Stanton Nuclear Security Fellows Seminar

PANEL 2: Nuclear Weapons Policies and Strategies

1. Anne Stickells, CEIP

Technology and U.S. Nuclear Policy: Understanding the Role of External Variables on the Interplay of Technology and Nuclear Strategy

On what nuclear security issue are you working and why is it important?
My dissertation seeks to clarify the interplay between technology and nuclear strategy. Specifically, I study the development of solid propellants and their incorporation onto U.S. ballistic missiles—leading to shifts in the U.S.'s understanding of survivability and promptness — in order to explain the conditions under which specific technologies are adopted and may then enable a shift in nuclear policy.

Research on emerging technologies often focuses on identifying a technology's likely capabilities (promptness, accuracy, maneuverability, etc.), and assessing their potential impacts. However, such assessments cannot fully predict the effect of an emerging technology because technologies that have the ability to improve nuclear-weapon capabilities are not always adopted. Moreover, changes in strategy sometimes precede or lag changes in technology. My research is important because it complicates the existing capabilities-based approach.

My dissertation helps to clarify the factors that complicate the traditional capabilities-based research approach used to assess emerging technologies. In particular, I aim to identify the bureaucratic and organizational factors that help to determine whether a technology is adopted. I also study how the adoption of a technology can change leaders' understanding of—and hence enable changes in—nuclear strategy.

What is the big question that you are seeking to answer about that issue?
What external variables influence the interplay between technology and strategy, and how do they impact the technologies that ultimately have a meaningful effect on nuclear strategy?

How are you going to answer your question?
To characterize and clarify the interplay between technology and strategy, I conduct an in-depth case study on solid propellants, addressing the question – why did the United States adopt solid-fueled missiles and what effect did their adoption have on U.S. nuclear strategy? Specifically, I study their development, their deployment on the Polaris and Minuteman I missiles, and the impact these systems had on U.S. leaders' understanding of survivability and promptness in the

1960s. I examine solid propellants across four phases of their development lifecycle, with the cycles drawn from existing work on inventive activity – basic science, applied science, advanced engineering and development, and product application.[1] Studying a single technology does limit the project's generalizability, but allows for a complete and thorough analysis of the interplay between strategy and technology throughout the technology's lifecycle.

For each phase, I study the impact of external variables by testing hypotheses drawn from three structural models – interservice rivalry, intraservice rivalry, and the role of the military industrial complex – against the historical evidence. For example, in the basic science phase I test whether any U.S. military service identified solid propellants as a capability that could allow them to compete for new mission sets to study the presence of interservice rivalry. I use this type of analysis not only to assess how nuclear strategy and solid propellants interacted, but also to understand which structural lenses provide the best explanatory power for the evolving relationship between technology and strategy.

Methodologically, the dissertation combines technical analysis with theory-based historical process tracing. It traces how a technology is managed and interpreted during the various steps in its development lifecycle. By doing so, I am able to identify when specific organizational structures play a dominant role in linking strategy and technology.

What is your answer to the question you are asking?

Different organizational variables are most critical at distinct points in a technology's development lifecycle. For example, during the technology advanced engineering and development phase intraservice rivalry plays a much larger role than during the basic science stage. In contrast, the impact of the military industrial complex is much more prevalent during the basic and applied science phases than the advanced engineering and development phase.

The direction of the linkage between technology and strategy influenced by an external variable can vary. For example, a structural factor can lead to emphasis on a particular set of perceived needs based on existing strategic rationales and preferences, resulting in a technology being developed or selected for incorporation into military systems. In contrast, a structural factor can also cause a new technology to be marketed in a particular way, such as emphasizing a specific new capability to encourage a shift in existing strategy.

How does your work fit into the existing work on your subject?

This dissertation sits at the intersection of two bodies of literature: the causes of military innovation and the development of technology. Both accept that technology can be impacted by

[1] David Novick, "What Do We Mean by Research and Development?," *California Management Review* 2, no. 3 (April 1, 1960): 9–24; Paul W. Cherington, Merton Peck, and Frederic Scherer, *Organization and Research and Development Decision Making Within a Government Department*, NBER Book Chapter Series, no. c2134 (Cambridge, Mass: National Bureau of Economic Research, 1962).

and ultimately shape military strategy but address the relationship in different ways. The first seeks to understand the causes of military innovation. Within this literature, authors tend to conclude that a structural factor – such as interservice rivalry,[2] intraservice rivalry,[3] and the role of the military industrial complex [4] – helps to explain the relationship between technology and strategy. Innovation studies do not always consider technological innovation, but when it is addressed the direction of the technology/strategy interplay varies. Some authors seek to explain weapons innovation and argue that specific structural factors impact how strategy influences technological development.[5] Others argue that the impact of technology on strategy is filtered by external effects, treating technology as an independent (if weak) variable.[6] Rosen offers a unique approach, in different sections of his work studying technology as an independent and dependent variable of military innovation.[7]

The second body of literature concerns historical analyses of the development of specific military technologies.[8] These works often conclude that individual structural models are inadequate to explain a technology's adoption and impact, and will frequently assess that many different structural factors play a role in shaping the technology/strategy relationship. In addition, they often argue that technology is not an autonomous determinant of, nor dependent on politics, but is rather an aspect of the strategic process.[9] Neither field offers a framework to suggest where and when specific external variables are most likely to play a critical role in the technology/nuclear strategy relationship. My work bridges the gap between these two bodies of work, offering a potential explanation for how various factors might be brought together in a structured and more predictable pattern.

What policy implications flow from your work? What concrete recommendations can you offer to policymakers?

This project has relevance in the public policy realm, as it helps identify when and why emerging and future technologies may be incorporated into nuclear enterprises. The effects of a number of

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[2] Samuel P. Huntington, "Interservice Competition and the Political Roles of the Armed Services," *The American Political Science Review* 55, no. 1 (1961): 40–52; Michael H. Armacost, *The Politics of Weapons Innovation: The Thor-Jupiter Controversy* (New York: Columbia University Press, 1969).

[3] Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military* (Cornell University Press, 1991).

[4] Mary Kaldor, *The Baroque Arsenal* (New York: Hill and Wang, 1981).

[5] Armacost, *The Politics of Weapons Innovation*.

[6] Barry Posen, *The Sources of Military Doctrine: France, Britain, and Germany between the World Wars*, Cornell Studies in Security Affairs (Ithaca: Cornell University Press, 1984).

[7] Rosen, *Winning the Next War*.

[8] Donald A. MacKenzie, *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance* (Cambridge, Mass.: MIT Press, 2001); Edmund Beard, *Developing the ICBM: A Study in Bureaucratic Politics* (New York: Columbia University Press, 1976); Harvey M. Sapolsky, *The Polaris System Development; Bureaucratic and Programmatic Success in Government* (Cambridge, Mass: Harvard University Press, 1972).

[9] MacKenzie, *Inventing Accuracy*, 412.

technologies, including hypersonic missiles, quantum sensing and navigation, and artificial intelligence, on nuclear strategy are currently being debated. My work emphasizes the full range of factors—including but not limited to capabilities—that must be considered. For example, my tentative conclusion would suggest that because quantum precision is still in the applied science phase, interservice rivalry issues are unlikely to lead the technology to be connected to strategy at this time. Instead, issues related to the military industrial complex are more likely to help develop a linkage.

What do you think is the weakest or most vulnerable aspect of your study and what sort of feedback would be most useful to you?

While I believe my research on the history of solid propellants offers useful insight into the relationship between technology and nuclear strategy, I recognize that there are limitations to studying a single technology. Solid propellants were incorporated into several different missiles managed by different military branches between 1955 and 1962, which allows me to study multiple examples of incorporation of a single technology. However, focusing on a single technology means that unique features of the time period are likely to impact my conclusions. In addition, research on other technologies would be needed to confirm that my conclusions are generalizable.

I welcome all feedback but am particularly interested in discussions regarding how to apply the results of this research to issues regarding emerging technologies today.

2. Sarah Bidgood, MIT SSP

Cold War Nuclear Crises and Their Impact on U.S.-Soviet Arms Control

Despite their enduring rivalries, the United States and Soviet Union/Russia have often found ways to cooperate to reduce the risks posed by nuclear weapons.[10] Between 1963 and 2010, for example, they implemented more than a dozen measures designed to halt the arms race, ranging from legally binding treaties with intrusive verification protocols (e.g., the 1987 Intermediate-range Nuclear Forces Treaty) to voluntary unilateral steps that the two sides took in parallel (e.g., the 1991-1992 Presidential Nuclear Initiatives). This track record raises intriguing questions about the factors that drive and inhibit nuclear arms control between adversaries. These questions merit further study now at a time when the future of U.S.-Russia relations and arms control is far from certain.

The conventional wisdom among both practitioners and scholars is that Cold War nuclear crises forced Washington and Moscow to engage in arms control by bringing them to the brink of thermonuclear war. As Russian academician Alexei Arbatov has written, for instance, "It took a series of dangerous nuclear crises …for the Soviet Union and the United States to realize the dangers they faced and the need for practical steps to prevent a global catastrophe."[11] On the surface, this characterization appears to be correct: in the five years after Cuban Missile Crisis, for instance, the United States and Soviet Union went from having virtually no arms control agreements in place to concluding the Hotline Agreement, the Limited Test Ban Treaty, and the Outer Space Treaty. Similarly, in the aftermath of another nuclear crisis—the Able Archer-83 command post exercise/Soviet war scare—the 1987 Intermediate-range Nuclear Forces treaty was concluded and significant progress was made on the Strategic Arms Reduction Treaty.

A closer look at this historical record suggests, however, that there is more to the story than meets the eye. It shows that the size of both the U.S. and Soviet strategic arsenals grew after these crises, undermining the idea that fear of nuclear war led leaders on either side to practice greater nuclear restraint. It also reveals that, five months after the Cuban Missile Crisis ended, nuclear test ban treaty talks were on the brink of collapse. Likewise, in the two months that followed the 1983 Able Archer command post exercise, the USSR walked out of INF treaty negotiations and suspended talks on START.

The historical record also points to instances when nuclear crises have not had an obvious impact on bilateral arms control. These include the October 1973 Arab-Israeli war, which culminated with

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[10] Avis Bohlen, "The Rise and Fall of Arms Control," *Survival* Vol. 45, No. 3 (2003), p. 8

[11] Alexei Arbatov. "An Unnoticed Crisis: The End of History for Nuclear Arms Control?" (Moscow: Carnegie Moscow Center, 2015), p. 5

Henry Kissinger—on behalf of Richard Nixon—raising the alert level of U.S. forces to DEFCON III in an effort to deter Soviet leader Leonid Brezhnev from intervening on the ground.[12] Although Washington and Moscow did sign the 1974 Threshold Test Ban Treaty the year after this nuclear crisis took place, the two sides were unable to ratify it until 1990. As national security expert Melvin Goodman asserts, this conflict seems to have done "great harm to détente" and represented "a great setback to Soviet-American relations."[13]

Together, these discrepancies call for a clearer understanding of the relationship between nuclear crises and arms control than existing work supports. My dissertation aims to fill this gap through a systematic examination of the following question: Is the conventional wisdom that Cold War nuclear crises drove Washington and Moscow to negotiate by bringing them to the brink of thermonuclear war supported by empirical evidence? To do so, it presents a comparative analysis of three nuclear crises and their impact of U.S. leaders' approach to arms control with the Soviet Union in their aftermath: the Cuban missile crisis, the 1973 Arab-Israeli War/DEFCON III alert, and the 1983 Able Archer exercise/Soviet war scare. While each of these events fits the definition of a nuclear crisis that Mark Bell and Julia Macdonald use in their work, they represent different models of crisis that they articulate in their typology, allowing for insights into the differentiated impact of specific crisis types on subsequent arms control outcomes. [14]

To examine my cases, I apply a unique analytical framework rooted in the literature on counterfactual thinking, "wakeup calls," and the circumstances under which individuals change their behavior following near-miss events. [15] Although this body of cognitive psychology research has been largely ignored in scholarship on nuclear decision-making, researchers in other areas have used it effectively to understand how individuals and organizations behave following close calls in civil aviation, automotive transportation, and space exploration, among other sectors. [16] This literature points to four criteria that must be met in order for the conventional wisdom in this field, and the assumptions that underly it, to be true, namely: (1) The leader in question must believe that the close call in question *almost resulted in a worse outcome*—nuclear use—than what actually transpired; (2) These beliefs about worse, alternative outcomes must be accompanied by a *strong negative emotional response* such as fear or anxiety; (3) Leaders must

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[12] Among the most complete discussions of this crisis appears in Yaacov Bar-Siman-Tov, "The Arab-Israeli War of October 1973," in Alexander George, ed., *Avoiding War: Problems of Crisis Management* (Boulder: Westview Press, 1991), pp. 342-367

[13] Richard Parker, ed., *The October War: A Retrospective* (Gainesville: The University Press of Florida, 2001) p. 199

[14]. See Mark Bell and Julia Macdonald, "How to think about nuclear crises," *Texas National Security Review,* Vol. 2 Issue 2 (February 2019), pp. 41-64

[15] Matthew McMullen and Keith Markman. "Downward Counterfactuals and Motivation: The Wake-Up Call and the Pangloss Effect," *PSPR,* Vol. 26, No. 5 (2000), pp. 575-584

[16] Michael Morris and Paul Moore, "The Lessons We (Don't) Learn: Counterfactual Thinking and Organizational Accountability after a Close Call" *Administrative Science Quarterly* Vol. 45, Issue 4 (2000), pp. 737-765.

assume that *other, similar close calls will happen in the future*, possibly with less sanguine outcomes; and (4) Leaders must believe that *arms control agreements are the right approach* to prevent these events from occurring in the future. Using extensive archival research, process-tracing, and interviews, I examine U.S. leaders' perceptions of the risk of nuclear use in these three crises; their emotional responses to them; their views about the probability of other, similar nuclear crises occurring in the future; and their approach to nuclear arms control before and after they took place to determine whether these criteria were met.

Through the method of structured, focused comparison, I find that none of the three cases—including the canonical case of the Cuban Missile Crisis—satisfied all four of the criteria outlined above. These results indicate that the conventional wisdom about the relationship between nuclear crises and arms control is not supported empirically and is of little value in predicting what may transpire after other nuclear crises in the future. Although my findings do support the view that nuclear crises have helped arms control succeed in some instances—such as by creating bureaucratic-political environments where institutional advocates can effectively promote arms control objectives —they also show that what leaders believed about the utility of arms control agreements *prior* to nuclear crises had a significant bearing on whether they pursue them once a crisis was resolved. Further, and in line with prior research on nuclear learning, they indicate that leaders who felt they successfully resolved a nuclear crisis—namely, by forcing their adversaries to back down—typically did not change their approach to managing nuclear danger in its aftermath. Together, these findings contribute to answering a bigger question in International Relations, namely: does the fear of nuclear use drive or inhibit nuclear diplomacy between Washington and Moscow?[17] They also allow for a clearer assessment of the merits and deficiencies of the nuclear learning argument which—as Mark Bell and Nicholas Miller note—"has rarely been subjected to direct critique" despite its ubiquity.[18]

Although my project is historical in nature, the insights I derive are particularly relevant today in the aftermath of Russia's invasion of Ukraine. Indeed, while some experts have suggested that the war and its attendant risk of nuclear use could precipitate a revival of bilateral arms control by underscoring the ongoing dangers posed by nuclear weapons, my findings show that this assumption should not be treated as a foregone conclusion or the basis for policy. Instead, my research suggests that scholars and policymakers should be prepared for a return to what Heather Williams calls an arms control "dark ages" by exploring alternative approaches to managing nuclear risks including unilateral measures.[19] I would particularly appreciate feedback regarding

[17] Joseph Nye outlined the two sides of this debate in the winter of 1989. See Joseph Nye. "Arms Control After the Cold War," *Foreign Affairs* Winter 1989, Vol. 68, No. 5, p 42.
[18] Mark Bell and Nicholas Miller, "The Limits of Nuclear Learning in the New Nuclear Age," in Vipin Narang and Scott Sagan, eds. *The Fragile Balance of Terror* (Ithaca, NY: Cornell University Press, 2023), p. 210
[19] Heather Williams, "How to Avoid the Dark Ages of Arms Control," *Foreign Policy,* April 1, 2022.

other policy implications that flow from my research and the expertise of the mentors in considering the strategies it could inform.

3. Justin Canfil, CFR

Future-Proof Arms Control: Success and Failure in the Quest to Engineer Against Creativity

Issue. Pundits and policymakers routinely lament how arms control, like any other legal institution, cannot keep pace with the unprecedented speed of technological change [1, 2]. Traditionally, arms control has been viewed as a viable strategy for mitigating disruptions to the status quo, offering a less risky and cost-effective alternative to arms racing. This is why arms control was seen by many—even deterrence proponents—as indispensable for nuclear security during and after the Cold War. However, even as the US, Russia, China, and others embark on a 21st-century arms race in all but name [3–10], arms control has increasingly fallen out of favor in the eyes of American political elites. On its face, this might seem puzzling: for a country already in the lead, why run a race—especially one you might lose?

Question. Like virtually all interstate contracts, arms control agreements are codified in writing. But text remains fixed, even as technology changes. Even before the ink has dried, adversaries may look to technology as a way to circumvent the rules. A classic example is the Washington Naval Treaty, which imposed specific limits on cruiser tonnage in 1922. Shortly thereafter, countries began developing "tinclad" cruisers that combined maximum firepower with lighter armor enabled by newer advances in metallurgy. Today, there is also concern that an adversary might leverage technology to circumvent its obligations.

Yet such examples are the exception, not the rule. In many cases, status quo powers decline opportunities to allege noncompliance when rising powers innovate. In others, would-be adopters are persuaded to shelve their innovations when weaker states complain. While individual examples may have case-specific explanations, international relations theory still cannot account for why noncompliance allegations do not correlate with changes to the balance of power [see Figure 1]. My book project advances a general theory of the conditions under which new technologies become subject to international regulation.

Research Plan. The project is based on significant research previously completed for my PhD dissertation. To test my argument, I relied on a three-pronged empirical approach involving experiments, text analyses, and deep case study research using primary source materials in the US and UK. An experimental approach uses randomization to control for potential confounders, typically at the cost of external validity. My approach differs from conventional experiments in two ways. First, I target national security professionals directly, boosting (although not guaranteeing) external validity. Second, I rely on qualitative output—long-form text—as a dependent variable.

I also triangulate experimental findings with richer, multimethod research into 16 real-world historical cases. Cases are selected in such a way that they maximize variation in the independent variable, consistent with best practices [11]. I then carefully separate them into sections according to the degree to which political decisionmakers were aware of technological concepts early on, or surprised by their nuclear applications at some point after they reached the point of feasibility.

Techniques from machine learning for measuring and comparing differences in text are then employed in both the experiments and cases.

My plan for the fellowship year is threefold. My first objective will be to convert my dissertation into a book manuscript by completely rewrite my introduction, theory, and case study chapters. I anticipate reframing efforts will take considerable work, given that I am targeting two audiences who do not usually cross-cite:

(a) arms control and security studies scholars and (b) international law scholars. I will also need to update the chapters to include newer work that appeared after my dissertation was published [eg. 12–16].

Second, before completing the book, I anticipate a need to field more "qualitative" experiments on national security practitioners. The first experiment tested how national security lawyers tend to view the legality of new technologies as technological attributes, treaty language, and political directives are varied. More research is needed to understand the conditions under which political decisionmakers will actually *listen* to legal advice, especially when it conflicts with national security demands or counterarguments from other agencies with competing interests. I plan to include other kinds of national security practitioners in the next wave, mainly by relying on PME contacts and LinkedIn targeting. Ideally, I would also conduct further archival research. I expect the qualify of these chapters, and especially the conclusion, will benefit enormously from the reservoir of expertise at my host institution, the Council on Foreign Relations (CFR). I plan to approach publishers by the fall of 2024, after the last research component is completed.

The Project. Drawing on interdisciplinary insights from linguistics and psychology, my book argues that the likelihood of stopping new arms races before they occur hinges less on the particulars of certain technologies, and more on underappreciated tradeoffs between what I call *adaptability* and *coherence* in treaty language. Coherent obligations discourage cheating through the use of highly specific language, which limits interpretative discretion. A side effect is that it also limits states' ability to argue it applies to novel situations. This may not pose problems when an adversary's next steps are predictable. However, these choices can have warped consequences in environments where technological surprise is likely.

States frequently engineer arms control agreements to subtly favor their own strengths, crafting terms that tacitly exempt their own advanced capabilities while stringently limiting the specific capabilities at which their adversaries are known to excel [16, 17]. As I show, however, by attempting to "game" treaty language, yesterday's negotiators often mistakenly handcuff their successors to unsuitable interpretations. These mistakes can force hard choices between maximizing security on the one hand, or salvaging international credibility on the other. Moreover, in contrast to concerns about how "ambiguous" arms control language—*incoherent* obligations—will encourage cheating [18–22], I find that technology first-movers can be persuaded to favor legitimacy, even at the cost of security.

Agreements that successfully anticipate all future contingencies are rare, for reasons the book also explains. In the event of technological surprise, states must decide whether their agreements can be informally adapted or must be formally updated. While generalizations are prone to

contestation, formal updates are an especially high bar [23] since states that stand to gain from technological change can simplfy opt out. Thus, the adaptability-coherence tradeoff functionally determines the range of "braking" options states have when confronted with harmful technological surprises for arms control agreements that are already in force. The book discusses how states craft imaginative legal arguments aimed at pressuring technological first-movers into compliance, even when the relevant frameworks did not explicitly address the technologies in question—sometimes by targeting the adversary's sense of credibility directly, and at other times, by appealing to international sentiment. However, the efficacy of legal maneuvering reaches its limits in regimes where coherence was prized above adaptability.

Scholarly Contributions. Part of the problem is that scholars of international institutions, concerned with the effects of treaty design on state behavior, work in relative isolation from theories of international security and arms control. While security studies scholars have imported extensive crossdisciplinary insights from psychology, the study of psycholinguistics has until recently eluded attention in political science [24]. As a result, few if any have offered a theory about how textual specificity might *interact* with technological novelty [see Figure 1]. My book attempts to bridge this gap.

Beyond bridging two parallel literatures in the study of international security and international institutions, the book can also help explain why past administrations have prioritized coherence at the expense of adaptability, shedding light on the downstream consequences of "competitive" approaches to arms control [16, 17]. In addition, it joins an emerging literature on the the recursive relationship between international legal norms, discourse power, and technology [14, 15, 19, 25–32].

Policy Implications. US adversaries have increasingly demonstrated their interest in exotic weapons concepts, and have been unafraid to brandish their accomplishments [see eg. 33]. However, even if there were sufficient political appetite in the US for updating and expanding the existing set of arms control frameworks, rising powers like China have shown little interest in coming to the table. Instead of offering concessions, the US government has also doubled down on emerging technologies, including hypersonics, robotics, and artificial intelligence (AI), all of which could affect the strategic balance.

Instead, my theory points to underappreciated ways in which the arms control regimes we already have—or any we might still be lucky enough to get, given the current environment—can be effectively harnessed for tomorrow's technology challenges. In some cases, decisionmakers might *want* the agreements they craft to promote maximum compliance today but fail tomorrow. But decisions to race should be based on calculations about how it would benefit the national interest and international security—not because of the belief that there is no other option.

The empirical content of the book is primarily historical, showing how the US, Soviet Union, and other states contested emerging military technologies by navigating and manipulating treaty interpretations. Notably, however, the cases demonstrate how technological adventurism was effectively constrained when—much like today—geopolitical rivalry was at its most intense, the technologies in question posed a dual-use dilemma, and verification was deemed impossible.

Takeaways should focus on what the past cannot teach us, as well as what it can. For example, in contrast to widespread beliefs about why the Soviet Union favored more general arms control language, the book suggests an alternative explanation: as a technological second-mover with good strategic foresight [34], Moscow may have been more interested in using *adaptability* to constrain US innovations than in exploiting a lack of coherence for itself. To what extent might this explain China's negotiating posture, today?

Another possible implication of the theory, along with data I present on the specificity of arms control agreements since 1850 [see Figure 1], is related to the broad decline in faith in arms control since the 2000s [35]. If the book is correct that a tradeoff exists between coherence and adaptability, it is conceivable that the push to make international law and arms control more specific and more enumerative in recent years—especially as the pace of technology has quickened—has contributed to a self-fulfilling prophecy about how such institutions are destined to lag behind.

Weak Points. My main concern is coming up with a suitable framing for the book. While I intend to submit it as a work of international security, I am drawing on two literatures (international security and international institutions). The argument of my book is that we can detect a constraining effect in international law even when there are material incentives to defect. Plainly, I will need to convince the international security audience that, despite our instincts, words matter—hence government efforts to tailor.

Second is a question of scope. While the introduction and conclusion will discuss what makes 21st century technologies different, a compounding fact is that the arms control landscape is much *thinner* (fewer agreements) and *harder* (more specific agreements) than at any point since perhaps 1963 [36–38]: few agreements are still in force and most are highly coherent (and therefore less adaptable).

A third, vital factor is the rise of China [39]. In recent years, China's leadership has stressed the importance of bolstering its international legal capacity [40] alongside its newfound technological prowess [41]. How China's leadership interprets any arms control commitments China has made, or might make, is likely influenced by the special role played by lawyers in the Chinese government hierarchy [42, 43] *or* peculiarities of the Chinese translation. Research in China could help shed light on how China's growing legal capacity has influenced its approach to weapons governance and nuclear arms control [see 44].[1]

[1]After the fellowship, I plan to spend up to six months at Peking University conducting historical research on China's approach to nuclear negotiations through the early 2000s. I have also applied for a Stanton Nuclear Security Grant in 2025, which, if awarded, would be used to fund this experimental and archival research in China.

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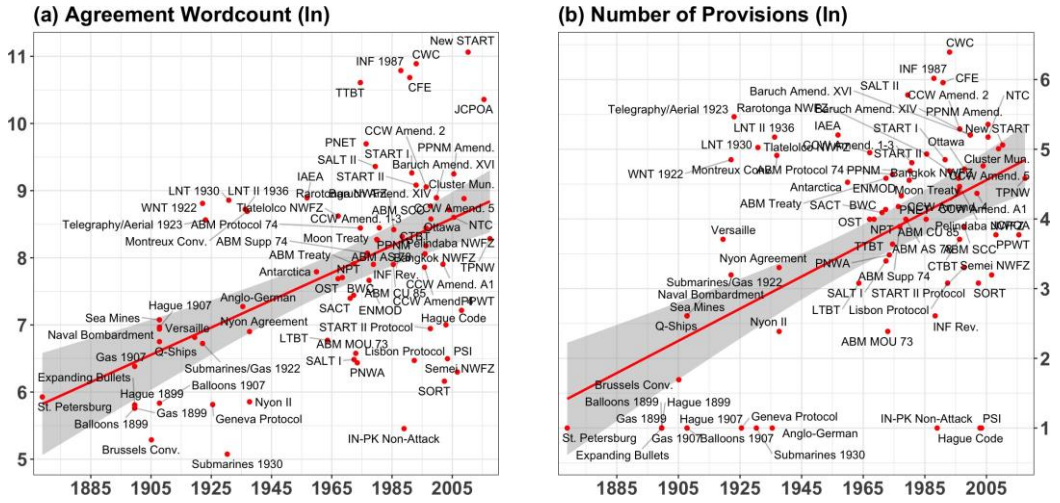
Table 1: Dominant explanations for how law and technology interact

		Technology	Specificity
IR Literature	**Security Institutions Literature**	Opens loopholes ✓	✗
Theory of the Book:		✗	Closes loopholes ✓
		Presents *motives* ✓	Offers *means* ✓

Table 1 describes the null predictions of two literatures, international security and political institutions, on questions about how technology can impact international law and arms control. Because each literature traditionally emphasizes the role of one variable—technology or linguistic specificity, respectively—they can only explain success or failure cases, but not both. By interacting technology and language, and especially by deepening our understanding of the the microfoundations of specificity by drawing on theory from linguistics, the book provides an interactive theory: while technological change may provide a motive to evade existing agreements, only some preexisting linguistic configurations can offer the means to do so.

Figure 1: Rising specificity of arms control agreements since 1850 AD



Note: Arms control agreements plotted across time. LEFT: log wordcount. RIGHT: log number of distinct provisions. The relationship is robust to a variety of measurement schemes (for example, reading ease and DIMI scores).

Figure 1 plots arms control agreements over time according to their specificity.[2] When plotted, we can see that these have indeed gotten more detailed over time—mirroring broader trends in international law since the 1970s [46]. If the theory is correct, then the increasing specificity of arms control language may contribute to the ossification of arms control agreements over time as the pace of technology increases.

[2]Though there are now more sophisticated methods, one of the classic ways political scientists have measured regulatory specificity is by a simple wordcount (by assumption, longer documents are more detailed) [45]. A section of my book discusses improved ways of conceptualizing specificity.