

Introduction

Understanding the Nuclear Renaissance

Adam N. Stulberg and Matthew Fuhrmann

INTEREST IN NUCLEAR ENERGY HAS SURGED IN RECENT YEARS, prompting some to tout a “global nuclear renaissance.” Iran became the first new member of the nuclear energy club since 1996, and it may be followed by the United Arab Emirates, Turkey, and Vietnam—states with profoundly different profiles. More than fifty other countries, including Chile, Jordan, Nigeria, and Saudi Arabia, are seriously considering nuclear power for the first time in decades. Other states, such as China, Russia, India, and South Korea, have recently announced plans to expand existing nuclear power programs, while Brazil is enlarging its fuel cycle activities, both independently and jointly with Argentina. Still other nuclear power states, such as the United States, stand on the precipice of ending a prolonged hiatus of new reactor construction. Meanwhile, some governments are rethinking their commitments to nuclear power in the aftermath of the March 2011 accident at Japan’s Fukushima Daiichi nuclear power plant. There, an earthquake and tsunami resulted in mechanical failures that caused some of the fuel rods to melt down, causing radioactive materials to spread into the surrounding environment. This disaster helped persuade Germany to shut down its oldest reactors and to implement plans to phase out the sector altogether. Other European states, such as Spain and Switzerland, may follow suit.

There are a number of explanations for the renewed interest in nuclear power. Concerns about global climate change, spiraling electricity demand, and excessive import dependency on fossil fuels are among the reasons

cited most frequently by pundits and policy analysts. Growing confidence in international nuclear fuel cycle markets and enhanced safety and efficiency of the sector are also winning over longtime critics. This confluence of factors seems to augur well for real growth of commercial nuclear energy worldwide.

Even before the dreadful Japanese nuclear accident, it was unclear whether the nuclear renaissance would blossom or fizzle. Nuclear plant construction is highly capital intensive and requires significant start-up costs that must be aligned with human capital and baseload power generation infrastructure. These requirements, combined with the industry's propensity for monumental cost overruns, limit the commercial appeal of nuclear power for some countries. Moreover, as evidenced by the global public debate precipitated by Japan's crisis, the consequences associated with even a single nuclear accident and the lack of long-term solutions for nuclear waste disposal continue to stoke public uneasiness and sap political will for jump-starting nuclear power programs across the globe. Some of these factors have derailed nuclear power ambitions in the past in countries that lacked active power programs, such as Egypt and Turkey; and as suggested by the freeze on new construction and attendant political fallout from the accident in Japan, it is possible that these factors will stymie the current nuclear renaissance even among nuclear states that currently rely on nuclear power generation.

At the same time, there is mounting anxiety that the diffusion of peaceful nuclear programs could undermine international security. Nuclear technology, materials, and know-how are dual-use in nature, meaning that they can be used for the production of electricity or nuclear weapons. India, for example, used nuclear materials supplied by the United States and a reactor provided by Canada to produce plutonium for a nuclear explosive that was tested in 1974; this early civilian nuclear assistance was the foundation upon which New Delhi built its nuclear program in the 1990s. Scientists who later produced the South African bomb in the 1970s—including the head of the nuclear weapons program—were trained by the United States as a result of government-backed programs. And a research reactor exported by the United States to Iran in the 1960s helped provide training to scientists that later became relevant for Tehran's nuclear weapons program. These stories are, unfortunately, not uncommon. There is an ongoing debate about the connection between proliferation and peaceful nuclear assistance, which is highlighted in the book, but such anecdotes underscore why some worry that the global dif-

fusion of nuclear technology could lead to the spread of nuclear weapons (see Fuhrmann 2009b, 2012b).

Nuclear proliferation may not be the only strategic consequence associated with the nuclear energy renaissance. Some scholars argue, for instance, that the global expansion of nuclear infrastructure could raise the risk of nuclear or radiological (NR) terrorism by facilitating terrorists' efforts to acquire NR materials, increasing targets of opportunity, and magnifying the economic and psychological costs of an attack (Early et al. n.d.; see also Miller and Sagan 2009). We now know, for example, that al Qaeda considered flying airplanes into nuclear facilities in the United States as part of the 9/11 attacks (Holt and Andrews 2007). Terrorists may attempt to target nuclear plants in other countries, potentially triggering a Fukushima-like disaster.

Peaceful nuclear programs also could be a source of international conflict. Because nuclear technology can be used for both civilian and military purposes, uncertainty about a country's intentions could raise the risk of preventive military action. This danger is best illustrated by Israel's 1981 "bolt from the blue" bombing of an Iraqi nuclear reactor known as Osiraq. Iraq procured this civilian facility from France and placed it under International Atomic Energy Agency (IAEA) safeguards designed to detect diversions of key materials to a military program. The Israelis, however, feared that Saddam Hussein intended to use this plant to produce plutonium for nuclear weapons, and it chose to take military action to limit Iraq's capacity to build the bomb. Israel took similar action in September 2007 when it destroyed a nuclear reactor under construction in Syria, although this facility was not under IAEA safeguards and it is unclear whether its purpose was military or civilian.

Such concerns are accentuated by debate over the desirability and feasibility of nuclear weapons that has gathered unprecedented momentum across the globe, most significantly among security communities within the nuclear weapons states. This has been accompanied by mounting anxiety that the resuscitation of interest in commercial nuclear power and fuel production portends the spread of sensitive technologies and know-how beyond the few countries that dominate the field. The result, if not managed appropriately, could be a leveling of nuclear capacities that effectively lowers the threshold for dangerous arms racing, crisis instability, and international insecurity (Glaser 2009).

This book examines the causes, processes, and broad international security consequences of the spread of nuclear power development, in light of the

shifting terrain and growing concerns. Recent books seek to explain nuclear proliferation or nuclear weapons strategy (e.g., Hymans 2006; Solingen 2007; Rublee 2009; Sagan 2009; Potter and Mukhatzhanova 2010; Fuhrmann 2012b). This volume, however, takes another tack by addressing the motivations for acquiring commercial and dual-use technology, material, and expertise short of the development of weapons systems, as well as by exploring the strategic implications associated with this diffusion that go beyond traditional weapons proliferation or energy security concerns. It extends recent scholarship on nuclear power and international security both to redress important empirical puzzles and intellectual questions derived from past commercial and strategic behavior, and to get out in front of future policy challenges and opportunities.

The authors of this book understand that they face a tall order, especially amid ill-defined and moving targets. Yet we believe that scholars and policy-makers possess the tools to refine their analyses and decisions, premised on rigorous and systematic examination of critical issues and patterns of behavior. Accordingly, the chapters together address a series of interrelated questions surrounding the sources and strategic consequences of the spread of nuclear energy. What will come of the nuclear renaissance? Will the benefits of nuclear power trump the costs, leading to the massive expansion in nuclear power that some have forecasted? Or will the risks and strategic consequences of nuclear energy development, brought vividly into focus by the 2011 Fukushima nuclear accident, discourage countries from developing or expanding civilian nuclear programs? These questions must be answered if we are to understand the contours and significance of the tensions between growing interest in and anxiety about nuclear power for international security.

The remainder of this introduction will proceed in three parts. First, we discuss the alternative futures for nuclear energy that inform respective chapter analyses. Second, we comment on the distance between efforts by academics and policymakers to grapple with the international security puzzles posed by nuclear energy and outline our approach to “bridging” this gap. We conclude with a succinct overview of the book.

A Nuclear Renaissance or Back to the Future?

While it is nearly conventional wisdom that the twenty-first century will witness a global expansion of nuclear energy, even in the wake of the 2011 Japanese crisis, neither the trajectory nor the dimensions of growth of the

nuclear expansion are well specified or commonly accepted (Economist Intelligence Unit 2011; Ferguson 2011). Industry, policy, and scholarly articles are replete with projections of a nuclear energy renaissance. But what does that mean? Explication of the puzzles linked to the sources and strategic consequences of nuclear energy require sound baselines for thinking about growth.

There are three possible alternative futures for nuclear energy. The first scenario, *stagnation*, is defined by straight-line projections of past performance of the nuclear sector. This presumes the continuation of negligible rates of reactor construction and growth in fuel cycle services that, in practice, have failed to keep pace with stated intentions or official targets. Such projections accord with both case-specific and macro-level evidence. In the United States, for example, almost half of all reactors ordered from 1953 to 2003 were canceled before the beginning of commercial operation (Bodansky 2004). There have been notable examples, most recently in the United States and Philippines, of reactors that were constructed but never made operational, as well as reactors in Germany and Spain that were not replaced upon retirement.

The share of total global electricity generation from nuclear plants leveled off in the late 1980s and began to decline by 2010. Extrapolations from this pattern hardly provide grounds for optimism concerning a nuclear energy renaissance (Squassoni 2009). The IAEA projects that the nuclear energy sector must grow significantly just to maintain present global and national shares in the face of accelerating worldwide demand for electricity through 2030. Low estimates, based on current trends augmented by assumed changes underway, reveal that the portion of total power plant capacity from nuclear reactors is likely to decline from 8.0 percent in 2008 to 7.1 percent in 2030, with total generation projected to decline from 14.0 percent in 2008 to 12.6 percent in 2030 (IAEA 2009a).

A second scenario reflects a *resurgence* of nuclear energy, marked by deepening reliance on the sector by states that currently possess nuclear fuel cycle capabilities. This too finds empirical support from contemporary trends. According to IAEA statistics, over two-thirds of the sixty plants under construction as of March 2012 (WNA 2012) are being built in just four countries that currently embrace nuclear power—China, India, South Korea, and Russia (IAEA 2010b). Notwithstanding temporary moratoria on construction and delays owing to safety checks precipitated by the Fukushima accident, China is projected to be home to more than one-third of the world's new reactors,

doubling power generation from the sector by 2020. Russia plans to build between two to three new reactors per year and for the sector to meet 25 percent of domestic demand for electricity by 2050; and India intends to triple nuclear power production by 2020. The United States is poised to regain its global stature in the industry, with twenty-one new construction and operating license applications on file as of March 2012 (Blake 2012). Similarly, the growth in power production is projected to be met primarily by the expansion of natural uranium mining and nuclear fuel production among existing suppliers. These states are expected to cover the global demand that exceeds the capacity of secondary supply sources (e.g., stockpiles, fuel blended down from destroyed weapons), leveraging respective national fuel cycle capabilities to compete intensely for greater market shares.

The trends toward concentration of growth would jibe with historical patterns, as over 58 percent of the 435 reactors currently in use are located in the United States (104), France (58), Japan (51), Russia (33), and Germany (9), and uranium enrichment is dominated by only five international suppliers (WNA 2012).¹ Similarly, rates for bringing new plants on line have come in waves for large nuclear states, with peak years of new construction corresponding with growth in only a few countries. Underpinning these projections are presumptions that start-up costs, economies of scale, tacit knowledge accumulation, export and market constraints, and the political clout of current stakeholders in commercial nuclear energy will favor growth among existing nuclear power generation and fuel cycle states, while raising barriers for aspirant states.

A third future to contemplate entails a nuclear energy *renaissance*, defined in terms of both the global deepening and broadening of nuclear fuel cycle and power generation activities. This scenario would constitute more than a simple rebirth of the sector among the existing “haves” but would be distinguished most notably by the success of a large share of the more than fifty current aspirant states at realizing ambitious plans for nuclear expansion. As suggested by one study, for this to transpire we would expect to witness the continued growth of nuclear power construction and generation (MIT 2003). States in East Asia, the United States, and Europe would have to fully meet respective new reactor construction targets to transcend the inertia of the lost decades since the late 1970s, and there would have to be widespread adoption of nuclear energy among emerging market and developing states. As proponents are quick point out, such projections should not be dismissed

as far-fetched, even in the aftermath of the scarring tragedy in Japan, as over 80 percent and 66 percent of total nuclear energy produced since the dawning of the nuclear era was generated following the accidents at Three Mile Island and Chernobyl, respectively (Glaser 2011). Such resilience in the face of few viable alternatives provides the basis for a protracted and muddled but stable expansion of the sector across both nuclear stalwarts and newcomers around the globe (Economist Intelligence Unit 2011).

Such a renaissance also would be characterized by reinvigorated technological innovation across both the front and back ends of the nuclear fuel cycle, as well as by new forms of public and private management and shared infrastructure arrangements. Here, the public outcry for enhanced safety to mitigate concerns about catastrophic accidents would redirect R&D toward fundamentally new reactors designs and dispositions that would avert vulnerability to experiencing meltdowns or costliness of large-scale, idiosyncratic units (Glaser 2011). In addition, there would be new entrants into global nuclear fuel supply markets, as states such as Brazil and South Africa would succeed in leveraging indigenous capacity to compete for growing shares in global and regional markets. The game changers for an over threefold increase in global nuclear power production by 2050 are associated with concerted political will, government intervention, and international institutional innovation aimed at reducing carbon emission targets and mitigating climate change, producing industrial-scale clean water, attracting an expert trade and technical workforce to the field worldwide, and reassuring safe and secure expansion of global nuclear fuel cycle and energy markets.

This book examines the drivers and strategic effects of nuclear power development in light of the global nuclear expansion. Applying diverse qualitative and quantitative research methods, the contributors strive to uncover historical patterns in nuclear energy development, pinpoint the connection between commercial nuclear programs and latent military activities, and forecast the implications of a global nuclear energy expansion for international security. The chapters address a number of specific questions that lie at the crux of understanding the sources and strategic consequences associated with these alternative nuclear scenarios. Why do countries rely on nuclear power? Will the Fukushima Daiichi accident be a game changer for the trajectory of global nuclear energy development? How do buyers and sellers of nuclear technology talk about nuclear power, and what does this reveal about their intentions? Why do countries provide peaceful nuclear assistance to other

states? Under what conditions do countries embrace multinational nuclear approaches, such as the establishment of international fuel banks? To what extent is global climate change a driver of the nuclear renaissance, and would nuclear power development make a meaningful dent in global greenhouse gas emissions? Do peaceful nuclear programs contribute to nuclear weapons proliferation? Will the diffusion of nuclear technologies lead to an increase in the trafficking of nuclear and radiological materials? Does the diffusion of sensitive enrichment and reprocessing technologies and latent nuclear weapons capabilities influence crisis stability and international conflict? If so, how?

Bridging the Policy-Scholarly Gap

The questions outlined above are critical for understanding the significance of the growing interest in nuclear power for international security for scholars and policy makers alike. Yet we know surprisingly little about the answers. There are several classic case studies of national nuclear energy programs (e.g., Poneman 1982), as well as burgeoning inquiries into the dynamics of illicit nuclear trafficking (e.g., Braun and Chyba 2004; Montgomery 2005) and the supply side of nuclear proliferation (e.g., Fuhrmann 2009a,b; Kroening 2009a,b). A small but growing body of work is beginning to analyze what drives the spread of nuclear energy and the potential strategic effects of the nuclear energy renaissance (e.g., Fitzpatrick 2009; Malley and Ogilvie-White 2009; Miller and Sagan 2009; Tertrais 2009; Findlay 2011; Fuhrmann 2012a), but our knowledge about the empirical puzzles or policy challenges presented by a global nuclear energy expansion remains incomplete. Indeed, relative to the research on nuclear weapons proliferation and strategy, there is a paucity of systematic analysis of the drivers of the spread of nuclear energy or the implications of nuclear power development for international cooperation and conflict. Consequently, the extant scholarly literature offers only a limited insight into the empirical puzzles or policy challenges presented by a global nuclear energy expansion.

At the same time, policy makers, businesspeople, and other professionals must prepare for future commercial and strategic realities, contending with the uncertainties surrounding a prospective global expansion of nuclear energy. This strategic forecasting, however, must be based on more than ad hoc case analyses, selective empirical evidence, untested assumptions, and gut instincts. Rather, forecasting requires the development of sound analytical

frameworks and rigorous examination of historical motivations, patterns of behavior, and strategic interaction that form the foundation of scholarly inquiry (Bueno de Mesquita 2009).

As the demand for systematic analysis of nuclear behavior has increased, the distance between scholars and government officials has widened. This is due in part to divergent research priorities within the two communities. On one hand, in the social sciences a premium is placed on employing sophisticated methodologies to discern epochal patterns of behavior and to advance the frontier of knowledge within respective disciplines. For scholars in the subfield of nuclear security, many of the interesting questions relate to why so few states are attracted to nuclear weapons, rather than to the causes or effects of civilian nuclear programs. Government officials and corporate executives, on the other hand, must contend with specific, concrete issues, and lack the time or resources to divine the policy relevance of methodological or theoretical debates. It is also taken almost as a given that both commercial and sensitive nuclear technologies and know-how will diffuse to state and non-state actors, presenting practical opportunities and challenges that necessitate taking action. The tension between these professional communities and respective orientations limits our collective capacity to understand and manage complex issues related to the sources and international consequences of an expansion of nuclear energy.

This volume aims to help bridge this gap. The respective chapters strive to extend scholarly research on the spread of nuclear energy in a manner that is policy relevant. The book contributes to the existing literature and narrows the distance between the scholarly and policy communities in four main respects. First, each chapter explicates an empirical puzzle associated with either the sources or international security consequences of the diffusion of nuclear energy and/or sensitive fuel cycle capabilities, identifying important patterns and practical issues for consideration. Second, the authors extend previous research, present alternative analytical frameworks, and employ cutting-edge qualitative and statistical methods to test respective arguments. Each author also teases out the practical implications or insights into forecasting developments under alternative nuclear futures as derived from systematic analysis. Third, to broaden accessibility and to reinforce the significance of seemingly arcane academic research, we invited three senior scholars to offer commentaries that succinctly compare and contrast the findings of a subset of chapters, and to distill the relevant policy implications. In addition

to generating substantive insight and highlighting themes that emerge from the different parts of the book, these commentaries serve as a critique of respective arguments and research methods posited by the authors within each part of the book. As a novel twist and complement to the substantive chapters, these commentaries purposefully expose analytical blind spots and reframe supplementary issues in need of deeper reflection by scholars and policy makers alike. Finally, recognizing that the chapters offer only an initial foray into this dynamic field of study, both the authors and commentators illuminate new directions for theoretical development, identifying critical case studies for future qualitative research and key-issues areas for future statistical analysis and closer policy attention.

Organization of the Book

The book is divided into three parts. Part I addresses the drivers of the nuclear energy renaissance. In Chapter 1, Bernard Gourley and Adam N. Stulberg analyze the correlates of nuclear power development from 1950 to 2001. They find that high levels of economic development and energy insecurity have historically motivated countries to rely on nuclear power. Conversely, they do not find support for the popular argument that countries pursue peaceful nuclear programs when they have an interest in building nuclear weapons (i.e., nuclear hedging). Their analysis has important implications for the future of the nuclear renaissance. It suggests, for instance, that stagnation or decline in developed countries such as France, South Korea, and the United States could prevent the realization of a true renaissance.

In Chapter 2, Allison Macfarlane examines multiple discourses surrounding the acquisition of nuclear energy technology to shed light on the motivations and intentions of actors who will shape the future of the nuclear renaissance. She finds that suppliers and buyers often tout the ambiguities of nuclear power in their rhetoric. In particular, discourses tend to emphasize the connection between nuclear power and nuclear weapons. Macfarlane does not suggest that countries pursue nuclear technologies because they have an interest in developing the bomb. Rather, buyer countries can enhance their power and prestige by maintaining ambiguity about their intentions. At the same time, suppliers have incentives to emphasize the ambiguity of nuclear technology because it helps them sell their product.

Matthew Fuhrmann addresses the supply side of the nuclear renaissance in Chapter 3. He analyzes why nuclear supplier countries assist other states in developing nuclear energy programs. We cannot fully understand the renaissance in nuclear power without grasping the incentives of nuclear suppliers, because most states depend on external sources for nuclear technology and materials. Fuhrmann shows that supplier states enter the marketplace to enhance their political influence. Normative concerns and a desire to sustain the domestic nuclear industry are less decisive for explaining civilian nuclear assistance than is commonly assumed. He concludes that the supply side will influence the renaissance mostly by affecting where—not if—countries are able to obtain nuclear assistance.

In Chapter 4, Adam N. Stulberg tackles the puzzle of international fuel supply cooperation. He explains why the historical record of multilateral nuclear approaches (MNAs) is mixed even though internationalizing the nuclear fuel cycle could make markets function more efficiently and reduce the risk of proliferation by eliminating the need for indigenous enrichment or reprocessing facilities. Framing this issue as an international credible commitment problem, Stulberg argues that the efficacy of MNAs hinges on the degree of power asymmetry and vulnerability among the bargaining parties. He demonstrates that countries are most likely to support MNAs when suppliers do not wield sufficient market power to blackmail other states and when customers do not expect to be overly reliant on nuclear energy.

Joshua William Busby analyzes the relationship between global climate change and nuclear power development in Chapter 5. Nuclear power is a possible solution to the problem of climate change because it is one of the few relatively carbon-free energy sources. Busby argues, however, that it is unlikely to play a major role in reducing global greenhouse gas emissions. Lingering concerns about cost, safety, and security are likely to prevent the requisite expansion in nuclear power development. He concludes that concerns about global warming will not singlehandedly drive a renaissance in nuclear power.

In Chapter 6, Christopher Way concludes Part I of the book by summarizing the key findings from the first five chapters and highlighting the underlying implications for the nuclear renaissance. Ostensibly, these chapters are a diverse lot, but as Way indicates, they all highlight the important role of politics in driving or limiting nuclear power development. Given the number of states seeking to provide nuclear assistance to enhance their international

influence and the primacy of politics in the nuclear marketplace more generally, access to the requisite technology and know-how is unlikely to stymie the renaissance. Taken together, the chapters in Part I are not necessarily optimistic about the prospects for a massive global expansion in nuclear energy. As Way discusses, the domestic politics of the renaissance are not promising in many countries. In the end, the renaissance may be more likely to fizzle than to thrive. At the same time, we cannot know for certain what form the renaissance will take. Whatever happens, it is likely that at least a few new nuclear power states will emerge. Even this modest resurgence could have consequences for international security.

Part II of the book addresses the effects of the nuclear renaissance on nuclear weapons proliferation. In Chapter 7, Alexander H. Montgomery explores whether nuclear assistance increases the likelihood that countries will explore, pursue, or acquire nuclear weapons. He finds that nuclear assistance appears to decrease the probability that countries pursuing nuclear weapons will successfully develop the bomb. This result emerges, Montgomery argues, because certain countries are unable to utilize technologies provided from foreign sources. In particular, neopatrimonial regimes, which are characterized by personalized rule and little or no accountability to domestic actors, take shortcuts by importing dual-use nuclear technology without having the capacity to absorb it properly. The result is that these countries end up taking longer to build nuclear weapons than they otherwise would have if they had not received foreign assistance.

In Chapter 8, Matthew Kroenig argues that the nuclear renaissance is unlikely to cause widespread nuclear weapons proliferation because it is difficult for states to obtain sensitive nuclear assistance in the international marketplace. States seeking to build domestic fuel cycle facilities will struggle to obtain foreign assistance, except under relatively rare strategic conditions. Without this assistance, Kroenig posits, countries will be unable to build nuclear weapons.

Justin V. Hastings analyzes the consequences of the nuclear renaissance for nonstate nuclear trafficking in Chapter 9. Trafficking in radioactive materials such as plutonium and highly enriched uranium constitutes one of the major nonstate proliferation threats. Hastings argues that the nuclear renaissance will diversify the locations from which nuclear materials can be obtained, which is potentially problematic given that many of the nuclear power aspirants have limited organizational and bureaucratic capacity. Yet the prac-

tical effects of the renaissance for nuclear trafficking are likely to be limited, because the strategies adopted by nuclear traffickers to transport materials will not change as more countries build nuclear power plants. Current strategies are vulnerable to state crackdowns given that they utilize commercial transportation infrastructure that is controlled in part by governments.

Erik Gartzke's commentary, Chapter 10, concludes Part II of the volume. As Gartzke discusses, one unifying theme that emerges from the chapters by Montgomery, Kroenig, and Hastings is that the nuclear renaissance is likely to be relatively innocuous from a proliferation standpoint. He cautions that the proliferation risks of the nuclear renaissance could magnify as the number of states with the capacity to provide nuclear assistance or with the basic infrastructure to build the bomb increases. Gartzke uses the chapters in Part II of the book as a springboard to address an important puzzle: Why have countries refrained from transferring complete nuclear weapons to non-nuclear weapons states? While civilian nuclear assistance could lead to proliferation in the long term, a quicker way to strengthen an ally or constrain an adversary would be to export an intact nuclear bomb. That we have not yet observed this implies that a complex combination of factors—including international norms, economics, and politics—explains the export practices of nuclear weapons states.

Part III of the book deals with the effects of the nuclear renaissance on international conflict. In Chapter 11, Kyle Beardsley and Victor Asal analyze the relationship between nuclear weapons programs and international crisis behavior. This issue is related to the central theme of Part III of the book because the nuclear renaissance could lead to further nuclear weapons proliferation.² Beardsley and Asal argue that the pursuit of nuclear weapons is threatening to other states because possessing the bomb yields important bargaining leverage. Consistent with their core argument, they find that countries facing potential opponents with nuclear weapons programs are much more likely to experience a crisis. States attempting to proliferate are themselves more likely to perceive a crisis as well. Yet Beardsley and Asal find that the mere possession of sensitive nuclear technology does not affect international crisis behavior. This suggests that the spread of civilian nuclear programs will be destabilizing only to the extent that such programs increase the likelihood of nuclear weapons pursuit.

Michael C. Horowitz examines in Chapter 12 how the pursuit of nuclear weapons and the possession of nuclear energy programs influence states'

propensities to initiate militarized conflict against other countries. He finds that states with active nuclear weapons programs are more likely to initiate interstate disputes, but countries with commercial nuclear power programs are much less likely to act aggressively toward their neighbors. Further analysis indicates that the amount of time that countries have had active nuclear weapons programs does not significantly change how they behave or how they are perceived by others.

In Chapter 13, Dan Reiter wraps up Part III of the book by discussing Chapters 11–12 and offering directions for future research. Reiter notes that, while the authors in Part III of the book present a series of nuanced empirical findings, the central theme is that nuclear power has historically had rather modest consequences for international conflict. Based on historical patterns, civilian nuclear energy programs may be more problematic for terrorism than international conflict. From a policy standpoint, Reiter suggests that the possible costs discussed in this part of the book are alone insufficient to derail the nuclear renaissance. At the same time, like Gartzke, he warns that the future may not necessarily resemble the past, and he encourages policy makers to remain vigilant in guarding against the strategic risks stemming from nuclear programs.

In the concluding chapter, we integrate the book's insights and distill the central conclusions. We argue that the future of nuclear power is most likely to resemble a nuclear resurgence rather than a renaissance or stagnation. In light of this projected nuclear future, we comment on the possible strategic effects of peaceful nuclear programs in the coming years and decades. We also discuss the main contributions of the book and flesh out its implications for international relations theory. The chapter ends by articulating policy recommendations for states that are considering building nuclear power plants and for countries that are interested in limiting the strategic effects of civilian nuclear development.

Notes

1. These numbers change monthly, with global reactors going on and off line for various reasons. However, the number of reactors in operation may change significantly for Japan and Germany in the near to midterm future.

2. Some have argued that the renaissance will lead to proliferation (e.g., Fuhrmann 2009b, 2012b), but the chapters in Part II of the book expose an important debate on this issue.

References

- Blake, E. M. 2012. "The Year Ahead: This Time for Sure?" *Nuclear News* 55 (1): 44–49.
- Bodansky, David. 2004. *Nuclear Energy Principles, Practices, and Prospects*. New York: Springer.
- Braun, Chaim, and Christopher F. Chyba. 2004. "Proliferation Rings: New Challenges to the Nuclear Nonproliferation Regime." *International Security* 29 (2): 5–49.
- Bueno de Mesquita, Bruce. 2009. *The Predictioneer's Game: Using the Logic of Brazen Self-Interest to See and Shape the Future*. New York: Random House.
- Early, Bryan R., Matthew Fuhrmann, and Quan Li. n.d. "Atoms for Terror? Nuclear Programs and Non-Catastrophic Nuclear and Radiological Terrorism." *British Journal of Political Science*, forthcoming.
- Economist Intelligence Unit. 2011. "The Future of Nuclear Energy: One Step Back, Two Steps Forward." *A Special Report of the Economist Intelligence Unit*, June.
- Ferguson, Charles. 2011. *Nuclear Energy: What Everyone Needs to Know*. New York: Oxford University Press.
- Findlay, Trevor. 2011. *Nuclear Energy and Global Governance: Ensuring Safety, Security, and Non-Proliferation*. London: Routledge.
- Fitzpatrick, Mark, Ed. 2009. *Preventing Nuclear Dangers in Southeast Asia and Australasia*. London: International Institute for Strategic Studies.
- Fuhrmann, Matthew. 2009a. "Taking a Walk on the Supply Side: The Determinants of Civilian Nuclear Cooperation." *Journal of Conflict Resolution* 53 (2): 181–208.
- . 2009b. "Spreading Temptation: Proliferation and Peaceful Nuclear Cooperation Agreements." *International Security* 34 (1): 7–41.
- . 2012a. "Splitting Atoms: Why Do Countries Build Nuclear Power Plants?" *International Interactions* 38 (1): 29–57.
- . 2012b. *Atomic Assistance: How "Atoms for Peace" Programs Cause Nuclear Insecurity*. Ithaca, NY: Cornell University Press.
- Glaser, Alexander. 2009. "Internationalization of the Nuclear Fuel Cycle." International Commission on Nuclear Non-proliferation and Disarmament, *ICNND Research Paper*, No. 9. February.
- . 2011. "After the Nuclear Renaissance: The Age of Discovery." *Bulletin of the Atomic Scientists*. March 17. Available at: <http://www.thebulletin.org/print/web-edition/op-eds/after-the-nuclear-renaissance>.
- Holt, Mark, and Anthony Andrews. 2007. *Nuclear Power Plants: Vulnerability to Terrorist Attack*. Washington, DC: Congressional Research Service.
- Hymans, Jacques E. C. 2006. *The Psychology of Nuclear Proliferation: Identity, Emotions, and Foreign Policy*. New York: Cambridge University Press.
- IAEA (International Atomic Energy Agency). 2009a. *Energy, Electricity and Nuclear Power Estimates for the Period up to 2030*. Vienna: IAEA.
- . 2010b. *International Status and Prospects for Nuclear Power*. Vienna: IAEA.
- Kroenig, Matthew. 2009a. "Exporting the Bomb: Why States Provide Sensitive Nuclear Assistance." *American Political Science Review* 103 (1): 113–133.

- . 2009b. "Importing the Bomb: Sensitive Nuclear Assistance and Nuclear Proliferation." *Journal of Conflict Resolution* 53 (2): 161–180.
- Malley, Michael S., and Tanya Ogilvie-White. 2009. "Nuclear Capabilities in Southeast Asia." *The Nonproliferation Review* 16 (1): 25–45.
- MIT (Massachusetts Institute of Technology). 2003. *The Future of Nuclear Power: An Interdisciplinary Study*. Cambridge, MA: MIT.
- Miller, Steven E., and Scott D. Sagan. 2009. "Nuclear Power Without Nuclear Proliferation?" *Daedalus* 138 (4): 7–18.
- Montgomery, Alexander H. 2005. "Ringing in Proliferation: How to Dismantle an Atomic Bomb Network." *International Security* 30 (2): 153–187.
- Poneman, Daniel. 1982. *Nuclear Power in the Developing World*. London: George Allen & Unwin.
- Potter, William, and Gaukhar Mukhatzhanova. Eds. 2010. *Forecasting Nuclear Proliferation in the 21st Century*. Palo Alto, CA: Stanford University Press.
- Rublee, Maria Rost. 2009. *Nonproliferation Norms: Why States Choose Nuclear Restraint*. Athens: University of Georgia Press.
- Sagan, Scott. Ed. 2009. *Inside Nuclear South Asia*. Stanford, CA: Stanford University Press.
- Solingen, Etel. 2007. *Nuclear Logics: Contrasting Paths in East Asia and the Middle East*. Princeton, NJ: Princeton University Press.
- Squassoni, Sharon. 2009. *Nuclear Energy: Rebirth or Resuscitation?* Washington, DC: Carnegie Endowment for International Peace.
- Tertrais, Bruno. 2009. "The Middle East's Next Nuclear State." *Strategic Insights* 8 (1).
- WNA. 2012. *World Nuclear Power Reactors & Uranium Requirements*. Available at: <http://www.world-nuclear.org/info/reactors.html>.