The Threat of Nuclear Proliferation: Perception and Reality

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Nuclear weapons proliferation is at the top of the news these days. Most recent reports have focused on the nuclear efforts of Iran and North Korea, but they also typically warn that those two acute diplomatic headaches may merely be the harbingers of a much darker future. Indeed, foreign policy sages often claim that what worries them most is not the small arsenals that Tehran and Pyongyang could build for themselves, but rather the potential that their reckless behavior could catalyze a process of runaway nuclear proliferation, international disorder, and, ultimately, nuclear war.[1]

The United States is right to be vigilant against the threat of nuclear proliferation. But such vigilance can all too easily lend itself to exaggeration and overreaction, as the 2003 invasion of Iraq painfully demonstrates. In this essay, I critique two intellectual assumptions that have contributed mightily to Washington's puffed-up perceptions of the proliferation threat. I then spell out the policy implications of a more appropriate analysis of that threat.

The first standard assumption undergirding the anticipation of rampant proliferation is that states that abstain from nuclear weapons are resisting the dictates of their narrow self-interest—and that while this may be a laudable policy, it is also an unsustainable one. According to this line of thinking, sooner or later some external shock, such as an Iranian dash for the bomb, can be expected to jolt many states out of their nuclear self-restraint.

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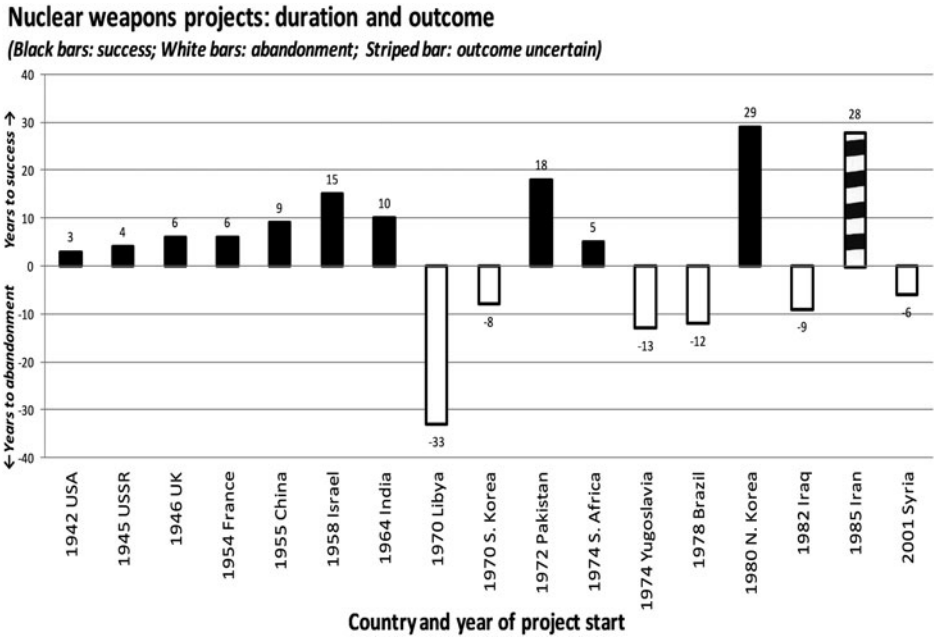
This assumption is highly questionable. There have been many supposedly destabilizing shocks to the global nonproliferation norm over the years. These include the Indian nuclear test of 1974, the revelation of Israel's secret nuclear arsenal in 1986, the Indian and Pakistani nuclear tests of 1998, and the North Korean nuclear tests of 2006, 2009, and 2013, to mention just a few. Yet, despite these provocations, today fewer states are engaged in suspicious nuclear activities than ever before.[2] The nonproliferation norm is much more solidly entrenched than most observers believe.

The historical resilience of the nonproliferation norm becomes much less surprising when we realize that abstention from nuclear weapons is not a bizarre departure from states' normal pursuit of national security and international standing. The effects of nuclear weapons are huge, indiscriminate, and long-lasting. Most thinkers have focused on the offense these monstrous characteristics give to the human conscience. But it is equally important to note that these same characteristics also render the bomb useless for almost all military purposes. Therefore, states that try to build new nuclear weapons arsenals have increasingly been seen not as prudent and pragmatic, but instead as paranoid and power-mad.[3] This essentially limits the bomb's appeal to those few state leaders who really *are* paranoid and power-mad.

The second—and even more fundamental—assumption undergirding the anticipation of rampant proliferation is that more than forty states now have the latent capacity to build the bomb within just a few years, if they wished to do so.[4] Former CIA Director George Tenet offers an even darker assessment: "In the current marketplace, if you have a hundred million dollars, you can be your own nuclear power."[5] In other words, getting the bomb today is merely a matter of money—and not even all that much money. If Tenet is right, then a mere trickle of new nuclear weapon states could rapidly turn into an unmanageable cascade.

This assumption of ubiquitous latent nuclear capacity, however, is just as questionable as the assumption of ubiquitous latent nuclear intentions.[6] It is true that some of the obstacles to building the bomb are lower than they used to be. For instance, most of the scientific secrets of the original nuclear weapons projects have long since been revealed, and many highly sensitive technologies are now available on the international black market. But the actual experiences of recent nuclear weapons projects contradict the conventional wisdom that the bomb is now easily within the reach of all but the most hapless members of the international state system. The fact is that recent nuclear weapons projects have not



Source: Updated from Hymans, *Achieving Nuclear Ambitions*, p. 3.

fared much better than their predecessors did; instead, they have fared much *worse*. This puzzling global trend demands careful examination.

The above chart summarizes the history of all the dedicated nuclear weapons projects since the start of the nuclear age. By "dedicated" projects, I mean projects that were the result of a clear commitment at the highest political levels to produce the bomb, and not just tentative explorations or diplomatic feints. There is a rough consensus among international security scholars that seventeen dedicated nuclear weapons projects have been launched since the beginning of the nuclear age.[7] The seventeen cases are lined up along the X-axis according to their start date. The black bars in the chart represent the number of years the successful projects took to produce their first big explosion or, in the cases of Israel and Pakistan, to allegedly produce untested but operational nuclear weapons.[8] The white bars represent the number of years the unsuccessful projects lasted until they were shut down. Finally, there is a striped bar for the case of Iran, because its ultimate outcome is uncertain. One may quibble with the interpretation of this or that country case, but the general patterns I will be discussing here persist even if we apply alternative codings.

If technological difficulty were the key factor driving proliferation outcomes, then early nuclear weapons projects should have taken many years to complete

and should have experienced a high failure rate, whereas more recent projects should have taken much less time and should have experienced a much lower failure rate. But as the above chart clearly demonstrates, precisely the opposite has happened. All of the dedicated nuclear weapons projects that were launched before 1970 succeeded, and their average time to the first nuclear test (or to the direct induction of operational weapons without a test) was about seven years. By contrast, only three of the ten dedicated nuclear weapons projects that were launched since 1970 have succeeded, and they needed an average of about seventeen years to do so. As for Iran, Israeli intelligence recently pushed back its estimated earliest potential date for a first Iranian bomb to 2015–2016—and this for a nuclear program that was launched way back in the mid-1980s.[9] Whatever Iran's ultimate nuclear intentions may be, the country's extremely slow technical progress to date is clearly consistent with the general proliferation slowdown.

Explaining the Slowdown

Why have nuclear weapons projects around the world become increasingly inefficient and prone to failure since the 1970s? One reasonable hypothesis is that the slowdown is due to the Non-Proliferation Treaty (NPT). Almost every state in the world is now party to the treaty and has signed NPT safeguards agreements that make its nuclear activities relatively transparent to the outside world. This is a good thing. But the NPT does not deserve the lion's share of the credit for the global proliferation slowdown. Recall that the main puzzle is not why so many states have chosen to abstain from building the bomb, but rather why the numerous states that aggressively flouted the NPT in recent years have so often fallen into nuclear R&D quagmires. This record of dysfunction could conceivably be chalked up to the difficulties of getting around the NPT regime's technical safeguards, on-site inspections, and export bans. Yet it is universally acknowledged that those mechanisms were quite feeble until the early 1990s. For instance, the International Atomic Energy Agency (IAEA) and Western intelligence services were unaware of Saddam Hussein's massive nuclear weapons project before stumbling across it at the end of the first Gulf War in 1991. Therefore, even if we stipulate that the nonproliferation regime today is very tough to deceive or circumvent—a claim that many would dispute—it was undeniably much less formidable in the 1970s and 1980s, and yet the great proliferation slowdown was already well in evidence at that time.[10] Thus, for all the merits of the NPT, it

was not the "silver bullet" that caused the trend toward nuclear weapons project inefficiency.

A second, more convincing hypothesis starts from the observation that most of the states that tried to obtain nuclear weapons during the first two decades of the nuclear age were in the developed world, but most of the states that have attempted to do so since that time have been in the developing world. What is it about most developing countries that might cause their nuclear weapons projects to run so inefficiently? One might guess that they cannot afford to devote the same amount of money as wealthier countries to their nuclear projects. But Iraq was able to spend a billion dollars on its nuclear weapons efforts during the 1980s, and it came up short anyway. In fact, the average per capita income (in constant 1990 international dollars) of the states that built the bomb was $3,773 at the start of their projects, but the average of the unsuccessful ones was considerably higher—$5,520. Clearly, we need to probe beneath such brute quantitative indicators to understand the true sources of developing country nuclear weapons project inefficiency.

The R&D success stories of the first four members of the nuclear club—the United States, Soviet Union, United Kingdom, and France—provide a good starting point for analysis. The classic historical studies of these efforts concur that their efficient performance was due in large measure to their scientific and technical (S&T) workers' autonomy and professionalism.[11] In other words, the S&T workers were not merely well-educated but were also able to control their own work process. Therefore, key decisions could be based on well-considered expert reasoning rather than arbitrary commands or political ideology. Moreover, the workers' enjoyment of autonomy mixed with their feelings of nationalism to generate a strong collective motivation to achieve the project's goal. This pattern can be seen in the totalitarian Soviet Union as well as in the three democratic countries.

If autonomous professionalism is the key to nuclear weapons success, then why haven't more recent proliferant states from the developing world respected it, too? The simple answer is that they have been highly prone to nuclear program mismanagement; the deeper answer is that their state institutions have made them prone to mismanagement. Most developed countries can be described—to borrow the language of Max Weber—as having "legal-rational" institutions.[12] In other words, they feature strong institutional barriers against the top-down politicization of bureaucratic policy implementation, especially on scientific and technical

questions. Political leaders in such contexts may well want to interfere in technical decision-making, but doing so is costly and runs contrary to standing behavioral norms. Consequently, they adopt a management model that is respectful of the S&T workers' need for autonomy. This choice creates the conditions for professionalism to flourish.

By contrast, most developing countries can be described—again, following Weber—as having "neopatrimonial" institutions.[13] In other words, they feature "big man" rule and lack the strong institutional barriers that characterize Weberian legal-rational states. Political leaders in such contexts find it easy to interfere in technical decision-making; in fact, the bureaucracy practically expects it of them. Consequently, they adopt a management model that undermines professionalism. And the more strongly a neopatrimonial state's leaders desire the bomb, the more invasive their management of the nuclear program is likely to be.

In sum, when you start with legal-rational state institutions, you are likely to end up with the kind of management that facilitates the efficient operation of nuclear weapons projects: management that is respectful both of the laws of thermodynamics and of the professional S&T workers who understand those laws. This was the typical pattern of the early nuclear efforts, most of which were carried out by developed countries. On the other hand, when you start with neopatrimonial state institutions, you are likely to end up with the kind of management that undercuts the efficient operation of nuclear weapons projects: management that privileges considerations of ideology or political expediency over those of empirical science, and favors sycophants over committed professionals.[14] This has been the typical pattern of the more recent nuclear efforts, most of which were carried out by developing countries. (As for the nuclear weapons projects of countries that stand somewhere in the middle of this spectrum, the management approach they adopt tends to reflect the overall direction in which their state institutions have been evolving.)

I am not claiming that neopatrimonial states are incapable of building the bomb. What I am claiming is that their nuclear weapons projects will usually take much longer and will fail much more often than most international security analysts would dare to hope. Moreover, since many states are still finding it so difficult to build the bomb, we should be very skeptical of claims that stateless terrorist groups could easily make one, too.

Note that although most developing states are neopatrimonial, some are not. India, for instance, boasts a relatively strong legal-rational institutional framework

that dates back to the "steel frame" bureaucracy of the British Raj.[15] Given this background, it is not surprising that Indian scientists and engineers were able to take a dominant role in their country's nuclear program, leading to a long series of impressive technological breakthroughs and, ultimately, a test explosion in 1974—only ten years after the country's so-called "peaceful nuclear explosive" project had been launched.[16]

China's Nuclear Miracle and Iraq's Nuclear Mirage

The merit of the hypotheses that I have sketched above can be seen in a wide variety of historical cases, including two cases that at first glance appear to contradict my argument: China in the 1950s and 1960s, and Iraq in the 1980s.[17]

China in the 1950s and 1960s was diplomatically isolated, economically backward, and socially in turmoil. Yet it was able to explode its first nuclear device as early as 1964—a mere nine years after its nuclear weapons project was launched, and three years in advance of its original target date. How did China do it? In their classic work *China Builds the Bomb*, historians John Lewis and Xue Litai emphasize the great professional commitment of China's nuclear scientists and engineers, which, in turn, was fostered by the management "genius" of the project leader, General Nie Rongzhen.[18] Nie's genius was to privilege professional expertise over political reliability, which was a real departure from the normal management culture of Maoist China. "As a manager, I am a servant," Nie liked to say. "I'm willing to serve the experts and their work."[19] The results were spectacular.

From today's vantage point, China's nuclear achievement may appear to have been inevitable. In fact, however, the project was regularly imperiled by Chairman Mao Zedong's ferociously anti-bureaucratic and neopatrimonial political impulses. To realize how close China came to failure in this endeavor, recall that Nie and his men miraculously brought the nuclear bomb project to fruition three years ahead of schedule, in 1964. Thus, if Nie had simply been a competent manager instead of a brilliant one, China would not have had the bomb before Mao launched his destructive Cultural Revolution in 1966. And a China that had not built the bomb by the start of the Cultural Revolution likely still would not have had one by the end of that tumultuous decade, what with the nuclear program's top scientists and engineers being packed off to work on pig farms and the like. Such was the fate of China's contemporaneous nuclear submarine

project, for instance.[20] Paradoxically, then, Maoist China's nuclear experience demonstrates the tight causal connection between well-ordered state institutions, respectful nuclear R&D management, and nuclear weapons project efficiency. China's nuclear bomb project was the exception that proves the rule about the difficulty of proliferation for most developing countries.

Now consider the case of Iraq. The shocking discovery of large and well-stocked secret nuclear facilities at the end of the 1991 Gulf War led many knowledgeable observers to conclude that Saddam had come within just a few months of obtaining the bomb. Over the course of the 1990s, the suspicion that Iraq was once again hiding something big kept gnawing at Washington policy-makers and the U.S. intelligence community. The fear that next time the cavalry might arrive too late was a key driver of the George W. Bush administration's decision to invade the country in 2003.[21]

But that fear was the product of a misunderstanding of the past. The Iraqi nuclear weapons project was not nearly as advanced as it initially appeared to outsiders at the end of the first Gulf War in 1991. Despite spending roughly a billion dollars on the project over nearly a decade, Iraq had produced only tiny quantities of enriched uranium and zero highly enriched uranium. A major 1997 IAEA report concluded that if Iraq had been able to continue its uranium enrichment work unimpeded, it might have obtained a first bomb with indigenously produced fissile material by 1994 at the earliest.[22] Washington dismissed the IAEA's analysis as being far too complacent. However, the IAEA was actually overstating Iraq's potential, for the Iraqi nuclear program of the 1980s was a classic case of neopatrimonial state mismanagement leading to technical blunders.

The original catalyst for Iraq's secret project was Israel's tactically brilliant but strategically foolish 1981 bombing of the country's half-built nuclear power plant, which was not a genuine proliferation threat. Touched to the quick by Israel's offense, Iraq's nuclear scientists and engineers responded enthusiastically to Saddam's order to build a nuclear weapon. But in subsequent years, the S&T workers' *esprit de corps* was gradually weakened by a long series of distrustful, divisive, and domineering actions by the leadership. Meanwhile, the program became abjectly dependent on unreliable and exploitative foreign suppliers. The result, in the words of former IAEA inspector Robert Kelley, "was a spectacular failure." As Kelley continues, "This was probably one of the most expensive industrial undertakings in the history of mankind in terms of dollars spent to material produced."[23] Furthermore, the so-called "crash program" that the Iraqis launched

immediately after invading Kuwait—their attempt to gin up a single bomb within a few months by misusing a small cache of highly enriched uranium that had been provided by France and Russia back in the 1970s—also became mired in technical problems and made almost no progress. Iraq's badly mismanaged program was clearly not on the verge of a major breakthrough in the early 1990s.

Nonetheless, one might retort, if Saddam's project had been left unimpeded, wouldn't it eventually have achieved its goal—if not within five years, then perhaps within ten? Whether Iraq could have conquered all the remaining technical hurdles is an open question. But more fundamentally, it is a mistake to enter into this discussion of what-ifs. Counterfactual historical analysis can be a useful tool, but it quickly loses real-world plausibility unless it is based on a "minimal rewrite" of the events that sent history down one path instead of another.[24] And much more than a minimal rewrite is necessary to imagine a big Iraqi nuclear weapons project remaining under the radar after 1991. To imagine a world in which Iraq's nuclear program could have operated freely for another decade, you need to suppose that the invasion of Kuwait did not take place; and yet it is clear that Saddam's political needs and personality were the driving force behind that conflict.[25] Moreover, you also have to suppose that Saddam in 1991 was still as supportive of the nuclear project as he had been in 1981; but this is probably wrong, too. After all, Saddam chose not to wait for the first Iraqi bomb to be born before ordering the invasion. Moreover, during the war he did not act as if his nuclear program was something that he had to protect at any cost. When the American bombs began to fall, the regime even required its top nuclear workers to remain inside their facilities as human shields. It is therefore hard to avoid the conclusion that Saddam had basically given up on his nuclear scientists by the time he invaded Kuwait. They had their chance, and they failed—end of story. When we see things from this perspective, the very half-hearted nature of Iraq's attempts to reconstitute its nuclear program after 1991 also becomes much easier to understand.

Proliferation in the Age of Globalization

China, Iraq, and many other states with nuclear ambitions followed the organizational model of the Manhattan Project, wherein a giant bureaucracy coordinates the efforts of a huge army of S&T workers. By contrast, many analysts believe that future nuclear projects will rely on a small cadre of expert managers who look abroad to get needed materials and know-how much more quickly and cheaply

than if they tried to do it all by themselves.[26] If that is the case, then perhaps the organizational and management challenges that have caused the great proliferation slowdown are about to disappear as a consequence of globalization.

The availability of foreign help for nuclear weapons projects is not a new phenomenon, however. For instance, the Manhattan Project itself was actually a joint effort by the United States and United Kingdom. And after the project achieved its goals, its S&T workers quickly carried their nuclear knowledge to the four corners of the globe.[27] Since the globalization-proliferation nexus is as old as proliferation itself, we can study history to anticipate its likely future consequences. The historical record indicates that well-managed nuclear weapons projects can certainly use foreign help to supercharge their progress. On the other hand, poorly managed projects are much less able to use foreign help effectively, and their progress can even be undermined by their attempts to take that shortcut. Recall also that the more recent nuclear weapons projects have indeed been poorly managed. Consequently, the current wave of globalization is unlikely to produce a cascade of proliferation.

More specifically, analysts have argued that the nonproliferation dam could break as a result of the global diffusion of three key nuclear resources: (1) nuclear hardware and materials; (2) nuclear education and training; (3) experienced nuclear manpower. Let us consider each of these dangers in turn.

The first danger for nonproliferation stems from the availability of key materials and nuclear and dual-use equipment on the international black market. Purchasing such items can of course make life easier for a nuclear program's scientists and engineers. Even so, the challenge of applying them to build working nuclear bombs remains enormous. For instance, Muammar Qaddafi's Libya, an ideal-typical neopatrimonial state, was a major customer of the Pakistani nuclear weaponeer A. Q. Khan's global proliferation network.[28] In 1997, Libya bought a complete kit for the construction of an industrial-scale centrifuge uranium enrichment plant. It also received Khan's blueprints for a nuclear explosive device. Yet the Libyan nuclear weapons project made almost no headway, and Qaddafi gave up his program in 2003. Indeed, when the IAEA inspectors came to cart away the contraband equipment, they found much of it still in its original packing crates. In the words of the blue-ribbon Robb-Silberman commission's report to the U.S. president, the Libyan case underscores the need to avoid making "a fundamental analytical error—simply because a state can buy the parts does not mean that it can put them together and make them work."[29]

The second danger for nonproliferation stems from the global diffusion of crucial scientific knowledge and practical techniques. This process of diffusion has been greatly accelerated over the years by "Atoms for Peace" policies of international civil nuclear cooperation. It is undeniable that some scientists and engineers from developing countries have taken advantage of the openness of Western nuclear laboratories to advance their states' nuclear weapons projects. For instance, A. Q. Khan was able to learn his diabolical trade while working in Holland for the European uranium enrichment consortium URENCO. But Western scientific openness has also had good consequences for nonproliferation. For one thing, developing countries' support for the NPT regime depends in part on the advanced states remaining true to their promise to spread the benefits of civilian nuclear power worldwide. Understanding this basic bargain, the IAEA still pointedly calls itself "the Atoms for Peace agency."[30] In addition, and perhaps even more importantly, the spirit of Atoms for Peace has allowed many S&T workers from developing countries to enjoy formative experiences in the West that subtly but powerfully turn them against participating in a nuclear weapons project back home. Their socialization into the cosmopolitan world of science is a major plus for nonproliferation, because if a state's S&T professionals do not want to build the bomb, its top leadership is going to have to wait a very long time to get it.

Take the case of Yugoslavia. The country's president for life, Josip Broz Tito, promoted a very suspicious dual-use nuclear program from the late 1940s onward, and later explicitly ordered his scientists to produce the bomb.[31] Tito may have thought his ambitions were within reach because, starting in the early 1950s, many young Yugoslav scientists and engineers received advanced education and training in top North American and European nuclear laboratories, learning much potentially dangerous nuclear knowledge. But they also learned that most of the world's top scientists find nuclear weapons loathsome and scientifically uninteresting. And they learned that they could better advance their careers by taking up positions outside Yugoslavia. Armed with this knowledge, thousands of Yugoslav scientists, engineers, metallurgists, and other S&T professionals—including several key members of Tito's original nuclear brain trust—made the choice to leave home for greener pastures in the West. Moreover, some of those who decided to keep working for Yugoslavia used their international connections to try to rein in the regime's military nuclear ambitions. The physicist Ivan Supek became a prominent anti-nuclear activist, and the engineers Dragoslav Popović

and Slobodan Nakićenović successively served as director of the IAEA nonproliferation safeguards department during the 1960s and 1970s. Meanwhile, the once-ominous Yugoslav nuclear program gradually spiraled downward "from 'Big Science' to Nullity," to quote the historian Dušan Ražem.[32]

The third danger for nonproliferation stems from the possibility of a "brain drain" of nuclear S&T workers streaming out of the advanced countries themselves. In particular, a common worry in the post–cold war world has been that just a handful of unemployed ex-Soviet nuclear weaponeers could provide the "missing link" that transforms nuclear wannabes into genuine nuclear threats.[33] We have indeed seen an exodus of S&T workers from the former Soviet states since the early 1990s, but this brain drain has overwhelmingly headed in the same direction as earlier ones: to North America and Western Europe. Furthermore, it is necessary to realize that would-be nuclear states do not receive employment inquiries only from top-notch ex-Soviet weaponeers; they also hear from many con men, kooks, and spies. How can scientifically challenged, poorly managed developing countries tell the difference? Often, they cannot.

Argentina is an interesting case in point. At the end of World War II, the Argentine state recruited at least 184 scientists and engineers from devastated Nazi Germany to industrialize its economy and develop advanced military equipment. In 1948, strongman President Juan Perón tapped one of them, an Austrian physicist named Ronald Richter, to launch a secretive nuclear program aiming to produce controlled fusion, the holy grail of nuclear researchers.[34] Like a James Bond villain, Richter proceeded to build a large laboratory on a secluded island in the Andes Mountains, and four years later he informed Perón that he had achieved the promised scientific breakthrough. However, not long after Perón had proudly announced to the world Argentina's achievement of controlled fusion, it became clear that Richter was badly misinterpreting the results of his own experiment. In retrospect, this was hardly surprising, as Richter was a mixture of con man and madman, with zero peer-reviewed publications to his name. Meanwhile, by throwing his weight behind Richter so completely, Perón definitively lost the support of Argentina's own scientific establishment. The head of the Argentine Physics Association, Enrique Gaviola, said that he would henceforth be willing to serve the president in one capacity only: as a member of Richter's firing squad.[35]

In sum, although many would-be nuclear weapon states today can be expected to try to acquire foreign-produced hardware, software, and brainpower in pursuit

of their goal, these efforts are unlikely to reverse the great proliferation slowdown. In fact, as globalization has accelerated, the slowdown has become ever more pronounced. The efficiency of nuclear weapons projects still depends heavily on the quality of management, and thankfully, high-quality management of nuclear weapons projects has become very uncommon.

Policy Implications of the Great Proliferation Slowdown

American liberals and conservatives today are deeply divided on an incredibly long list of issues, but one thing they share in common is the perception that nuclear proliferation poses the single greatest threat to American national security.[36] In order to fend off this much-feared outcome, many policy-makers and activists of different ideological stripes have pushed for a radical rethinking of some of the country's traditional core foreign policy principles. In particular, the long-standing U.S. policies of promoting open science, abstaining from preventive first strikes, and maintaining a large nuclear deterrent force have become major targets for at least one side of this debate. But when we recognize the durable empirical reality of the great proliferation slowdown, the difficult policy dilemmas that are seemingly raised by the specter of proliferation largely dissipate.

The first perceived policy dilemma pits the goal of nonproliferation against the culture of scientific openness, one of the core values of modern civilization. Fears of proliferation have intensified to the point where one now hears calls essentially to return to the McMahon Act restrictions of the late 1940s, which forbade open discussions even of something as basic as the fission cross-section of uranium-235.[37] But given that the McMahon Act failed to stop the diffusion of nuclear knowledge in its own day, the idea that a reimposition of draconian curbs on scientific interchange could prevent proliferation today is frankly preposterous. Moreover, far from being a naïve giveaway to bomb-desiring dictators, Western scientific openness substantially complicates their road to the bomb by raising the opportunity costs that developing country S&T workers must consider before disappearing into a nuclear weapons project. A. Q. Khan surely betrayed the trust of his URENCO colleagues by stealing information to advance Pakistan's nuclear weapons ambitions. But we need to weigh the Khan example against the less well-publicized actions of people such as the Yugoslav physicist Ivan Supek, who rewarded the trust of his Western friends by fighting against

Tito's nuclear weapons ambitions. Would Supek have made the same choice if the West had shunned him because of the passport he held?

The second perceived policy dilemma pits the goal of nonproliferation against the strong international norm restricting preventive (or "preemptive") war. Despite the intelligence and military fiascos of the 2003 Iraq war, acceptance of the so-called logic of preemption remains strong in many quarters. In particular, various current and former high-ranking officials in the United States and Israel have urged the launching of military attacks against the relatively advanced nuclear program of Iran. Since Iran's nuclear work has progressed so slowly, however, these calls are at best premature. As noted previously, in January 2013, Israeli intelligence admitted that Iran could not build its first bomb until 2015 or 2016 at the very earliest. Moreover, given the Israeli intelligence service's self-described tendency to "cry wolf" on the Iran nuclear issue, we should not be surprised if that timeline is pushed back again.[38] In short, there is still ample time for diplomacy to try to resolve this difficult problem peacefully.

Those advocating an attack on Iran also fail to recognize that bombing Iran's nuclear facilities could actually speed up the country's attainment of its first nuclear weapon. Although we do not know much about the internal culture of Iran's nuclear program, circumstantial evidence suggests that a key cause of Iran's nuclear sluggishness since the program's start in the 1980s has probably been the reluctance of the country's best scientists and engineers to commit themselves wholeheartedly to providing a bomb for the ayatollahs.[39] But a U.S. or Israeli military strike on the Iranian nuclear program would almost certainly rally Iran's S&T establishment and public opinion behind the current political leadership and the military nuclear option. Indeed, it may be that such a process is already underway, due to the recent spate of assassinations of Iranian scientists and engineers, which are widely rumored to be Israel's handiwork. For example, the killing of the young chemical engineer Dr. Mostafa Ahmadi-Roshan reportedly led many students at Iran's top universities to switch their majors to nuclear physics and engineering.[40] If we see such a reaction to the death of one scientist, imagine what would happen if the Israeli Air Force were to destroy the Natanz uranium enrichment plant. Whatever temporary damage the bombing raid might do to Iran's nuclear hardware, it would also surely inflame the Iranian S&T workers' spirit of nationalism and anti-imperialism. And in that case, the pattern of slow and halting Iranian progress toward the "ultimate weapon" could change rapidly.

The third perceived policy dilemma pits the goal of nonproliferation against America's policy of maintaining its own nuclear deterrent. Foreign policy eminences, including President Barack Obama and the so-called "four horsemen" (Henry Kissinger, George Shultz, Sam Nunn, and William Perry), have become highly concerned that the large U.S. nuclear arsenal—which they view as the bedrock of national security in the short term—is undermining the cause of nonproliferation, and therefore national security, in the long term.[41] The only way out of this dilemma, they believe, is to construct a major global nuclear disarmament initiative that mandates specific, gradual, and verifiable reductions in the capabilities of the nuclear weapon states and nuclear threshold states.

There is much to be said for the idea of reviving serious nuclear disarmament negotiations. The United States and Russia still have enough bombs to destroy human civilization, and China may be on its way toward becoming the third member of this infamous club. The four horsemen's case for a reinvigorated nuclear disarmament push, however, leans heavily on the scenario of a coming proliferation cascade. As I have argued, the overwhelming majority of states have little desire to acquire a nuclear arsenal, and the few that do are proving to be terrible at implementing that policy choice. As for terrorist groups, the notion that they could build the bomb all by themselves is a fantasy, and the possibility that they might be able to steal or buy what they need is already being minimized by ongoing international efforts to secure vulnerable nuclear material stockpiles.[42] In other words, if the reason for nuclear disarmament is the prospect of rampant proliferation, then there is little reason for nuclear disarmament.

What is more, the attempt to base the case for disarmament on the fear of proliferation is likely to backfire in the domestic American political context. By stoking the public's nuclear fears in this way, advocates of disarmament could well end up causing the bulk of the American people to demand more nuclear deterrence, not less. Social psychologists have found that when people's mortality is made salient to them, the typical reaction is to become more intellectually rigid and egocentric, more prejudiced and self-righteous, and more aggressive and violent toward threatening "others."[43] In other words—to paraphrase Obama's much-maligned statement during the 2008 campaign—when people feel threatened, they often respond by clinging ever more tightly to God and their guns. Therefore, asserting that the threat of runaway proliferation is high actually plays straight into the hands of those who want the United States to *increase* its nuclear arsenal.

If scare tactics are likely to backfire, do we therefore have no chance of getting to nuclear zero? In fact, there might be another option. Sociologists Donald MacKenzie and Graham Spinardi have argued that it is possible to conceive of the "uninvention" of nuclear weapons via simple disregard rather than a grand disarmament treaty.[44] After all—as the national laboratories are constantly reminding us—it is the carefully nurtured communities of weapons researchers who are the real keepers of the nuclear flame.[45] Therefore, if the bomb were to be seen not as exciting and powerful, but instead as old-fashioned and useless, this could lead, in turn, to ever-deeper budget cuts and to the gradual dissipation of the practical knowledge that constitutes the real DNA of the nuclear estate.

Such a policy of disarmament through disregard would not be without its own political and technical dangers, and it would require many years before fully coming to fruition. But as I have argued throughout this essay, the robustness of the great proliferation slowdown suggests that we may well be able to wait that long. Moreover, even Obama himself has stated that his goal of a globally negotiated, complete, and verifiable nuclear disarmament might not be achievable in his lifetime, so the respective timelines for the two strategies are not so different.[46] And during the transition period, the possibility that some of the old bombs still work should provide sufficient deterrence. There was much wisdom in the old bumper sticker: "Nuclear Weapons: Rust in Peace."

NOTES

[1] See, e.g., "Davos 2013: Kissinger Says Iran Crisis Close," BBC News, January 24, 2013, www.bbc.co.uk/news/business-21177535.

[2] Harald Müller and Andreas Schmidt, "The Little Known Story of De-Proliferation: Why States Give Up Nuclear Weapon Activities," in William C. Potter and Gaukhar Mukhatzhanova, eds., *Forecasting Nuclear Proliferation in the 21st Century, vol. 1: The Role of Theory* (Stanford, Calif.: Stanford University Press, 2010), pp. 124–58.

[3] Jacques E. C. Hymans, *The Psychology of Nuclear Proliferation: Identity, Emotions, and Foreign Policy* (New York: Cambridge University Press, 2006), esp. ch. 1.

[4] United Nations, *A More Secure World: Our Shared Responsibility. Report of the Secretary-General's High-Level Panel on Threats, Challenges, and Change* (New York: United Nations, 2004), p. 39.

[5] George Tenet, *At the Center of the Storm* (New York: HarperCollins, 2007), p. 287.

[6] What follows is a summary of the argument in Jacques E. C. Hymans, *Achieving Nuclear Ambitions: Scientists, Politicians, and Proliferation* (New York: Cambridge University Press, 2012), chs. 1 and 2.

[7] Philipp C. Bleek, "When Did (and Didn't) States Proliferate? Coding the Spread of Nuclear Weapons throughout the Atomic Age," Occasional Paper, Working Draft 2.1 (2011 revision), James Martin Center for Nonproliferation Studies, Monterey Institute of International Studies, Monterey, CA.

[8] For a discussion of the many theoretical and practical reasons for relying on the nuclear test as the standard means of distinguishing nuclear from nonnuclear weapon states, see Jacques E. C. Hymans and Matthew S. Gratias, "Iran and the Nuclear Threshold: Where is the Line?" *The Nonproliferation Review* 20, no. 1 (March 2013), pp. 13–38.

[9] Sheera Frenkel, "Israel: Iran slowing nuclear program, won't have bomb before 2015," McClatchy Newspapers, January 28, 2013, www.mcclatchydc.com/2013/01/28/181276/israel-iran-slowing-nuclear-program.html.

[10] The fact that the slowdown began in the 1970s also falsifies the popular view that it was caused by the increased U.S. ability to threaten preventive war after the end of the cold war. Cf. Alexandre Debs and Nuno Monteiro, "Nothing to Fear but Fear Itself? Nuclear Proliferation and Preventive War" (Yale University, November 5, 2010, unpublished), www.yale.edu/leitner/resources/papers/DebsMonteiro2011-01.pdf.

[11] See, e.g., Kai Bird and Martin Sherwin, *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer* (New York: Random House, 2005), pp. 224–26; David Holloway, *Stalin and the Bomb: The Soviet Union and Atomic Energy, 1939–1956* (New Haven, Conn.: Yale University Press, 1994), pp. 136–41 and 204; Margaret Gowing with Lorna Arnold, *Independence and Deterrence: Britain and Atomic Energy, 1945–1952,* Vol. 2: *Policy Execution* (New York: St. Martin's Press, 1974), p. 4; and Gabrielle Hecht, "Political Designs: Nuclear Reactors and National Policy in Postwar France," *Technology and Culture* 35, no. 4 (October 1994), p. 665.

[12] Weber's concept of legal-rational domination should not be confused with the liberal idea of the "rule of law" as a constraint on state power. On Weber and liberalism, see David Held, *Models of Democracy*, 3rd edition (Polity Press, 2006), esp. p. 137.

[13] Gero Erdmann and Ulf Engel, "Neopatrimonialism Reconsidered: Critical Review and Elaboration of an Elusive Concept," *Commonwealth and Comparative Politics* 45, no. 1 (February 2007), pp. 95–119.

[14] There is an enormous management literature that accords with these basic hypotheses, beginning with Douglas McGregor, *The Human Side of Enterprise* (New York: McGraw-Hill, 1960).

[15] Christophe Jaffrelot, "India and Pakistan: Interpreting the Divergence of Two Political Trajectories," *Cambridge Review of International Affairs* 15, no. 2 (2002), esp. pp. 253–55.

[16] Robert S. Anderson, *Nucleus and Nation: Scientists, International Networks, and Power in India* (University of Chicago Press, 2010).

[17] For my complete description of the Iraqi and Chinese cases, see Hymans, *Achieving Nuclear Ambitions*, chs. 3 and 4.

[18] John Lewis and Xue Litai, *China Builds the Bomb* (Stanford University Press, 1988).

[19] Chen Hong, ed., *Nie Rongzhen's Scientific and Technological Thoughts and Practice* (Beijing: National Defense Industry Press, 2009), p. 39.

[20] John Lewis and Xue Litai, *China's Strategic Seapower: The Politics of Force Modernization in the Nuclear Age* (Stanford, Calif.: Stanford University Press, 1996).

[21] Robert Jervis, *Why Intelligence Fails: Lessons from the Iranian Revolution and the Iraq War* (Ithaca, N.Y.: Cornell University Press, 2011).

[22] International Atomic Energy Agency (IAEA), *Fourth Consolidated Report of the Director General of the International Atomic Energy Agency*, October 8, 1997, Part II.

[23] Robert E. Kelley, "The Iraqi and South African Nuclear Weapon Programs: The Importance of Management," *Security Dialogue* 27, no. 1 (1996), pp. 27–38.

[24] Richard Ned Lebow, *Forbidden Fruit: Counterfactuals and International Relations* (Princeton, N.J.: Princeton University Press, 2010), p. 44. Lebow also supports the use of "miracle world" counterfactuals that do violate the minimal rewrite stricture, but he emphasizes that these are mind-bending thought experiments, not plausible historical near-misses.

[25] Janice Gross Stein, "Deterrence and Compellence in the Gulf, 1990–1991: A Failed or Impossible Task?" *International Security* 17, no. 2 (Autumn 1992).

[26] James A. Russell, "Peering into the Abyss: Non-State Actors and the 2016 Proliferation Environment," *Nonproliferation Review* 13, no. 3 (2006), pp. 645–57.

[27] Ferenc Szasz, *British Scientists and the Manhattan Project: The Los Alamos Years* (New York: St. Martin's Press, 1992).

[28] See David Albright, *Peddling Peril: How the Secret Nuclear Trade Arms America's Enemies* (New York: The Free Press, 2010).

[29] Commission on the Intelligence Communities of the United States Regarding Weapons of Mass Destruction, *Report to the President of the United States*, March 31, 2005, ch. 2, govinfo.library.unt.edu/wmd/report/wmd_report.pdf.

[30] See www.iaea.org/About/about-iaea.html.

[31] For my full description of the Yugoslav case, see Hymans, *Achieving Nuclear Ambitions*, ch. 5.

[32] Dušan Ražem, "Radiation Processing in the Former Yugoslavia, 1947–1966: From 'Big Science' to Nullity," *Minerva* 32, no. 3 (Autumn 1994), pp. 309–26.

[33] Dorothy S. Zinberg, "The Missing Link? Nuclear Proliferation and the International Mobility of Russian Nuclear Experts," *UNIDIR Research Paper*, no. 35 (New York: United Nations Institute for Disarmament Research, 1995); and Sharon K. Weiner, *Our Own Worst Enemy? Institutional Interests and the Proliferation of Nuclear Weapons* (Cambridge, Mass.: MIT Press, 2011).

[34] See Mario A. J. Mariscotti, *El secreto atómico de Huemul: crónica del origen de la energía atómica en la Argentina*, 4th ed. (Buenos Aires: Estudio Sigma, 2004); and Hymans, *Achieving Nuclear Ambitions*, ch. 6.
[35] Mariscotti, *El secreto atómico de Huemul*, p. 177.
[36] For instance, both President George W. Bush and Senator John Kerry explicitly agreed on this point in their first televised presidential debate in the 2004 electoral campaign. See "September 30, 2004 Debate Transcript" Commission on Presidential Debates, http://www.debates.org/index.php?page=september-30-2004-debate-transcript .
[37] Alisa Carrigan, "Learning to Build the Bomb," *Physics Today* 60, no. 12 (December 2007), pp. 54–55.
[38] Jacques E. C. Hymans, "Iran Is Still Botching the Bomb," *Foreign Affairs* online, February 20, 2013, www.foreignaffairs.com/articles/139013/jacques-e-c-hymans/iran-is-still-botching-the-bomb.
[39] Jacques E. C. Hymans, "Botching the Bomb: Why Nuclear Weapons Programs Often Fail on their Own —and Why Iran's Might, Too," *Foreign Affairs* 91, no. 3 (May/June 2012), pp. 44–53.
[40] Lee Ferran, "After Nuke Scientist's Murder, Iranian Students Switch Majors to Nuclear Sciences: Official," ABC News, January 17, 2012, abcnews.go.com/Blotter/scientists-murder-iran-students-switch-majors-official/story?id=15377748#.UFIXxa5VWt8.
[41] George P. Shultz, William J. Perry, Henry A. Kissinger and Sam Nunn, "A World Free of Nuclear Weapons," *Wall Street Journal*, January 4, 2007; Shultz, Perry, Kissinger, and Nunn, "Deterrence in the Age of Nuclear Proliferation," *Wall Street Journal*, March 7, 2011; and Shultz, Perry, Kissinger, and Nunn, "Next Steps in Reducing Nuclear Risks," *Wall Street Journal*, March 5, 2013.
[42] Miles Pomper and Meghan Warren, "Progress Since the 2010 Washington Nuclear Security Summit: Successes, Shortcomings, and Options for the Future," conference paper prepared for the 2012 Seoul Nuclear Security Symposium, March 23, 2012, cns.miis.edu/stories/120316_nuclear_security_summit.htm.
[43] Daniela Niesta, Immo Fritsche, and Eva Jonas, "Mortality Salience and its Effects on Peace Processes: A Review," *Social Psychology* 39, no. 1 (2008), pp. 48–58.
[44] Donald MacKenzie and Graham Spinardi, "Tacit Knowledge, Weapons Design, and the Uninvention of Nuclear Weapons," *The American Journal of Sociology* 101, no. 1 (July 1995), pp. 44–99. See also John Mueller, *Atomic Obsession: Nuclear Alarmism from Hiroshima to Al-Qaeda* (New York: Oxford University Press, 2010), pp. 80–87. The most recent spin is Benjamin Sims and Christopher R. Henke, "Repairing Credibility: Repositioning Nuclear Weapons Knowledge after the Cold War," *Social Studies of Science* 42, no. 3 (June 2012), pp. 324–47.
[45] Hugh Gusterson, *Nuclear Rites: A Weapons Laboratory at the End of the Cold War* (Berkeley, Calif.: University of California Press, 1998).
[46] See Benoît Pelopidas, "Perhaps Not in his Lifetime: The Missing Timeline in the Debate about Nuclear Disarmament," paper prepared for the Public Policy and Nuclear Threats Program, San Diego, Calif., August 19, 2011.