent nuclear power. State A perceives that an attack would compel State B to weaponize its nuclear program, and that it would have its first bomb in a year or two. Under these conditions, State A may exercise caution so that its aggressive policies do not cause nuclear proliferation.

Consider the crisis over Iran's nuclear program from 2002 to 2015. Tehran's pursuit of nuclear latency generated calls for preventive military action in Tel Aviv, Washington, and elsewhere. In the context of the present crisis, however, no country has carried out strikes against Iran's sensitive nuclear plants. (In the 1980s, Iraq bombed Iran's nuclear infrastructure during the Iran-Iraq War, but such direct actions have not been repeated.) There are many reasons why this is the case. One factor contributing to deterrence seems to be Iran's capacity to build nuclear weapons. At least some U.S. elites acknowledge that attacking Iran would only increase Tehran's determination to build nuclear weapons, thereby inducing proliferation. As General Michael Hayden, who directed the Central Intelligence Agency (CIA) under President George W. Bush, put it: "The view among Mr. Bush's top advisers was that a strike would drive them to do what we were trying to prevent."[21] Washington was not worried that Tehran would quickly fashion a nuclear device and use it in immediate retaliation. U.S. officials instead voiced concern that the military option would make it more difficult to keep Iran nonnuclear in the coming months and years, which would impose costs on the United States in the medium to long term.

However, latent nuclear deterrence does not always work. Countries have been attacked even though they have the capacity to build a nuclear arsenal. Pakistan instigated a war with India in 1965, for example, despite (and perhaps because of) New Delhi's demonstrated capacity to produce plutonium.[22] Successful latent nuclear deterrence depends on several conditions.[23] First, the defender must possess a viable ENR program about which the potential attacker knows; capabilities that are secret cannot deter. Second, the potential attacker must be threatened by the defender's acquisition of nuclear weapons (if the defender hopes to deter by proliferation rather than delayed attack). Third, the stakes must be high. It is not credible to build or use nuclear weapons in retaliation for minor transgressions. As the stakes increase for the defender, however, the possibility of activating a previously latent capability becomes more realistic. Fourth, the defender's nuclear facilities must be survivable. If the attacker believed that it could significantly degrade the defender's nuclear program by destroying critical nuclear facilities, the development of an ENR program may induce rather than deter conflict. Fifth, the attacker must not see nuclear proliferation by the defender as inevitable. If it does, the attacker may conclude that it could do no harm from the standpoint of nonproliferation by attacking, since the defender intends to obtain nuclear forces anyways. A military strike, the attacker may calculate, would be the only chance to stop proliferation. These conditions do not

"As the stakes increase for the defender, however, the possibility of activating a previously latent capability becomes more realistic."

hold in all circumstances. When they do, though, ENR programs lower a country's vulnerability to military conflict.[24]

Nuclear latency may also be useful for offensive political purposes, not just deterrence.[25] In this view, countries can extract concessions from their adversaries by threatening to go nuclear if their demands are not met. Compellence based on nuclear latency may be more difficult than deterrence, since the stakes involved are smaller for the latent nuclear power. Iran, for instance, could threaten to build nuclear weapons unless the United States signs a formal nonaggression pact. This might be a credible threat under certain conditions. It is more plausible, however, that Iran would proliferate in response to a U.S. attack that threatened its core interests. At the same time, nuclear latency appears to have aided coercive diplomacy in other instances.

At least some countries believe that nuclear latency is useful for deterrence or compellence. Former Japanese defense minister Ishiba Shigeru seemingly embraced the deterrent benefits of Japan's nuclear latency: "I don't think Japan needs to possess nuclear weapons," he said, "but it's important to maintain our commercial reactors because it would allow us to produce a nuclear warhead in a short amount of time." Japan's nuclear program serves as "a tacit nuclear deterrent," he added.[26] Beyond deterrence, countries such as Egypt appear to buy the notion that nuclear latency provides political leverage. According to a formerly top-secret U.S. intelligence assessment from September 1981, "Egypt probably believes that an expanded nuclear power program eventually will give it the technical capability to develop nuclear weapons and that such a capability would provide leverage in future deals with Israel, Iraq, and Libya."[27] Some countries may develop latent nuclear capabilities because they desire the strategic benefits that ENR programs seem to afford.

ARMS RACES

Matching the capabilities of a strategic adversary has long been a driver of nuclear proliferation.[28] As former U.S. secretary of state George Schultz once put it, "proliferation begets proliferation."[29] In this view, countries seek nuclear weapons in response to a rival's acquisition of a nuclear arsenal. One might argue, for example, that the Soviet Union built an arsenal in response to the Manhattan Project and Pakistan obtained bombs because of India's nuclear program. A single case of proliferation, based on this line of thinking, can generate a proliferation "chain reaction." This is a big reason why many scholars and policymakers worry about the possibility of Iran becoming a nuclear-weapon state.[30] If Tehran gets the bomb, they argue, others in the region will follow, including Egypt, Saudi Arabia, and the United Arab Emirates.

The arms-racing logic applies to the international spread of latent nuclear capabilities, in addition to nuclear arsenals. When a country pursues nuclear latency, its rivals cannot be sure of its intentions. As discussed previously, there are legitimate commercial reasons for developing ENR technology, and so a latent nuclear power's aims may be largely innocuous. At the same time, a country could exploit the dual-use nature of nuclear technology to hide more sinister intentions. The development of latent nuclear capabilities may, in fact, represent a concerted effort to build nuclear weapons as quickly as possible. The uncertainty generated by a country's pursuit of ENR facilities may compel its rivals to take action. If the rival goes on to proliferate, others will be at a strategic disadvantage if they have to start nuclear programs from scratch. To avoid falling behind, countries might begin ENR programs as soon as their adversaries do so, or shortly thereafter. Reactive ENR development does not necessarily imply that a state is determined to build nuclear weapons—only that it wants to be in a position to do so in the future, if necessary. A rival's development of nuclear latency, then, can trigger the hedging logic described above. More generally, states may seek to match their rival's nuclear capabilities to keep up in competitions for regional influence or supremacy.

The nuclear programs of Argentina and Brazil illustrate the interdependence of state policies in this area. Buenos Aires began constructing a small plutonium reprocessing plant at Ezeiza in the late 1960s. It announced plans to build a larger reprocessing facility at the same site in 1978, but that plant never entered into operation. Argentina pursued an enrichment capability as well: it built a pilot plant at Pilcaniyeu that began operating in the 1980s. Brazil began work on a small reprocessing laboratory at its Nuclear Energy Research Institute in 1960, and completed this site in 1982. However, most of Brazil's ENR work has been in the area of enrichment. The country's first small-scale enrichment plant began operation in 1979 and Brasília eventually obtained a serious enrichment capability. In 2005, Brazil opened the first commercial enrichment plant in Latin America. Historical evidence shows that Argentina's progress motivated Brazil to advance its own ENR capabilities, and vice versa. As a declassified CIA assessment from October 1983 put it, "Brazilian officials are distressed by their inability to match the nuclear advances of their unpredictable neighbor."[31] A January 1978 State Department underscores that the inverse also was true: "Brazil's reprocessing plans are encouraging accelerated Argentine movement toward [the development of an] unsafeguarded reprocessing plant."[32]

PRESTIGE

Nuclear weapons are a status symbol in international relations.[33] Having a "peaceful" nuclear program can signal technological modernity and relevance, too. Sensitive fuel cycle technology, in particular, may afford countries with esteem. The proliferation-significance of fissile material production capacity and the exclusivity of the "ENR club" could make latent nuclear capabilities attractive for states seeking to enhance their standing internationally or domestically.

Prestige-related considerations appear to be salient for at least some latent nuclear powers. Canada maintained its nuclear program after World War II, which included reprocessing activities at the Chalk River Laboratories near Ottawa, in part for prestige-related reasons. As the historian Margaret Gowing wrote, "atomic energy had helped to carve a new status for Canada in the postwar world. It had brought her to the top diplomatic tables and it had demonstrated and enhanced her underlying scientific, technological, and industrial strength."[34] Iran developed its enrichment capacity partially for prestige-related reasons as well. Muhammed ElBaredei, the former director general of the International Atomic Energy Agency, characterized Iran's motives in 2009: "In my view Iran's nuclear program is a means to an end: it wants to be recognized as a regional power, they believe that the nuclear know-how brings prestige, brings power, and they would like to see the U.S. engaging them."[35] Status-related considerations also contributed to Brazil's nuclear program. As a U.S. intelligence assessment put it 35 years ago, "Brazilian leaders clearly see the eventual mastery of nuclear fuel cycle technology as necessary for the great power status to which they aspire."[36]

It is not clear, however, that a search for prestige is alone sufficient to produce latent nuclear capacity. It is a relevant factor for many countries, but it may not be the central cause of beginning an ENR program in any single case. Prestige seems to have its strongest effects after a country is a latent nuclear power, partially because leaders use status-related considerations to justify continued investments in nuclear technology to domestic audiences. Canada's nuclear program, for instance, emerged from its role in the Manhattan Project. Its ENR activities therefore had a clear military purpose at the outset, but became a salient status symbol as time passed.

CONSTRAINTS AND RISKS

The preceding discussion highlights several factors that could motivate countries to seek sensitive fuel cycle facilities.

However, this is just one side of the coin. To explain any political outcome—including why some countries develop latent nuclear capacity and others do not—one must account for the constraints that a country faces, in addition to its motivations. The so-called "supply side" of nuclear proliferation emphasizes factors that give countries the opportunity to obtain critical technology and weapons.[37] In the context of nuclear latency, two supply-side factors are significant.

First, a country's existing nuclear infrastructure and know-how may be important for explaining the development of latent nuclear capacity. The indigenous development of ENR technology requires some preexisting capacity in nuclear engineering and related fields. States with considerable wealth and nuclear-specific experience can take a decade or more to successfully build an ENR plant. For example, Urenco, a consortium that includes British, Dutch, and German entities, began a uranium enrichment program in 1960 and did not have an operational demonstration plant until 1971.[38] Countries with fewer domestic resources may struggle to build ENR plants. Saudi Arabia's underdeveloped nuclear program—it does not even operate a research reactor—substantially limits its ability to enrich uranium domestically. The country's wealth would probably allow it to build up the requisite knowledge and infrastructure eventually, but this would take years and perhaps decades. Countries can bypass relevant technological hurdles by obtaining foreign assistance. Yet even substantial outside help does not guarantee success. Libya received enrichment-related assistance from Pakistan, for instance, but it still was unable to successfully produce a demonstration plant.

"Saudi Arabia's underdeveloped nuclear program—it does not even operate a research reactor—substantially limits its ability to enrich uranium domestically."

Second, there are international political barriers to ENR development. International law permits states to obtain ENR technology, and the NPT guarantees the right to produce nuclear energy for peaceful purposes. Some countries, especially the United States, have nonetheless sought to limit the spread of ENR technology because of its strategic significance. Washington routinely puts pressure on those that pursue latent nuclear capacity, along with suppliers that want to sell sensitive technology. In the 1970s, France agreed to sell South Korea a plutonium reprocessing plant. After learning of the deal, Washington applied substantial political pressure on Seoul, and South Korea eventually agreed to abandon its purchase of the facility.[39] The application of U.S. leverage appears to be decisive in explaining why South Korea did not move beyond laboratory ENR activities. As this case suggests, countries may desire nuclear latency for political or strategic reasons, but refrain from moving forward because of actual or anticipated diplomatic blowback.

Third, a state's pursuit of nuclear latency could lead to concerns that it covets nuclear weapons. If this happens, a country might take preventive military action against the latent nuclear power. Israel destroyed nuclear reactors in Iraq (1981) and Syria (2007) because it believed that proliferation would occur in the absence of a military attack. Countries might fear that they will suffer a similar fate if they seek ENR technology, which could deter them from pursuing latent nuclear capacity.[40]

These factors underscore that the spread of latent nuclear capabilities does not happen simply because of the benefits that ENR technology may afford. Significant constraints and risks may block ENR development, even in situations where states seemingly have high demand for latent nuclear capacity. At the same time, the lowering of structural constraints does not necessarily lead to nuclear latency when the benefits of achieving this capability are low. Ultimately, the interaction between supply and demand best accounts for the global spread of sensitive nuclear technology.[41]

Conclusion

This chapter addressed the spread of latent nuclear capabilities. It discussed some of the ways that scholars have measured nuclear latency, focusing on an earlier effort by the author to collect data on ENR activities around the world.[42] The chapter then developed six explanations for the proliferation of latent nuclear capabilities. First, countries may build ENR plants for commercial or economic reasons—namely, to produce nuclear fuel for indigenous nuclear power plants or export fuel to foreign clients. Second, states may desire to build nuclear weapons immediately, or to keep that option open by shortening the time needed to make bombs, and seek to harness ENR technology to do so. Third, having nuclear latency may increase a country's ability to deter conflict or extract concessions from their adversaries. States might seek latent nuclear capabilities in pursuit of these benefits. Fourth, the proliferation of nuclear latency follows the logic of an arms race. States build ENR plants in response to their rivals' pursuit of the same capability. Fifth, becoming a latent nuclear power might enhance a country's prestige internationally and have domestic benefits as well. Sixth, constraints and risks—technological deficiencies, international pressure, and the risk of preventive war—could effectively prevent a state's efforts to achieve nuclear latency.

The analysis carries implications for future trends in nuclear latency. At least some countries are likely to show an interest in developing fuel cycle technology in the years and decades ahead. Given the high barriers to market entry and the uncertain financial payoffs, political factors—not economic ones—are likely to drive future investments in latent nuclear capacity. Economic forces could become more salient, however, if there is a substantial increase in demand for nuclear power globally. Concerns about nuclear proliferation are likely to play a key role. North Korea's nuclear-weapon capability could motive South Korea to hedge its bets by ramping up its latent nuclear capabilities. Uncertainty about Iran's nuclear intentions could also encourage countries in the Middle East to develop ENR programs.

Based on this analysis, there are good reasons to expect that nuclear latency will not inevitably lead to proliferation. Latent nuclear powers might be able to obtain some of the benefits normally associated with nuclear arsenals. In particular, states with nuclear latency can deter conflict by threatening to build nuclear weapons if they are attacked. At the same time, there are costs to building nuclear weapons, and some countries therefore might conclude that maintaining nuclear latency alone is an optimal strategy. Many analysts and policymakers fear that Iran will build bombs in the near future. Although it is impossible to know Iran's intentions with certainty, it would not be surprising if Tehran is content to have the capacity to obtain an arsenal—at least for now. If Iran's security environment changes dramatically, it ultimately may opt for bombs.

Not every state that desires nuclear latency, though, will successfully enrich uranium or reprocess plutonium. Achieving nuclear latency requires states to overcome some technical challenges. Some states may be unable to do so, even if they receive significant foreign assistance. The United States likely will continue to apply political and economic pressure on any state, ally or adversary, that expresses interest in obtaining ENR technology. On top of this, the risk of preventive war may discourage states from attempting to build ENR plants.

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37 See, for example, Matthew Fuhrmann, *Atomic Assistance: How "Atoms for Peace" Programs Cause Nuclear Insecurity* (Ithaca, NY: Cornell University Press, 2012); and Matthew Kroenig, *Exporting the Bomb: Technology Transfer and the Spread of Nuclear Weapons* (Ithaca, NY: Cornell University Press, 2010). This literature suggests, in particular, that foreign nuclear assistance increases the likelihood that countries will pursue or acquire nuclear weapons by lowering technological barriers.

38 M. D. Zentner, G. L. Coles, and R. J. Talbert, *Nuclear Proliferation Technology Trends and Analysis* (Richland, WA: Pacific Northwest National Laboratory, 2005), 20.

39 See William Burr, ed., *Stopping Korea from Going Nuclear, Part I,* National Security Archive Electronic Briefing Book No. 582, NSA GWU, March 22, 2017, https://nsarchive2.gwu.edu/nukevault/ebb582-The-U.S.-and-the-South-Korean-Nuclear-Program,-1974-1976,-Part-1/.

40 Research shows that the risk of preventive war may curtail the international spread of nuclear weapons. See Debs and Monteiro, Nuclear Politics; Sarah E. Kreps and Matthew Fuhrmann, "Attacking the Atom: Does Bombing Nuclear Facilities Affect Proliferation," *Journal of Strategic Studies* 34, no. 2 (2011): 161–87; and Matthew Fuhrmann, "When Preventive War Threats Work for Nuclear Nonproliferation," *The Washington Quarterly* 41, no. 3 (2018): 111–35.

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Atomic Leverage: Compellence with Nuclear Latency

Tristan A. Volpe

When does nuclear technology provide a country with bargaining leverage in world politics? In the past, nations have attempted to compel concessions from the United States by wielding the threat of nuclear proliferation. Some governments played the nuclear card by choice as part of a compellence strategy. During the Cold War, officials in Rome and Tokyo threatened to retain unrestricted civil nuclear programs to pressure Washington into complying with various requests, from enhanced military assistance under the NATO alliance for Italy, to the territorial reversion of Okinawa in the case of Japan.[1] The South Koreans tried to acquire a plutonium capability to prevent the withdrawal of U.S. forces from the peninsula in the early 1970s. In June 1979, officials at the U.S. Department of State believed that Pakistan's quest for nuclear technology was driven in part by a desire to acquire "a 'bargaining chip,' and that the [government of Pakistan] might be willing to hold its nuclear capability at

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a stage short of actual weapons development" for the right price.[2] In the early 1990s, North Korea threatened to produce plutonium for nuclear weapons unless U.S. officials provided energy assistance. Much more recently, Saudi Arabia promised to match Iran's uranium enrichment capability in 2015 to gain leverage over the White House in negotiations for a formal defense treaty and conventional weapons.

Other nations have engaged in coercive diplomacy as a tactical response to alleviate pressure or buy time. The North Koreans returned to concession-seeking diplomacy during the Six-Party Talks after a U.S. delegation confronted them with evidence of a covert enrichment program. In 2003, Libya traded its uranium gas centrifuge program for sanctions relief, while the revelation of covert nuclear facilities in Iran forced Tehran to open a diplomatic channel to ward off preventive military action. These nations preferred to develop nuclear capabilities in secret, but diplomacy afforded each the opportunity to transform a besieged nuclear program from a liability into a means of leverage. Indeed, a former spokesman for Tehran's nuclear negotiating team claimed that Iran was pursuing a strategy of "turning threats unto opportunities" by seeking to "obtain maximum concessions from their foreign counterparts in return for cooperation."[3]

As this track record underscores, some U.S. allies and even adversaries used offers to limit nuclear technology as a means of extracting concessions at the bargaining table with Washington. At other times, the threat of proliferation was not enough to coax U.S. officials into complying with expensive demands, or even worse, generated a dangerous and costly backlash. Given the wide spectrum of nuclear capabilities below the actual possession of nuclear weapons, when will a country be in the strongest position to extract concessions from the United States?

The central argument of this chapter is that there is an optimal range of nuclear technology for compellence because challengers are caught on the horns of a credibility dilemma. They must demonstrate sufficient resolve to cross the nuclear-weapon threshold while also reassuring the target with costly signals that compliance will be rewarded with a nonproliferation commitment. The challenger's level of latent capacity to produce nuclear weapons drives the severity of this tension between issuing credible threats and assurances. Moving closer to the bomb ratchets up threat credibility and the strength of the costly signals needed to convince the target to comply. When a nuclear enterprise is in a middle zone between having too little and too much nuclear latency to extract coercive benefits, the challenger should be most able to reach an optimal bargain because the proliferation threat puts enough pressure on the target to comply, and the assurance costs of signaling strategic intent are low relative to the concessions reaped from the nuclear deal. An empirical effort to identify the lower and upper boundaries of the sweet spot in actual nuclear programs, examining different U.S. allies and adversaries over the past six decades, consistently finds that it involves the ability to produce fissile material at enrichment and reprocessing (ENR) facilities.

This finding about the bargaining utility of nuclear latency overturns the conventional wisdom that nuclear weapons are a binary capability with uniform deterrent effects. Proliferation is not a dualistic outcome, "with states either having a fully-fledged arsenal or nothing at all. It spans a continuum" of latent nuclear capabilities, from countries that struggle to operate uranium centrifuges to sophisticated programs with stockpiles of fissile material.[4] Yet the literature "suffers from a considerable 'existential bias,' focusing almost entirely on a state's quest for a nuclear-weapon capability."[5] Aside from a few notable pioneers, "the existence of a tier of states technically capable of making weapons offering them significant military options in war and political leverage in peace is hardly noticed."[6] But the analytic focus is shifting down the capability spectrum as key countries in the Middle East and East Asia continue to retain nuclear latency in lieu of the bomb.[7]

This chapter joins an ongoing effort to understand the political implications of nuclear latency by explaining how "various thresholds in nuclear power technology" can be leveraged to practice compellence.[8] The chapter is organized into four parts. The first crafts the logic of nuclear latency as an instrument of compellence. The second scopes out where the sweet spot might be in practice. The third part studies episodes of compellence with nuclear latency and finds that the sweet spot is consistent over time and across challengers as different as South Korea, North Korea, and Japan. The conclusion situates these findings within the nuclear and crisis diplomacy literature, and explores the implications of the theory for U.S. nonproliferation policy.

The Logic of Compellence with Nuclear Latency

A theory of compellence with nuclear latency involves explaining how a challenger dials up its threat to produce nuclear weapons until the target capitulates, and then sends costly signals to solve a commitment problem about its strategic intent. As a result, challengers are often caught in a credibility dilemma—they must demonstrate resolve to go nuclear, but they also need to adequately reassure the target that compliance will be rewarded with nuclear restraint.

NUCLEAR LATENCY AND THE CREDIBILITY DILEMMA

Compellence refers to a situation in which one state (the challenger) inflicts, or threatens to inflict, some form of pain against another country (the target) until it complies with an explicit set of demands. How does a country's ability to produce nuclear weapons translate into a means of compellence? Unlike threats of economic or military punishment, a nuclear program bestows a nation with the capacity to move, or threaten to move, closer to the bomb. Since nuclear weapons are the great strategic equalizers among nations, a proliferation threat puts pressure on other countries to forestall an adverse shift in the balance of power before it is too late.[9] Adversaries fear a loss in relative military power. With only a few nuclear weapons, a weak state can undercut the conventional capabilities of a superior rival by creating an entirely new strategic calculus.[10] Within an alliance, proliferation by a protégé increases the risk of entrapping a patron in a local conflict and restricts freedom of action. Rather than endure these costs and risks, the United States in particular has long opposed the spread of nuclear weapons.[11] Yet this opposition creates an opportunity for a challenger to threaten proliferation unless the target provides concessions, backed with an assurance to forswear nuclear weapons once compliance is forthcoming.

The effectiveness of compellence depends on whether the challenger's mix of threats and assurances puts enough pressure on the target to comply. Success is measured by how closely the target complies with the challenger's demands, and whether the costs paid by the challenger to cut a deal are relative to the benefits reaped from coercion.[12] A compellent threat obviously fails if the target refuses to change the status quo. When the challenger achieves compliance, however, the costs paid to pressure and reassure the target also must be factored into the outcome. As Lawrence Freedman notes, if these "enforcement costs" exceed the value of the concessions extracted from the target, this "Pyrrhic victory . . . is always likely to be sub-optimal."[13] Instead, compellence is deemed to be successful when the challenger employs coercive instruments that allow it to quickly extract maximum benefits from the target at minimal cost.

"When the challenger achieves compliance, however, the costs paid to pressure and reassure the target also must be factored into the outcome."

How does a challenger make threats and assurances with its nuclear program to reach such an optimal bargain? The challenger must reconcile the competing objectives of threatening proliferation while promising nuclear restraint. On one hand, it must demonstrate sufficient resolve to follow through on the threat. The target estimates the credibility of this threat in terms of the challenger's capability and intent to produce nuclear weapons. Intelligence monitoring helps the target "determine the magnitude, pace, and capabilities" of the nuclear program by focusing on measures of nuclear latency: how quickly it would take the challenger to produce the fissile material—highly enriched uranium or plutonium—at the heart of a nuclear weapon with ENR technology.[14] The challenger's intent to proliferate is "far more difficult to discern than capabilities," as the "focus of intelligence efforts will be on gauging strategic intention; the desire to acquire a nuclear weapon in the first place.[15] The challenger must show that it will proliferate only if the target fails to comply with the compellent demands.

But at the same time, the target must be assured that coercive diplomacy is not a ruse by a determined proliferator. For compellence to work, the proliferation threat should be backed up with "a convincing, self-binding promise" to refrain from nuclear weapons or further harassment once the target complies.[16] Otherwise, the target will drive up the enforcement costs as it resists the challenger's demands, and may leave the negotiation table. The goal is for the challenger to demonstrate that it will no longer be resolved to acquire nuclear weapons once the target complies and that this nonproliferation pledge will be relatively immune to future geopolitical or domestic change.[17] The underlying issue is that the challenger's incentives to remain a nonnuclear-weapon state may change over time, "making it unwilling to live up to its promise at a later date. The change in incentives can be anticipated and is the source of others' doubts about the promise."[18] Compellence makes this commitment problem acute because the challenger is trying to convince the target that noncompliance will be punished with proliferation.

The solution is for the challenger to send costly signals that reveal its nuclear intentions and bind the nuclear program to a nonproliferation pledge. A challenger has two typical ideal mechanisms to send information about its incentives to keep a promise. Hand-tying actions increase the costs of reneging and boost the benefits of keeping the promise, while sunk-cost signals increase the costs of making the promise in the first place and act as an investment that only a committed challenger would be willing to make.[19] Even though successful compellence requires these costly signals, this type of nonproliferation assurance has "not generally been a focus of empirical research."[20] The challenger then may pick from four complementary options the challenger to reassure the target—and each option will be considered below in light of how it was employed by countries attempting to reassure the United States.

First, the challenger can roll back or limit its technical capacity to produce nuclear weapons, or accept an intrusive monitoring regime to verify compliance. Since a revisionist state interested in the rapid production of nuclear weapons would not agree to incur delay, impose limits, or accept enhanced monitoring provisions, the challenger signals its benign motives to cooperate with the target.[21] The strength of the signal required to assure the target depends on the challenger's level of nuclear latency. For instance, consider the technical steps taken by North Korea in 1994 compared to Iran in 2015. In the early 1990s, North Korea cleared an important hurdle by bringing a nuclear reactor and plutonium reprocessing plant on-line, but had not yet produced large quantities of fissile material. North Korea reassured the United States by verifiability shutting down operations at the plutonium complex. By contrast, Iran's large centrifuge capacity and enriched uranium stockpile put its program on the cusp of the bomb by 2015, so it had to send a costlier signal by rolling back its latent capacity to proliferate.

Second, the nuclear program itself can be given up as a hostage if the infrastructure is vulnerable to preventive action or dependent on foreign suppliers.[22] Again, if the potential proliferator has an extensive and protected nuclear infrastructure, it may need to give up key facilities or make itself more vulnerable to send a costly signal. This is precisely why the fate of Iran's hardened underground enrichment facility at Fordow was critical to cutting a deal in 2015. Since Fordow was the least vulnerable part of Iran's nuclear program, the Iranians had to limit enrichment activities at the facility. For civilian nuclear energy programs, nodes of the nuclear fuel cycle often rely on contracts with foreign suppliers. Japan, for instance, "has enmeshed itself in a web of international agreements . . . with its nuclear suppliers banning it from using imported materials for purposes other than its civilian nuclear energy program."[23] All else being equal, an exposed nuclear complex reliant on international trade stands to lose more from breaking a nonproliferation promise.

"As Pyongyang became dependent on Beijing for energy assistance in the early 2000s, U.S. officials requested that the Chinese underwrite diplomacy because Beijing could turn the oil spigot off and on to punish or reward North Korea."

The third option is to bring in another state to help underwrite the challenger's promise. An ideal guarantor would punish the challenger if it reneged on its nonproliferation promise.[24] China's role as lead mediator of the Six-Party Talks between North Korea and the United States illustrated the promises and pitfalls of an outside guarantor. As Pyongyang became dependent on Beijing for energy assistance in the early 2000s, U.S. officials requested that the Chinese underwrite diplomacy because Beijing could turn the oil spigot off and on to punish or reward North Korea.[25] Yet China's tepid response to North Korea's first nuclear-weapon test in 2006 shows that third parties may end up playing an unproductive role if they are unwilling to punish the challenger.

Fourth, the parameters of the deal can be structured to build confidence. Between allies, the high level of trust facilitates a front-loaded exchange. Consider the agreement reached in 1969 between Japan and the United States. Japanese officials promised to sign the Treaty on the Nonproliferation of Nuclear Weapons (NPT) without worrying about whether the United States would live up to its end of the deal. Similarly, U.S. officials agreed to take the irreversible step of returning the Ryukyu and Daito Islands to Japanese control, confident that their Japanese counterparts would not renege on the deal.

In an adversarial relationship, neither side is likely to trust the other to uphold the deal. The challenger can take incremental steps toward a binding nonproliferation promise, such as shipping out fissile material or shuttering facilities, while the target reciprocates with phased concessions. If both sides implement these confidence-building measures, "each may be willing to risk a small investment to create a tradition of trust," as a precursor to a grand bargain.[26] The July 2015 Joint Comprehensive Plan of Action (JCPOA) reached between Iran and the P5+1 (the five permanent members of the United Nations Security Council, plus Germany), for instance, included an entire annex that described the phased "sequence of actions" each side would take to implement the complex array of commitments involved in the nuclear agreement.[27] By back loading concessions in this way, the target agrees to provide a stream of benefits contingent on the challenger's continued compliance.

These costly signals provide the challenger with a menu of options to solve the commitment problem. But to convince the target that the promise of nuclear restraint is credible, the challenger must calibrate the signals to countervail the proliferation threat made at the outset. As the empirical examples underscored, the cost of the signals depends on how close the challenger is to the bomb. At a moderate level of nuclear latency, the challenger cannot present the target with a nuclear fait accompli, so the hand-tying and sunk-cost mechanisms do not need to guard against this type of rapid breakout incentive. At an advanced level of latency, the challenger will need to accept sunk costs, decrease its nuclear latency, and accept hand-tying mechanisms to assuage the target's fear of the future. In sum, the costly signals required for successful compellence become increasingly expensive as the challenger ratchets up its nuclear latency.

THE SWEET SPOT HYPOTHESES: JUST ENOUGH NUCLEAR LATENCY

Since the success of coercive diplomacy rests on the interaction of credible threats and assurances, the challenger must resolve a dilemma to use nuclear technology as an optimal bargaining chip. The proliferation threat should put sufficient pressure on the target to comply, yet not so much that the reassurance and overall enforcement costs exceed the benefits to be gained from reaching a nuclear deal. The challenger's level of nuclear latency drives the severity of this dilemma: advances in the technical capacity to produce nuclear weapons increase threat credibility, but also escalate the corresponding strength of costly signals needed to convince the target to comply with the compellent demands.

With too little technology, the challenger's proliferation threat is not credible for two reasons. First, in the absence of observable indicators, it is difficult for the target to measure nuclear latency or divine intent with high confidence. Tangible investments in nuclear technology show that the challenger is not just inaugurating a program as a bluff. A case in point is Saudi Arabia's failed proliferation gambit during the summer of 2015. Repeated threats by high-ranking Saudi officials to develop enrichment technology were designed to put pressure on Washington for a defense treaty and the transfer of advanced conventional weapon systems, such as the F–35 fighter jet.[28] Yet, given the lack of nuclear infrastructure and expertise in the Kingdom, the White House ended up rebuffing these demands because it was not clear whether the statements about enrichment reflected an official nuclear policy position, or if a few members of the royal family were turning up the heat on Washington. Rather than fulfill expensive demands, U.S. officials decided to wait and see where the Kingdom's civil nuclear program was headed.

Second, announcing intent without actual capabilities on the ground is a risky gambit that leaves the challenger vulnerable to technology denial, coercive sanctions, or military action—the standard levers of nonproliferation policy. The United States has an effective track record of inhibiting the spread of sensitive nuclear technology at a nascent stage of development.[29] In the past, U.S. officials pressured members of the Nuclear Suppliers Group to either impose strict conditions on the sale of nuclear technology around the globe or outright cancel the sale of ENR facilities.[30] Cut off from the ability to import turnkey nodes of the nuclear fuel cycle, and under the threat of sanctions, U.S. allies such as South Korea and Taiwan eventually abandoned the plutonium route.[31] Argentina and Brazil took much longer to develop indigenous enrichment capabilities, while Iran and Pakistan moved onto the illicit market to slowly procure technology at great risk of discovery. In sum, the United States is in a strong position to neutralize progress or levy sanctions before a country has the technical pieces needed to solve the nuclear jigsaw puzzle.

If nuclear bluffs are ineffective and risky endeavors, then perhaps a challenger should move as close to the bomb as possible to extract concessions. On initial consideration, it seems as though being a "screwdriver turn away" from having a nuclear weapon should put the burden on the target to cut a deal. Indeed, Henry Kissinger worried in 2012 that if Iran acquired "a military nuclear program at the very edge of going operational," other countries in the region "would be driven to reorient their political alignment toward Tehran."[32] Some analysts contend that Japan's contemporary stockpile of plutonium gives Tokyo a so-called "bomb in the basement" that can be used "to signal or increase its leverage with both Washington and Beijing."[33] If more nuclear technology is better, then perhaps the challenger will be in the best position when it can rapidly produce nuclear weapons.

With too much nuclear latency, however, an advanced nuclear program triggers three distinct causal mechanisms that contribute to suboptimal compliance, noncompliance, and the breakdown of diplomacy, respectively. First, high levels of nuclear latency can be leveraged to extract concessions, but the challenger often returns home with a Pyrrhic victory. A case in point is the 2015 Iran nuclear deal that provided the regime in Tehran with sanctions relief and a pathway to normalize its controversial enrichment program. The problem is that the benefits reaped from coercive diplomacy must outweigh the enforcement and assurance costs that the challenger must pay to issue a credible promise. One interpretation of the Iran deal that aligns with this logic is that the Iranians absorbed massive sunk costs and paid high costs in return for the concessions gained under the terms of the JCPOA. The challenger may still decide to solve the commitment problem with strong costly signals, as the Iranians did, but the final bargaining outcome is not optimal.

A second mechanism is a path-dependent process that increases the domestic costs of signaling nonproliferation intent, all else being equal. Nuclear latency exhibits path dependency because each step the program takes down a technical route to the bomb produces positive benefits that "increase the relative attractiveness of that path . . . As such effects begin to accumulate, they generate a powerful cycle of self-reinforcing activity."[34] Nuclear technology tends to generate increasing returns to various players within the state. The scientific complex becomes entrenched in the political system and seeks to retain budget outlays.[35] Politicians accrue power from managing these operations, and may veto any attempts to curtail nuclear projects.[36] Military officers or the energy industry push for tangible returns on the long-term investment.[37] Coalitions form strong incentives to pressure the leadership to stay the course, or at a minimum not trade away the nuclear infrastructure.[38] The domestic political costs of giving up or even restraining the nuclear program rise the more it matures into a valuable operational complex.

Path dependency can contribute to a Pyrrhic victory by driving up the domestic costs of cutting a deal. The Iranian negotiation team in 2015 fended off a domestic faction that had become deeply vested in the nuclear infrastructure over time, thereby raising the internal costs of cutting a deal for sanctions relief. Path dependency explains why it becomes expensive for a challenger in Iran's position to solve the commitment problem with costly signals. But this mechanism can also cause the challenger to reverse or renege on decisions to curtail the nuclear program. In October 2009, for example, Iranian diplomats agreed to an interim nuclear proposal from U.S. officials during negotiations in Geneva and returned home to sell the deal in Tehran. Yet when discussions resumed two weeks later, the Iranians walked back the deal because hard-line elements in Iran had thrown up insurmountable political barriers and costs to trading away the valuable stockpile of enriched uranium.[39]

A third mechanism of strategic intent to proliferate must be considered as an endogenous influence.[40] Some challengers may be determined to field nuclear forces, even if they come to bargaining table to avoid costly sanctions or a war. North Korea's behavior during the Six-Party Talks highlights how this mechanism confounds the assurance dilemma. Perhaps the regime in Pyongyang always wanted nuclear weapons. Since the North Koreans built up nuclear latency to achieve this goal, they had no intention of trading it away, and hence there was no credibility problem to solve with the United States.

If low levels of nuclear latency undermine threat credibility while advanced nuclear programs increase the assurance costs, there should be a technical sweet spot in between these extremes for extracting coercive benefits. Once the challenger's nuclear latency reaches a certain threshold, the proliferation threat should be credible because the target can assess its capabilities and motives. Moreover, it becomes difficult for the target to undo or stop proliferation after the nuclear program develops a cadre of scientists and engineers with the tacit knowledge gained from operating nuclear fuel cycle facilities. This was one crux of the Iran preventive strike debate: the program had the technical knowledge and organizational capacity to reconstitute physical assets in the aftermath of an attack, so limited air strikes against nuclear infrastructure might just delay Iran's progress.[41] In such a situation, complying with the challenger's demands may be the best way to inhibit further progress toward the bomb.

The conditions should also be favorable in the sweet spot for sending costly signals to assure the target. Since the nuclear program has not moved to the threshold of nuclear-weapon acquisition, the challenger has latitude to convince the target that it is not a determined proliferator. From a domestic perspective, the path-dependent effect should be less pronounced for an emerging program. The commitment to uphold the deal also can incorporate less costly hand-tying options when the challenger lacks the technical capacity to fully develop a nuclear weapon before the target can respond. The enforcement costs should be lower if the target calculates that complying with the challenger's demands is a modest price to pay to keep a potential proliferator at a manageable point on the latency continuum.

Although the credibility dilemma points toward this sweet spot, the theory does not stipulate where this Goldilocks zone starts and ends in practice.[42] There should be a range of possible values between having no nuclear latency at all and teetering on the brink of nuclear-weapon acquisition. With this theoretical foundation established, the next section devises a research strategy to test the validity of the Goldilocks hypotheses and identify the practical boundaries of the sweet spot zone.

Grounding the Logic in the Historical Record

What in practice are the major thresholds in nuclear latency? A country's nuclear latency jumps up as it passes through four technical milestones arrayed along a continuum, shown in table 15-1.

TABLE 15-1. TECHNICAL MILESTONES OF NUCLEAR PROLIFERATION

STEP 1: INITIATE	STEP 2: OPERATE	STEP 3: SCALE UP	STEP 4: WEAPONIZE
Initiate nuclear program with research and development on ENR technology and rest of the nuclear fuel cycle.	Operate uranium enrichment facility or nuclear reactor with plutonium-reprocessing capability.	Produce a significant quantity of highly enriched uranium or plutonium, or have the ability to produce a significant quantity quickly.	Turn fissile material (highly enriched uranium or plutonium) into a fission weapon.

On one end of the continuum, a country translates its latent capacity into a first-generation fission weapon. A gun-type design slams together sub critical masses of highly enriched uranium to enable a nuclear chain reaction, while an implosion weapon surrounds a sub critical mass of plutonium or highly enriched uranium with high explosives to compress the fissile material into a denser, supercritical mass.[43] These requirements of an operational weapon indicate that a nuclear program has advanced beyond the sweet spot when it can produce and weaponize fissile material before the United States can effectively respond, such as North Korea did in 2006 and Iran did in 2015. The upper boundary of the sweet spot therefore lies further down the latency continuum, between the operation (Step 2) and subsequent scale up (Step 3) of ENR technology.

Where might the lower end of the sweet spot lie in practice? On the other end of the latency spectrum are countries that range from having almost no nuclear infrastructure at all (for example, Saudi Arabia in 2015) to more sophisticated nations that remain far away from bringing an ENR facility on-line (for example, Japan in 1957). This nascent threshold of latency (Step 1) is too little for a challenger to issue a credible threat because the United States must be able to differentiate cheap talk from a genuine threat. Concrete capabilities lend themselves to high-fidelity intelligence estimates more readily than amorphous intentions. The lower boundary of the sweet spot should capture a range of nuclear programs beyond this point that are on a clear trajectory (capability plus development speed) to operate ENR facilities. By being on the cusp of surmounting a major technical hurdle to the bomb, the challenger can generate a credible proliferation threat while also offering a verifiable assurance before path dependency makes it difficult to trade away an operational ENR facility.

A nuclear latency dataset provides a comprehensive foundation to scope out the universe of possible cases because it measures levels of latency for 32 countries from 1939 to 2012 according to the possession of laboratory or pilot-scale ENR facilities.[44] For this study of compellence, 12 countries that never made an explicit proliferation threat are dropped. The remainder attempted in some way to leverage nuclear latency for political benefit. Of this subset, nine are flagged for further study because they used nuclear latency to achieve various geopolitical objectives, but not as part of an observable compellence strategy.[45] Egypt, Italy, and France are included but are tagged as borderline cases because each informally drummed up interest in nuclear weapons to put pressure on the United States. Four episodes are added where the challenger did not have enough nuclear latency to be included in the dataset (no ENR at all), and hence are prime candidates for possessing too little capacity to issue a credible threat. The final universe in table 15-2 contains 15 compellence episodes involving 12 challengers who targeted the United States.

TABLE 15-2. COMPELLENCE WITH NUCLEAR LATENCY

Challenger	Episode	Nuclear Latency	Outcome
Australia	1968	No ENR	Noncompliance
Egypt	1981–2011*	Laboratory ENR	Noncompliance
France	1951–1957*	Full-Scale Plutonium	Noncompliance
Iran	2003–2005	Laboratory ENR	Partial Compliance
Iran	2009–2010	Full-Scale Enrichment	Noncompliance
Iran	2013–2015	Full-Scale Enrichment	Suboptimal Compliance
Italy	1950–1968*	Laboratory ENR	Partial Compliance
Japan	1957	No ENR	Noncompliance
Japan	1964–1970	Laboratory ENR	Optimal Compliance
Libya	2003	Laboratory ENR	Optimal Compliance
North Korea	1991–1994	Plutonium Capacity	Optimal Compliance
North Korea	2003–2007	ENR + Weapon Test	Noncompliance
Pakistan	1978–1979	Full-Scale Enrichment	Noncompliance
Saudi Arabia	2015	No ENR	Noncompliance
South Korea	1974–1975	No ENR	Noncompliance
West Germany	1968	Laboratory ENR	Partial Compliance

Although this universe exhibits full variation along a number of key dimensions, the issue of selection bias emerges because the starting group of nuclear latency is not randomly chosen from a larger set of cases. Instead, a comparative research design strategy is employed to achieve three more modest goals. The first is a type of plausibility probe to prove the existence of the causal mechanisms associated with the Goldilocks hypotheses. If the evidence suggests that nuclear latency drives the compellence outcome through the stipulated mechanisms, then these results would partially validate the theory. Second, a most-similar approach to case selection is employed to control for other variables and isolate how change in nuclear latency shapes the bargaining outcome. Specifically, the goal is to test the sweet spot argument by selecting cases that represent distinct and increasing values of nuclear latency while holding other key variables constant. If each compellence outcome moves in the hypothesized direction, this can be taken as correlational evidence in support of the theory. The third and final goal is to identify the sweet spot boundaries in different types of nuclear programs and countries. The least-similar principle of comparative case selection recommends that the final mix be diverse enough to see whether the sweet spot remains constant despite variation among all other critical variables, such as being an ally or adversary of the United States, regime type, compellent demands, and root motives for developing nuclear technology in the first place.

The Practice of Compellence with Nuclear Latency

The aim of this empirical section is to assess the Goldilocks theory's validity across five important episodes of compellence with nuclear latency by South Korea, Japan, and North Korea from 1957 to 2007. By tracing the causal mechanisms through which increasing values of nuclear latency affect the bargaining dynamic, each case study tests the logic of the sweet spot and establishes its technical parameters in nuclear programs. The results are summarized at the end of this section, and it includes a brief discussion of Iran's diplomatic track record from 2003 to 2015.

SOUTH KOREA'S EMPTY TRUMP CARD

This section explores a failed attempt by the Republic of Korea (ROK) in 1975 to compel changes in its security relationship with the United States. The case study finds three pieces of evidence to support the mechanisms of bargaining failure. First, the United States dismissed the proliferation threat as incredible because South Korea did not have ENR technology. Second, in the absence of capabilities, U.S. officials believed the ROK leadership was bluffing to gain leverage. Third, South Korea's premature threat triggered U.S. efforts to prevent it from importing a reprocessing facility.

In the early 1970s, the South Korean government was shocked by the decision of the Nixon administration to withdraw a division of U.S. forces from Korea. President Park Chung-hee appears to have concluded that while he could not reverse this strategic realignment, Seoul needed a "nuclear trump card" to play in case U.S. officials tried to withdraw more troops or support.[46] Park therefore added a military dimension to South Korea's plans to develop the civil nuclear fuel cycle by creating two new defense agencies in 1970. The Agency for Defense Development and the Weapons Exploitation Committee were tasked with kick-starting an indigenous nuclear-weapon program.[47]

Aside from a research reactor, though, South Korea had no ability to produce fissile material. Park moved to rectify this weakness by procuring a nuclear reactor and plutonium processing facility from French, Belgian, and Canadian firms. The focus on purchasing turnkey facilities made sense since "some participants recalled that acquiring the capability, rather than the actual bomb, was the goal of the time."[48] The fact that other projects languished without proper funding led ROK scientists to believe that Park just wanted "a bargaining card to prevent later U.S. troop withdrawal."[49] A trove of new archival evidence indicates that this prediction was accurate.

In a cable to Washington in February 1975, the U.S. Embassy in Seoul sounded the clarion call over Park's plan and highlighted the nascent stage of technology in South Korea as a key vulnerability. "Evidence accumulated in recent months justifies strong presumption that the Korean [government] has decided to proceed with the initial phases of a nuclear-weapon development program."[50] Washington determined that the "ROK nuclear-weapon effort has been in part a reflection of lessened ROK [government] confidence in [the] U.S. security commitment."[51] But the program was "still in [a] rudimentary stage and lacking a number of critical items such as fuel reprocessing and plutonium."[52] U.S. officials estimated they had a good chance to "slow the pace of ROK effort," and "increase costs significantly" by inhibiting "ROK access to sensitive technology and equipment."[53] On the diplomatic front, Washington also decided to adopt "a more explicit course" with a series of "direct, early, and firm" demarches over the nuclear issue.[54]

Initial protests from the United States set the stage for President Park to draw out the link between South Korea's nuclear ambitions and demands for enhanced U.S. military support. In a public interview, Park cast doubt on the commitment of the United States to defend Seoul after the fall of Saigon (which had happened only a few months before), and raised the prospect of "developing our nuclear capability . . . If American ground troops were removed."[55] Park's comments "plainly indicated that he would develop a nuclear weapon unless [President] Ford promised an American defense commitment," which many "interpreted as bluffing to steer ongoing negotiations with the US toward a desired direction."[56] Several months later, Park and his cabinet met in private with

U.S. secretary of defense James Schlesinger to ask for greater reassurances and deliverables, but once again were rebuffed. The ROK demand for a pledge that the United States would "react instantaneously in the event of an attack" on a series of contested islands in the Northern Sea was simply "too expensive to exchange for a South Korean promise to end its fledging nuclear scheme."[57]

The nuclear bluff proved to be counterproductive as U.S. officials ramped up pressure on the South Koreans to cancel their plutonium-reprocessing contract with the French. At first, the ROK government refused to cave because the "leadership considered its nascent nuclear program a trump card in negotiations with the U.S.."[58] In December 1975, the Ford administration authorized the strongest démarche ever issued to the South Koreans: "We must make indelibly clear that far more than our nuclear support is at stake here, that if ROKs proceed as they have indicated to date [the] whole range of security and political relationships between us and ROK will be affected."[59] After the U.S. ambassador to Korea and the secretary of defense both delivered this blunt message, President Park and the ROK leadership finally agreed to cancel the French reprocessing contract.

JAPAN MOVES INTO THE SWEET SPOT

Japan's efforts from 1957 to 1970 to negotiate the territorial reversion of the Ryukyu and Daito Islands from the United States constitute an ideal longitudinal study for tracing the leverage gained when an ally's nuclear program moves into the sweet spot. In several instances, Japanese leaders made veiled threats to step out from under the U.S. nuclear umbrella if the status of Okinawa, a sore spot leftover from the postwar occupation period, was allowed to fester. Since the asymmetric nature of the alliance relationship carried into the next decade, the failure of the 1957 threat to influence negotiations establishes a firm baseline to hone in on the advantage bestowed by the acquisition of nuclear technology in the 1960s.

From 1957 to 1960, Japan and the United States endured the first crisis in the alliance over the territorial reversion of Okinawa. Trouble started to brew in 1957 when Prime Minister Kishi Nobusuke assumed office and passed the American ambassador in Tokyo a list of Japanese stipulations for renewal of the U.S.–Japan security treaty. The premier's main request was for the return of Okinawa and the neighboring Bonin Islands to Japanese control.[60] With support from former premier Yoshida Shigeru, Kishi attempted to back his position by suggesting that Japan might pursue an independent nuclear deterrent. In January 1957, Yoshida laid out the case for Japan to acquire nuclear weapons as an option to counter entrapment scenarios from the American New Look defense reorientation.[61] Kishi then told his cabinet, "[t]here would be nothing against using nuclear weapons if they were within the limits of self-defense."[62] This signaled that proliferation might be legal under Article 9 of Japan's constitution, which permitted the buildup of military force only for defensive purposes. Yoshida and Kishi used the nuclear question to suggest that Japan might chart a more independent foreign policy.

"Because Japan did not have the nuclear latency necessary to credibly threaten proliferation, Yoshida and Kishi made the untimely decision to engage in a veiled form of proliferation diplomacy."

Yet this diplomatic maneuvering rested on a shallow technical foundation, as Japan had just started its nuclear energy program in 1956 with U.S. backing, and was dependent on foreign assistance for its continued operation. Washington exerted too much control through technology transfers and uranium fuel supply and could have prevented Japan from acquiring key nodes in the nuclear fuel cycle.[63] Because Japan did not have the nuclear latency necessary to credibly threaten proliferation, Yoshida and Kishi made the untimely decision to engage in a veiled form of proliferation diplomacy.

The Japanese narrowly avoided the fate of the South Koreans because the proliferation threat had little impact on the political leadership in Washington. Premier Kishi visited the White House in June 1957 to bargain over the renewal of the security pact. No publicly available evidence suggests that the Eisenhower administration considered Japanese proliferation to be a concern when negotiations began. Eisenhower stonewalled Kishi, who then faced electoral challenges in the Japanese Diet in 1960 when he failed to obtain concessions over the occupied islands.[61] Premier Kishi's gambit ended his political career, but not Japan's nuclear energy program.

Less than a decade later, Prime Minister Sato Eisaku also found himself under domestic duress to resolve the territorial status of the Ryukyu Islands. Sato turned to Japan's burgeoning civil nuclear industry to help him succeed where his predecessors had failed. Three pieces of evidence highlight the impact of the Japanese nuclear energy program on intraalliance negotiations from 1965 until 1970.

First, declassified reports show how the United States started to take Japan's proliferation potential seriously as its civil nuclear program glided into the fissile material sweet spot. In December 1964, State Department analysts concluded that whereas Japan had the technical capacity to quickly "create a deliverable *nuclear force*, probably comparable to any in the world," the government in Tokyo was unlikely to exercise this option.[65] Over the next six months, progress on plutonium reprocessing experiments and a large nuclear reactor project led to a revised estimate from Foggy Bottom: "A realistic assessment of Japan's prospects in the nuclear weapons field must thus recognize Japan's capacity to build its own nuclear force as a near-certainty."[66] The "important question" for the United States now became "whether the decision to develop this potential is likely to be made."[67] Japan was on track to acquire the full nuclear fuel cycle just as uncertainty started to emerge over its future nuclear ambitions.

Second, summaries of private meetings between Japanese and American leaders shed light on the tactics employed by Premier Sato and his cabinet. Since public threats would have damaged the alliance and Japan's economy, Sato drummed up uncertainty about Japan's nuclear intentions during private consultations with top U.S. officials. In 1965, Sato set the stage for a meeting at the White House by telling the U.S. ambassador that China's nuclear test in October of the previous year meant that it was "only common sense for Japan to have nuclear weapons," and then linked Chinese proliferation, Japan's nuclear latency, and the reversion of Okinawa in a conversation with President Lyndon B. Johnson and a flummoxed Dean Rusk, his secretary of state.[68] When discussions over Okinawa broke down in 1969, Sato told a stunned room of American diplomats that his recent pledge to the Japanese public to remain a nonnuclear-weapon state was "nonsense."[69]

Over the course of four years, the Japanese premier and his cabinet used these threats to sell a bargain to the Johnson and then Nixon administration. If the Americans agreed to return the contested islands to the Japanese, the renewed strength of the alliance would obviate any need for Japan to go its own way with an indigenous nuclear force. The executive branch of the U.S. government reached the same conclusion. As one report forecast, a failed Okinawa bargain might "constitute a turning point" in the alliance by stimulating a "Japanese decision to plot a more independent military course" that would "entail serious consideration of nuclear arms development."[70] By January 1969, Washington had coalesced around the core deal proposed by Premier Sato: if Japan signed the NPT, Okinawa would be returned on favorable terms to ensure a nonnuclear Japan.

Third, since path dependency had not set in, Japan's leaders were willing to trade ascension to the new NPT for the return of Okinawa. Premier Sato benefited from Japan's nuclear program being in the Goldilocks zone. Japan was on a rapid trajectory to operate the complete nuclear fuel cycle by the mid-1970s but had not begun reprocessing plutonium from the reactor complex. This was a prime opportunity for the government to further lock the nuclear program into the civil energy pathway by joining the NPT. If Japan joined the vanguard of the NPT to "limit the proliferation of nuclear weapons worldwide," the U.S. government believed that "its involvement would tend to commit Japan more firmly to a nonnuclear role."[71] Even deep skeptics of the NPT, most notably President Richard Nixon and National Security Advisor Henry Kissinger, regarded Japan's participation in the regime to be an essential exception.

The quid pro quo was finally hashed out at a November 1969 summit between Premier Sato and President Nixon. Nixon dangled the reversion of Okinawa in an attempt to entice Japanese cooperation over trade and security issues. On the U.S.–Japan security relationship, defense burden sharing and nonproliferation became intertwined into a single demand. Nixon wanted Japan to "assume a greater role" in the region. But the president repeatedly "emphasized that he had been talking in terms of conventional military forces," and "did not mean that this should include a nuclear capability."[72] If Sato promised to expand defense spending, keep the country on its nonnuclear path, and cut back textile exports that were hurting American textile industries, Nixon was willing to return Okinawa.

Nixon's offer was the first proposal from a U.S. president to return Okinawa on terms favorable to Japan's sovereignty. Sato praised Nixon for such a "magnanimous" decision, and agreed to make vague increases to Japan's defense capability and reduce textile exports.[73] The NPT would also be introduced to the next session of the Diet for a vote. Sato returned to Tokyo with a victory for Japan, having successfully bargained for the return of Okinawa without giving up much except a firm pledge to nonproliferation. Sato pushed the Diet to sign the NPT, and after several months of legislative wrangling, Japan became a signatory to the treaty on February 3, 1970. In exchange for

Okinawa, Japan bound its burgeoning nuclear energy program to the nonproliferation mast.

NORTH KOREA LEAVES THE GOLDILOCKS ZONE

North Korea illustrates the bargaining benefits that an adversary can reap from a program ostensibly developed to produce nuclear weapons, as well as the path dependency that sets in with operational ENR facilities. The first episode in the early 1990s shows how North Korea leveraged the threat of producing plutonium to pressure the United States but managed to keep open a low-cost assurance option. The second episode a decade later during the Six-Party Talks indicates that costly signaling options grew more expensive as the government steadily committed to the weapons pathway as the nuclear enterprise matured.

North Korea entered the fissile material sweet spot in 1991 when construction on a reprocessing plant at the Yongbyon nuclear complex neared completion. After the United States opened a diplomatic channel to resolve the nuclear issue, it soon became apparent that the North Koreans were "setting the stage to negotiate with the United States on a package that would secure the greatest benefits on the easiest terms possible."[74] North Korea manipulated the plutonium program on several occasions to increase pressure on Washington. In the most striking instance, North Korea announced that it would begin to separate plutonium because Washington had no intention of complying with Pyongyang's demands.[75] North Korean officials then started a ticking clock by highlighting a crucial qualification: it would take about two months to completely unload all the spent reactor fuel, leaving "ample time for the United States and North Korea to strike a deal."[76] The explicit nature of these brinksmanship tactics indicates that Pyongyang may have recognized the leverage provided by being in the Goldilocks zone.

The ultimatums revealed Washington's bottom line as U.S. officials considered a preventive strike against North Korea in the summer of 1994.[77] Before the situation could escalate out of control, the unexpected visit of former U.S. president Jimmy Carter provided North Korean leader Kim Il-sung with an off-ramp to reach a deal. After diplomacy resumed, the United States agreed to buy out North Korea's plutonium program with a package that consisted of $50 million in energy assistance each year, $4 billion in nuclear reactor technology, political normalization, and a negative security assurance. In return, North Korea agreed to freeze operations at the Yongbyon complex, seal the reprocessing facility for eventual dismantlement, ship all spent reactor fuel out of the country, halt construction of two large reactors, and remain party to the NPT.[78] The final Agreed Framework signed by North Korea and the United States on October 21, 1994, formalized the bargain.

North Korea was able to strike a low-cost, high-reward deal because it could reassure the United States by simply freezing operations at Yongbyon. The nuclear program had not left the Goldilocks zone by producing large amounts of plutonium, so the deal focused on shutting down the reprocessing facility. This was a modest price to pay. Pyongyang avoided military attack and reaped badly needed energy assistance. The lead U.S. negotiator noted that the Agreed Framework was "not based upon trust," but rather a tit-for-tat structure with the burden of upfront performance falling on the North Koreans.[79] To receive the first shipment of heavy oil, North Korea had to freeze all its declared nuclear operations. Larger benefits would come only once the United States "had an opportunity to judge [North Korea's] performance and its intentions."[80] The Clinton administration contended that this structure gave them some power to hurt Pyongyang "if North Korea reneges on any of its commitments at any time."[81] Since North Korea needed energy assistance, Pyongyang seemed unlikely to do so in the near future.

A second North Korean nuclear crisis illustrates how nuclear programs generate increasing returns over time as an operational capability but diminishing returns as a bargaining chip. In 2002, U.S. officials claimed that North Korea was cheating on the Agreed Framework with a covert uranium enrichment program, so Washington stopped providing assistance under the agreement. This revelation was problematic, as the North Koreans would have preferred to keep it in place while they secretly acquired a stockpile of enriched uranium. Pyongyang withdrew from the NPT in January 2003, restarted the dormant plutonium program, and began to emulate their playbook from the 1990s. The major problem, however, was that North Korea became unwilling to trade away its nuclear assets for two reasons.

First, North Korea's nonproliferation options grew expensive after it cheated on the Agreed Framework and then left the Goldilocks zone. The Bush administration made rewards conditional on an agreement for the complete, verifiable, and irreversible dismantlement (CVID) of North Korea's nuclear program, and requested China underwrite the diplomatic process as lead of the Six-Party Talks. Rather than pay the high costs of CVID, Pyongyang attempted to break Washington's tough stance by producing large quantities of plutonium from 2003 to 2005. A senior North Korean official admitted that this move was designed "to force Bush to negotiate on terms more favorable to North Korea."[82] Instead, the United States levied crippling sanctions against the regime's financial assets. The North Koreans boycotted negotiations and tested a nuclear weapon on October 9, 2006. This move managed to bring U.S. officials back to the table, but the nuclear test shifted the bargaining parameters away from nonproliferation to the disablement of nuclear forces and the underlying production complex.

Second, there are several indicators that North Korea became locked into the pathway to nuclear weapons soon after the plutonium reprocessing campaign in the winter of 2004. Foremost, North Korean negotiators started to signal a profound unwillingness to give up the nuclear program. By February 2005, North Korea's lead negotiator for the Six-Party Talks made a dramatic statement: "The time for discussing give and take type issues, such as freeze and reward, at the Six-Party Talks has passed. Now that we have become a dignified nuclear weapons possessing state, the Six-Party Talks must naturally become arms reduction talks."[83] By trying to shift the focus from nonproliferation to bilateral U.S.–North Korean arms control negotiations, Pyongyang may have been signaling that the nuclear production complex was now too valuable to trade away. Nonetheless, the United States laid out a roadmap in 2007 for North Korea to denuclearize in exchange for concessions. The leadership in Pyongyang took some initial steps, most notably disabling aspects of the plutonium program at Yongbyon, but eventually refused to verifiably dismantle key parts of the nuclear complex. By the fall of 2008, North Korea seemed to decide that previously sufficient concessions were no longer good enough to outweigh giving up its nuclear program.

The historical case studies traced out the effect of bringing too little, too much, and just the right amount of nuclear technology to the bargaining table with the United States. As tabulated in table 15-3, the boundaries of the sweet spot consistently lined up with challenger's ability to produce fissile missile at ENR facilities.

TABLE 15-3. THE SWEET SPOT ZONE IN PRACTICE

	Nuclear Program's Trajectory		
	Too Little	**Just Right (Sweet Spot)**	**Too Much**
Technical Signposts	Emerging ambition for ENR capability, but limited ability to import and/or indigenously develop the technology	Capability and speed of progress put the nuclear program on the cusp of being able to produce fissile material with either a uranium enrichment facility, or nuclear reactor and plutonium separation facility	Operational fissile material production capability for either military weapon or civilian energy program
Compellence Episodes	Japan 1957 South Korea 1975 Iran before 2003	Japan 1965–1970 North Korea 1991–1994 Iran 2003–9	North Korea after 2006 Iran 2009–2015

Most of the causal mechanisms stipulated by the Goldilocks hypotheses also appeared to be empirically validated. The United States did not deem that the proliferation threats from South Korea in 1975 and Japan in 1957 were credible, and Washington specifically ended Seoul's quest to import ENR technology. The sweet spot hypothesis was also supported by the fact that Japan was able to compel concessions a decade later once its nuclear program was on an inexorable trajectory to reprocess plutonium, and a similar bargaining leverage was bestowed on North Korea when it gained an operational plutonium capacity in the early 1990s. North Korean behavior during the Six-Party Talks revealed evidence of path dependency at work.

Further research should examine the bargaining behavior of other countries at advanced stages of nuclear latency, notably France, Pakistan, and Iran, to test the mechanisms against one another. A brief overview of Iran's nuclear odyssey, for instance, lends qualified support for the theory. Iranian negotiators managed to bargain out of a dangerous situation in 2003 when the enrichment program was gliding into the sweet spot. U.S. officials later put a deal on the table in 2009 to induce Iran to give up most of its enriched uranium, but the sudden change of heart indicated that the government was already locked in to the nuclear program. The successful negotiation of the comprehensive nuclear accord in 2015 in one assessment, is that the Iranians achieved a Pyrrhic victory because they paid excessive enforcement costs and weathered strong U.S. resistance to retain a scaled-back enrichment infrastructure with little short-term benefit. Another interpretation is that Iran cut an expensive yet optimal bargain because the nuclear accord provided a long-term pathway for the regime to normalize its uranium enrichment program. Unfortunately, there is not enough information on the regime's cost-benefit calculus to make a high-confidence assessment about whether the concessions in the JCPOA outweighed the costs.

Conclusion

The identification of a sweet spot for compellence with nuclear technology contributes to a broader research agenda that is questioning tenants of the nuclear revolution.[84] By focusing on how variations in nuclear latency affect a country's bargaining posture, this chapter pushed against the tendency to treat proliferation as having a binary outcome with homogenous consequences. Instead, a continuum of nuclear latency exists with clear thresholds of technical development below the initial acquisition of nuclear weapons. To be sure, countries do not pass through these stages "simply to accumulate negotiating chips," and some undoubtedly are driven to acquire nuclear weapons.[85] But governments pursue multiple objectives over the lifespan of a nuclear program.[86] In line with recent work on the strategic posture choices that regional powers make to achieve foreign policy goals beyond deterrence, governments as different as Japan and North Korea leveraged nuclear latency to extract concessions from the United States.[87] There is an optimal middle range of nuclear latency for compelling the most benefits at the lowest cost possible.[88] Contrary to the dualistic view of proliferation, nuclear technology can be integrated into a compellence posture to generate powerful and nonlinear political effects well before a country deploys its first weapon system.

There is also a wrinkle in the traditional view of power dynamics between strong and weak nations. Compellence is supposed to be difficult, and should favor the most powerful actors.[89] But a recent comprehensive study found that while weaker nations are reluctant to challenge the strong, they tend to be more successful at compelling changes to the status quo.[90] One possible explanation is that nuclear latency could be a unique weapon of the weak.[91] Proliferation is one of the only ways that a conventionally inferior challenger can threaten to undercut the power projection capabilities of a stronger target. But further research should build on the work of Todd S. Sechser and Phil Haun to determine whether the ability and willingness of the United States to uphold its end of the nuclear deal affects a country's decision to play the latency card in the first place.[92] Weaker adversaries such as North Korea may develop and refuse to give up nuclear weapons out of a fear of suffering the same fate as Libya's Muammar Gaddafi, whose luck ran out in 2011 when he was overthrown as a result of the intervention in a civil war of an international coalition involving the United States.[93] If an adversary takes irreversible steps away from the bomb, then the strength of this commitment may create disincentives for the United States to continue paying concessions or live up to the terms down the road. While the sweet spot remains the same for adversaries and allies, the perceived credibility of U.S. assurances certainly differs when viewed from Tokyo or Pyongyang.

What do these findings about the bargaining utility of nuclear latency mean for U.S. nonproliferation policy? Recent scholarship shows how U.S. officials have consistently employed a mix of technology denial, coercion, inducements, and even collusion with rivals to limit the spread of sensitive nuclear technology among both adversaries and allies.[94] The steady and effective application of these options established the acquisition of ENR technology as a clear red line in U.S. nonproliferation policy.[95] Given the bargaining advantages bestowed by sensitive nuclear technology, the Goldilocks principle lends strong analytic support to the U.S. objective of keeping countries out of the fissile material sweet spot, but recommends a possible shift in means to achieve this long-standing goal.

Beyond Iran, no other adversaries of the United States are seeking nuclear latency in lieu of nuclear weapons, and yet a handful of U.S. allies in Northeast Asia and the Middle East have refused to foreclose the option to develop ENR facilities for civilian nuclear energy programs. The challenge is how to respond.[96] Technology denial and coercive threats worked well four decades ago in the South Korea case, but these options are less effective and prudent today. As the global role of the U.S. nuclear industry continues to shrink, allies can turn to an alternative field of nuclear suppliers—notably France, Russia, and China—that are eager to offer a full range of nuclear fuel cycle services without the stringent nonproliferation requirements demanded by the U.S. government. The cost of coercive sanctions against an ally that pursues a nuclear program in full compliance with international monitoring and safeguards is high. In 2004, for example, Washington was reluctant to allow South Korea to be even censured for undeclared ENR experiments.[97]

The United States may want to consider shifting toward a strategy of buying out an ally's sensitive nuclear program with tailored packages of military, economic, and energy assistance. The U.S. government has long rewarded some countries for upholding nonproliferation commitments, so inducements are not a new policy instrument. Instead, the novel twist identified in this chapter is that incentives are most likely to influence the trajectory of a nuclear program if they are offered at an early stage of development. The United States can use its leverage at this phase to induce countries without ENR capabilities from ever pursuing these sensitive technologies in the first place. Once an ally glides into the sweet spot, however, U.S. officials will have to put more lucrative rewards on the table.

Although the United States is in the strongest position when an ally is at a low level of nuclear latency, the Goldilocks principle also points toward three challenges. The first is how to divine a country's future nuclear intentions. Without clear capabilities to measure, it can be hard to know if an ally is serious about ENR or just bluffing for leverage. Indeed, this uncertainty is the exact reason why U.S. officials remain skeptical today about Saudi Arabia's purported ambitions to match the Iranian nuclear program. Second, uncertainty over intent points toward a moral hazard. An ally with no desire for uranium enrichment could inaugurate a fuel enrichment plant, and then trade away this bargaining chip. The costs of buying out nonexistent ENR ambitions must be weighed alongside the risk of calling the ally's bluff. Third, inducements may create a marketplace for governments to sell the United States a bad nuclear deal, especially if some are unwilling to accept ironclad ENR constraints.

These are nontrivial issues to consider before adopting an inducement policy. The upshot is that the United States does have more leverage and bargaining room at an early stage of latency to convince nuclear newcomers to make at least a political commitment to forgo ENR technology. But to do so, U.S. negotiators should have the flexibility to bargain over the modalities of how exactly an ally will credibly commit itself to restraint, and the backing to put lucrative offers and credible long-term promises on the table if the moral hazard risks are deemed to be acceptable.[98]

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