

Nuclear “Pork” Revisited: Organizational Imperatives and Nuclear Weapon Program

Abandonment

by

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Abstract

Since 1941 at least 30 countries have conducted nuclear weapon activities. Over two-thirds of those countries have abandoned their nuclear weapon activities as a matter of policy, making nuclear abandonment the dominant historical tendency. Understanding why countries abandon their nuclear weapon activities holds the promise of allowing policy makers to improve efforts to control the spread of nuclear arms around the world.

This dissertation offers a novel explanation for nuclear abandonment. It draws from the literature about bureaucracy and foreign policy to argue that the narrow imperatives of the organizations that conduct nuclear weapon activities can actually make nuclear weapon program abandonment more – rather than less – likely. This stands in stark contrast to the conventional wisdom about bureaucratic imperatives and nuclear weapons, which is that bureaucratic organizations, such as nuclear science agencies and militaries, push governments to acquire nuclear arms. In contrast to that prevailing wisdom, this thesis explains why some of the organizations that governments have charged with executing national nuclear weapon policies face weak incentives to act as nuclear bomb lobbyists. Thus, bureaucratic or organizational imperatives do not only work in favour of nuclear proliferation. They can also work in favour of nuclear abandonment by contributing to a policy environment that makes nuclear abandonment more likely.

While there are many explanations for why countries abandon their nuclear weapon activities, most explanations are only substantiated by small, non-random data samples. This dissertation offers a generalizable and probabilistic explanation for nuclear abandonment, and substantiates its theoretical claims with large- N multivariate regressions that use an original data set that covers approximately 670 country-year observations and that exploits natural variation in the types of organizations that have conducted nuclear weapon activities. The large- N empirics are supplemented with two case studies of nuclear weapon policy in Switzerland (1945-1988) and South Africa (1969-1993).

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LIST OF ACRONYMS

AAA – Working Committee for Nuclear Issues (Switzerland)
ADD – Agency for Defense Development
AEB – Atomic Energy Board (South Africa)
AEC – Atomic Energy Corporation (South Africa)
AEIO – Atomic Energy Organization of Iran
BARC – Bhabha Atomic Research Centre
CHF – Swiss franc
CI – confidence interval
CoW – Correlates of War
DoE – Department of Energy (United States)
DV – dependent variable
EIR – Federal Institute for Reactor Research (Switzerland)
EMD – Federal Military Department (Switzerland)
EVED – Department of Transport, Communications and Energy (Switzerland)
GDP – gross domestic product
GKO – State Defence Committee (Soviet Union)
IAEA – International Atomic Energy Agency
IAEC – Israel Atomic Energy Commission
IMF – International Monetary Fund
InAEC – Atomic Energy Commission (India)
IR – international relations
IV – independent variable
JAEC – United States Congress Joint Committee on Atomic Energy
JCPOA – Joint Comprehensive Plan of Action
KAERI – Korea Atomic Energy Research Institute
KC – Kentron Circle
LR – likelihood ratio
LVK – National Defence Commission (Switzerland)
MODAFI – Ministry of Defence and Armed Forces Logistics (Iran)
MID – militarized interstate dispute
MMMB – Ministry of Medium Machine Building (Soviet Union)
MP – Manhattan Project
MW – megawatt
MWe – megawatt, electric
NATO – North Atlantic Treaty Organization
NIC – National Identity Conception
NMC – National Material Capabilities
NPT – Treaty on the Non-Proliferation of Nuclear Weapons
NSG – Nuclear Suppliers Group
NWA – nuclear weapon activities
NNWS – Non-Nuclear Weapon State
NWS – Nuclear Weapon State
OECD – Organization for Economic Cooperation and Development
PAEC – Pakistan Atomic Energy Commission
PGU – First Main Directorate (Soviet Union)
PM – Prime Minister
PMO – Prime Minister's Office
PNE- peaceful nuclear explosive
R – South African rand
RD – Reactor Development division (South African AEB)
SADF – South African Defence Force
SKA – Study Commission for Atomic Energy (Switzerland)
SMA – simple moving average
SQ – Significant Quantity

SSSC – secure, second-strike nuclear capability
SWU – separative work unit
UKAEO – United Kingdom Atomic Energy Organization
UNGA – United Nations General Assembly
US/USA – United States/United States of America
USAEC – United States Atomic Energy Commission
USAF – United States Air Force
USD – United States dollar
USSR – Union of Soviet Socialist Republics
WEC – Weapons Exploration Committee (South Korea)
WTO – Warsaw Treaty Organization

1 Introduction - Why Do Countries End Their Nuclear Weapon Activities?

Why do states abandon their nuclear weapon programs? In other words, how and why do nuclear weapon programs end?

Understanding why countries abandon their nuclear weapon activities is a natural complement to understanding nuclear weapon proliferation: that is how and why states seek out and acquire nuclear weapons. Preventing nuclear weapon proliferation is a worthwhile policy goal, and consequentially academics and policymakers have focussed on when, why, and how states research, develop and acquire nuclear arms. Understanding nuclear weapon program onset has dominated the political science and international relations research agenda. This tendency extends to recent quantitative research looking for correlates of nuclear proliferation.¹ From general proliferation patterns, academics and policymakers make conclusions about how to dissuade states from seeking nuclear weapons, or how to stop interested parties from acquiring the knowledge, material, technical expertise and industrial capacity needed to build them.

However, only studying nuclear program onset and weapon acquisition obscures the fact that since 1945 more states have explored and abandoned the nuclear weapon option than have built nuclear weapons. This study seeks to explain some of this behaviour. Is there a pattern to why states abandon nuclear weapon programs? Or are these events not just rare, but also unique to the point that they can only be understood as individual events? Do different states abandon their nuclear weapon policies for unique or similar reasons? This thesis strives to answer those questions by offering a probabilistic and general explanation for nuclear abandonment.

¹ Sonali Singh and Christopher R. Way, "The Correlates of Nuclear Proliferation: A Quantitative Test," *Journal of Conflict Resolution* 48.6 (2004): 859-885; Dong-Joon Jo and Erik Gartzke, "Determinants of Nuclear Weapons Proliferation," *Journal of Conflict Resolution* 51.1 (2007): 167-194; Matthew Fuhrmann, "Spreading Temptation: Proliferation and Peaceful Nuclear Cooperation Agreements," *International Security* 34.1 (2009): 7-41; Matthew Kroenig, *Exporting the Bomb: Technology Transfer and the Spread of Nuclear Weapons* (Ithaca, NY: Cornell University Press, 2010), and; Philipp C. Bleek, "Does Proliferation Beget Proliferation? Why Nuclear Dominoes Rarely Fall," PhD diss., Georgetown University, 2010.

Understanding why nuclear abandonment happens has potentially significant policy implications, as an abandoned nuclear program represents one less potential nuclear-armed state. In particular, since China's 1964 nuclear weapon test, states have often designed nuclear non-proliferation policies that are geared to prevent states from acquiring the knowledge, technology, and shop-floor expertise necessary to build nuclear arms (or to verify - if a state does have some of the necessary means – that states are not conducting nuclear weapon activities).

However, once a state has launched a research and development program aimed at building nuclear explosives (but not necessarily decided to use this program to build deliverable weapons), these sorts of non-proliferation policies have already failed to a degree. States may take further action to deny other countries the hardware and material necessary to weaponize the outcomes of a research program, or political, economic, or military sanctions can be applied in order to dissuade a state from continuing its efforts. However, if a state has determined – as a matter of policy – that acquiring a nuclear capacity is necessary for its security, prestige, or to achieve some other goal, it may be difficult to dissuade them from proliferating via technology denial alone. In some cases, aggressive counter proliferation policy may have the opposite of its intended effect: take, for example, Operation Opera, during which on 7 June 1981, the Israeli Air Force bombed Iraq's Osirak reactor complex. Not only did Israel's effort fail to dissuade Saddam Hussein from considering acquiring nuclear weapons, but some analysts suggest that Israel's attack encouraged Hussein to accelerate Iraq's effort to build a nuclear bomb. According to several accounts of Iraq's nuclear history, in Baghdad's eyes, the Osirak attack was proof that Israel was hostile to Iraq, and Iraqi leadership concluded that Israel would not dare strike at them

if they had a nuclear deterrent.² Better understanding why states abandon nuclear programs may offer policymakers ideas and insight into how to craft more effective non-proliferation policies.

This dissertation offers a novel explanation for nuclear abandonment. It draws from the literature about the role of bureaucratic interests in developing foreign policy to argue that the narrow imperatives of the organizations that conduct nuclear weapon activities can actually make nuclear weapon program abandonment more – rather than less – likely. This stands in stark contrast to the conventional wisdom about bureaucratic imperatives and nuclear weapons, which is that bureaucratic organizations, such as nuclear science agencies and militaries, push governments to acquire nuclear arms. Scott Sagan has referred to this as the “nuclear pork and parochial interests” explanation for nuclear weapon proliferation.³

In contrast to that prevailing wisdom, this thesis lays out an argument for why some of the organizations that governments have charged with executing national nuclear weapon policies have faced weak incentives to act as nuclear bomb lobbyists. When the organizations responsible for nuclear weapons development are not solely dedicated to that task – such as when they have competing priorities that may be compromised by the pursuit of nuclear weapons – those organizations may decide to deprioritize their nuclear efforts and be relatively amenable to plans (e.g. by the executive branch) to end the state’s nuclear weapon activities. Thus, bureaucratic or organizational imperatives need not only work in favour of nuclear proliferation. They can also work in favour of nuclear abandonment.

² Joseph Cirincione, Jon B. Wolfsthal, and Miriam Rajkumar, *Deadly Arsenals: Nuclear, Biological, and Chemical Threats*, 2nd ed., (Washington, D.C.: Carnegie Endowment for International Peace, 2005), 338.; Målfrid Braut-Hegghammer, "Revisiting Osirak: preventive attacks and nuclear proliferation risks," *International Security* 36.1 (2011): 101-132; Hal Brands and David Palkki, "Saddam, Israel, and the bomb: nuclear alarmism justified?," *International Security* 36.1 (2011): 133-166.

³ Scott D. Sagan, "Why Do States Build Nuclear Weapons? Three Models in Search of a Bomb," *International Security* 21.3 (1996-7): 63.

This study's central claims and hypothesis are probabilistic. They are also general in nature, meaning that they apply to most (if not all) cases of nuclear abandonment.⁴ However, they are also complimentary to other explanations of nuclear abandonment, as this study assumes that nuclear abandonment, like many other social phenomena, is influenced by multiple factors. The individual effects of those factors can add up to tip the scales towards nuclear abandonment or retention. Thus, this study's explanation – that the interests and motives of a country's nuclear weapon organization can push a government towards abandonment – may be at work in most (or all) cases, but it is at work alongside other factors.

The rest of the introduction will proceed as follows: first, the introduction will offer definitions of nuclear weapon programs/nuclear weapon activities, as well as a definition of nuclear abandonment. Second, it will briefly situate this study in the larger context of scholarly work on nuclear abandonment. Third, it will introduce the concept of nuclear weapon organizations that this study uses to help explain nuclear abandonment. Fourth, it will introduce the study's central premise, goals, scope, and explain some of the study's methodological assumptions. Finally, the introduction will conclude by foreshadowing the rest of the study.

1.1 What is a Nuclear Weapon Program? What is Nuclear Abandonment?

For the purposes of this study, it is necessary to define what a nuclear weapon program is, and what nuclear weapon activities are. When this thesis uses the terms “nuclear weapon activities” or “nuclear weapon program” this thesis is referring to the activities involved in researching, designing, and assembling nuclear weapons. These activities fall across a broad

⁴ This study's proposed explanation for nuclear abandonment is probabilistic in that the explanation's key factor – the degree of specialization of a nuclear weapon program – changes the probability that a state will abandon its nuclear weapon activities. The relationship between the organization type and abandonment is not deterministic. This study's explanation is general in nature in that it is common to most (but not necessarily all) of the universe of cases of nuclear abandonment.

spectrum. These can range from basic research into the physics of nuclear fission or fusion, to producing the fissile materials that are necessary to assemble a nuclear explosive, to building and maintaining the infrastructure that a country needs to make fissile materials (such as industrial-sized enrichment and reprocessing facilities) which in turn feed the production facilities that make nuclear warheads.

Nuclear weapon activities do not include activities that could be used as part of an effort to develop nuclear weapons, but where the available literature does not clearly claim that those activities were in fact intended to be nuclear weapon activities. Therefore, Japan's large-scale fissile material production efforts are not considered to be nuclear weapon activities. Likewise, the Brazilian navy's project to develop uranium centrifuges in the 1980s is not considered an example of nuclear weapon activities since the academic and policy literature tends to strongly conclude that the project was aimed at developing nuclear naval reactors, rather than weapons. On the other hand, the literature agrees that the Brazilian air force's nuclear activities during that same decade were aimed – at least in part – at developing a nuclear weapon. So for example, this thesis treats the Brazilian air force's activities as nuclear weapon activities, but it does not consider the Brazilian navy's activities to be weapon activities.

1.1.1 Nuclear Weapon Activities and "Paper Studies"

This thesis treats "paper studies," which are largely planning exercises, as nuclear weapon activities. This is because in theory (and to an extent in practice), a state can make a decision to undertake a nuclear weapon program without first achieving all the technical, economic, and political requirements first.

Take, for example, West Germany, which developed concrete plans to partner with France and Italy in the late 1950s to build nuclear weapons. Germany's actual military nuclear

program was practically non-existent in the sense that there was no organization dedicated to the task, and little in the way of laboratories or workshops assigned to the project, but at the highest political levels there was a decision and a plan to acquire nuclear arms. Similarly, for a period of time the Swiss government had plans to acquire nuclear arms, but did little in the way of making any investments in the necessary technology and infrastructure to do so. In both cases there is a strong case for treating these countries as “pursuing” nuclear weapons, since policymakers made a decision to try to acquire nuclear weapons, even if the necessary physical infrastructure and human resources were lacking. Accordingly, this study treats so-called “paper studies” as nuclear weapon activities.

This definition of nuclear weapon activities that includes paper studies can be critiqued in at least two specific ways. The first critique is that it is too broad to be useful, and captures too many states. Second, it uses an arbitrarily low threshold to define nuclear weapons activity, and that simple planning exercises are irrelevant, especially when discussing cases like the South African, Iraqi, and Iranian nuclear weapon programs, which were well advanced by the time their governments ended them. In essence, states that are making fissile material, designing weapons, and contemplating building delivery systems cannot be meaningfully compared to Germany or Australia’s plans to build nuclear weapons. Neither of these critiques ultimately have much merit. The first critique is simply incorrect: even if we use this relatively broad definition of nuclear weapon activities, only thirty-some countries qualify as having nuclear weapon activities after 1946 (see Table 1.1).⁵ This is a significant, but not particularly large, number of states.

⁵ The precise number of states that have conducted nuclear weapon activities after 1946 varies according to the burden of proof that an analyst requires before concluding that a state has conducted nuclear weapon activities. This study claims that there is strong evidence to claim 30 states have initiated and conducted nuclear weapon activities

The second critique misses an important benefit of using this broader definition of nuclear weapon activity. Specifically, counting paper programs as nuclear weapon activities helps address one of the longstanding challenges of analyzing nuclear weapons proliferation, namely the fact that government intentions are often opaque and difficult to measure, while technical capabilities (what a country could do) are usually more measurable and observable. The gap between what we can observe about a state's intentions, goals, and desires, and the relative ease at which we can measure the size of a state's armed forces, population, and economy and the basic problem this poses for analyzing foreign policy and making predictions about the future is a common theme in international relations literature. Certain strands of realist analysis, for example, assume that when it comes to matters of national security, states are risk-averse. Accordingly, since governments cannot be absolutely sure about the intentions of other states, they concern themselves with the material capabilities of other states, and from that basis infer the threat that others could pose, assuming malign intentions.⁶ States therefore see countries that have the raw capability to inflict harm, because they have a large army, navy, or air force, and the economic means to wage war or enact trade embargoes, as potentially threatening, regardless of their true intentions.

Clearly differentiating between capabilities and intent is not simply an academic problem. Raymond Garthoff has argued that the US intelligence and military communities focused on measuring Soviet military capabilities during the Cold War, to the detriment of their efforts to understand Soviet policy goals and intentions.⁷ While estimates of military capabilities are supposed to provide an objective measure of what a state is capable of doing, the problem is that

since 1946. This number does not include Belarus, Kazakhstan, and Ukraine since those three states acquired nuclear weapons due to a historical accident rather than because of their government's policy intentions.

⁶ Stephen G. Brooks, "Dueling Realisms," *International Organization* 51.3 (1997): 445-477; Robert Jervis, "Realism, Neoliberalism, and Cooperation," *International Security* 24.1 (1999): 42-62.

⁷ Raymond L. Garthoff, "On Estimating and Imputing Intentions," *International Security* 2.3 (1978): 22-32.

when analysts look at a country's capabilities, it is easy to quickly jump to identifying the worst-case scenarios that those capabilities could create. An example from the Cold War would be to look at the distribution of Warsaw Treaty Organization (WTO) military forces in Eastern Europe, and then using that data to estimate the likelihood that the WTO could successfully invade West Germany, if it decided to. This sort of analysis would implicitly ignore other possibilities, such as the likelihood that the WTO will disarm or reduce its capabilities, or the possibility that the WTO would simply not take aggressive action against NATO. In other words, focusing on capabilities can easily lead analysts to focus on what a state could do, rather than what they are most likely to do.⁸ This phenomenon afflicts analyses of national nuclear policies too, as basic nuclear technologies (such as research reactors) and knowledge quickly spread around the world from the 1950s to 1970s, giving many states some of the technology that is necessary to build nuclear arms.⁹ This sort of logic is evident in analysis that raises concerns about Japan's civilian nuclear industry. Given Japan's position as the largest plutonium producer in the world, analysts sometimes raise the possibility that the Japanese government could use its civilian nuclear assets as the core of a nuclear weapon program.¹⁰ This leads to conclusions that are really largely speculative: yes, Japan could build a nuclear weapon. The economic, engineering, and technical challenges are entirely surmountable. However, without some measure of the intention or desire

⁸ Another historical example of policy makers struggling to clearly delineate capabilities and intentions was the United Kingdom's Joint Intelligence Committee of the late 1940s, which assessed the USSR's military and industrial capacities as being substantial and potentially threatening to British interests, but remained less certain about how the Soviet government intended to use those capabilities. See Peter Hennessy, *The Secret State: Preparing for the Worst 1945-2010* (London: Penguin Books, 2010).

⁹ Stephen M. Meyer, *The Dynamics of Nuclear Proliferation* (Chicago: University of Chicago Press, 1984), 1-6.

¹⁰ See for examples, Paul L. Leventhal, "Introduction: Nuclear Power without Proliferation?" in Paul L. Leventhal, Sharon Tanzer, and Steven Dolley, eds., *Nuclear Power and the Spread of Nuclear Weapons: Can We Have One Without the Other?* (Washington, D.C.: Brassey's, 2002), 8; Kurt M. Campbell and Tsuyoshi Sunohara, "Japan: Thinking the Unthinkable," in Kurt M. Campbell, Robert J. Einhorn, and Mitchell B. Reiss, eds., *The Nuclear Tipping Point: Why States Reconsider Their Nuclear Choices* (Washington, D.C.: Brookings Institution Press, 2004): 218-253.

of the Japanese government, it is virtually impossible for an analyst to assign a meaningful probability to Japan acquiring nuclear weapons.

Clearly, the gap between our ability to measure capabilities and intentions can lead to over-predicting the likelihood that countries will acquire nuclear arms. The opposite can also be true though. If a country does not have a large civilian nuclear infrastructure, or no obvious military nuclear facilities, it is also easy to conclude that they will not (or do not want to) acquire a nuclear weapon. This can lead to the erroneous conclusion that because a state lacks the material capability to do something, it does not want to do that thing. While this is likely a less common error than predicting bad intentions on the basis of measuring capabilities alone, it does occur (e.g. many governments underestimated both the nuclear weapon intentions of the Iraqi, Libyan and North Korean governments). Classifying activities such as planning exercises – which are intended to lay the groundwork for a nuclear weapon program – as nuclear weapon activities helps reduce the likelihood of making that error. Thus, when West Germany, Australia, Italy, and Japan explored nuclear weapons or made preparations to acquire nuclear weapons at various times in the 1950s, 1960s, and 1970s, this study treats those states as having nuclear weapon activities. In all those cases (and others) the national policy was clear: there was at least a decision to investigate acquisition, or to put into motion policies that would be necessary to acquire a full-fledged nuclear weapon capability. In other words, these are cases where we have evidence of a state's intent to at least investigate the acquisition of nuclear weapons, even if its material capabilities and technical preparations were lacking.

Including these sorts of nuclear weapon activities also gives analysts more data to work with. This does not mean that it simply makes the sample size larger (which it obviously does). Instead, it means that it offers more opportunities to control for the various factors that may

influence a state's nuclear weapons policy. Ultimately, it is difficult to definitively conclude why any single state abandoned its nuclear weapon activities. For every candidate cause (e.g. another state threatened war if the first state went ahead and acquired nuclear arms), there is no counterfactual to test against. That means that if one believes that Iran has stopped its nuclear weapon activities it fears that the US and/or Israel will attack it, there is no way to know how Iran would behave if it had not been threatened by those states. The best an analyst can do is compare one country to another (or several others), controlling for as many differences between countries as possible. While this is a simple methodological point, it is an important one. Thus, using an expanded definition of nuclear weapon activity gives us more observations and therefore more opportunities to control for important cross-country variation.

Finally, it should be noted that the dataset which chapter four of this thesis uses is designed to be compatible with the datasets used in the nuclear weapon proliferation literature to the greatest practical extent. This means that some observations where the evidence does not definitively point to nuclear weapon activities – such as in Argentina during the 1980s – are included as observations of nuclear weapon activities, since they are included in practically all academic datasets on nuclear weapon activities. However, there is good reason to believe that the inclusion of these borderline cases does not strongly influence the study's overall results, since the tests reported in chapter four were repeated without these observations.

1.1.2 Nuclear Abandonment: Basic Data

In its analytically simplest form, “nuclear abandonment” refers to when a country that has built nuclear arms disarms itself of those weapons. The archetypical case of this form of abandonment (and the only country to have done so) is South Africa. However, studying only countries that successfully built nuclear weapons and then relinquished them in an effort to

understand why states abandon their nuclear weapon activities would be methodologically unsound and would ignore a large amount of potentially interesting data. First, doing so would introduce a selection bias, increasing the risk of coming to spurious conclusions about what causes (or does not cause) nuclear abandonment. While this could be remedied in part by also studying states that have not given up their nuclear weapons, this is still an unsatisfying solution, as it ignores the larger population of states that at one time or another, have conducted nuclear weapon activities (i.e. taken steps towards acquiring nuclear arms), potentially affecting the internal validity of any study's conclusions. To overcome these challenges, this study uses an expansive definition of nuclear abandonment, which is when a state disarms itself of its nuclear weapons or abandons its efforts to, research, build, acquire, or retain them. This more relaxed definition expands the universe of cases to approximately thirty cases, depending upon the burden of empirical evidence one requires to identify a state as having a nuclear weapons program.

For this study's purposes, a state's nuclear weapon activities are considered to be abandoned if the available literature indicates that there was a clear decision to stop the nuclear weapon activities, or if efforts appear to have stopped and did not in turn resume within five years. Periods of less intense activity do not constitute abandonment for the purposes of this study.¹¹ So, for example, this thesis considers India to have started nuclear weapon activities in

¹¹ Less intense, in this context, would be a situation where an organization conducting nuclear weapon activities appears as if it could have taken additional steps towards developing a nuclear weapon, but did not take them, yet did not appear to terminate all activities. For example, after India elected Morarji Desai to the prime minister's office in 1977, efforts by India's nuclear science establishment to further weaponize the 1974 Smiling Buddha device paused – or at least slowed - for a time. The available evidence, however, suggests that overall, India's nuclear weapon program was still intact, with scientists, engineers, and operators still conducting theoretical work, producing fissile materials, and at least on paper, contemplating weapon designs. See Raj Chengappa, *Weapons of Peace: The Secret Story of India's Quest to be a Nuclear Power* (New Delhi: HarperCollins Publishers, 2000), 216-230, and; George Perkovich, *India's Nuclear Bomb: The Impact on Global Proliferation* (Berkeley, CA: University of California Press, 1999), 200-205.

1964, with no interruptions, despite some periods where the government appears to have slowed work on the project.

The basic data that motivates this study is given in Table 1.1, below.

Table 1.1 Nuclear Weapon Activities, 1942-2009

<i>States That Initiated and Abandoned Nuclear Weapon Activities between 1946 and 2010 (Activity Dates in Parentheses)</i> ¹²		<i>States That Have Not Abandoned Nuclear Weapon Activities (Start Date in Parentheses)</i>
Algeria (1983-1990)	Norway (1947-1951)	China (1955)
Argentina (1968-1990)	Romania (1981-1989)	France (1954)
Australia (1956-1973)	South Africa (1969-1990)	India (1964)
Brazil (1968-1990)	South Korea (1970-1978)	Israel (1955)
Egypt (1955-1972)	Sweden (1946-1969)	North Korea (1965)
Indonesia (1958-1966)	Switzerland (1946-1988)	Pakistan (1972)
Iran (1974-1978, 1984-2009) ¹³	Syria (2002-2007) ¹⁴	Soviet Union/Russia (1943)
Iraq (1973-1991)	Taiwan (1967-1977, 1987-1988)	United Kingdom (1945)
Italy (1955-1958)	West Germany (1957-1958)	United States of America (1942)
Japan (1967-1970)	Yugoslavia (1953-1963, 1974-1987)	
Libya (1970-2003)		

As Table 1.1 shows, the vast majority of countries that had initiated nuclear weapon activities since 1945 had reversed that policy by the end of the 20th century (at approximately a 2:1 ratio). While nuclear abandonment has been the dominant historical trend, social scientists have focused on the conditions under which states successfully acquire nuclear weapons.¹⁵ The nuclear proliferation research typically (though not exclusively) treats a state's nuclear weapons activity in a binary fashion: either a state has acquired nuclear weapons, or it has not.¹⁶ This simplification is justified for identifying the conditions that are strongly associated with nuclear weapon acquisition, but the binary simplification means many analysts have failed to take

¹² Dates are approximate.

¹³ The International Atomic Energy Agency concluded in 2015 that Iran's nuclear weapon activities most likely ended sometime in 2009. See International Atomic Energy Agency, *Final Assessment on Past and Present Outstanding Issues regarding Iran's Nuclear Programme*, GOV/2015/68, 2 December 2015.

¹⁴ Syria is not included in the analyses in chapter four. The dataset used in chapter four covers the years 1950-2000.

¹⁵ For a recent and thorough summary of this voluminous research see Scott D. Sagan, "The causes of nuclear weapons proliferation," *Annual Review of Political Science* 14 (2011): 225-244.

¹⁶ An alternative approach some of these studies use is to code states on the basis of either having or not having a nuclear weapons program. Studies that use this sort of coding tend to focus on explaining nuclear weapon program onset.

advantage of the information embedded in the approximately 750 cumulative country-years of nuclear weapon activity since 1945.

There is considerable variation in the “intensity” of the nuclear activities that this study analyses. In some countries (such as Germany, Japan, and Italy) governments merely made preparations or plans to begin building fissile material facilities or begin research and development work on weapon design. In other cases (such as Brazil, Iraq, and Libya), efforts went further, as governments built facilities to manufacture fissile materials or designed weapons. South Africa famously built nuclear weapons in the 1980s, and then voluntarily relinquished them at the beginning of the next decade. As of 2016, nine countries maintain nuclear weapon arsenals, and Iran researched nuclear arms as recently as 2009. Variation in the “intensity” of a state’s may constitute an important determinant of whether a government, in a given year, ends its nuclear program. Analysts may therefore want to account for it when testing other hypotheses. This thesis addresses this issue in greater depth in chapter four and Appendix I.

1.2. What Do We Know About Nuclear Abandonment and What Does This Study Contribute?

While political scientists have examined why states abandon their nuclear weapon activities, this study makes two significant contributions to our efforts to understand nuclear abandonment. The first is methodological: the nuclear abandonment literature predominantly uses small numbers of case studies to make general claims about what causes nuclear abandonment. Making broad claims about a phenomenon on the basis of small samples is difficult, and there are reasons (as explained in chapter two) for analysts to be cautious about extrapolating findings from one or two cases into universal explanations for nuclear abandonment. This study offers a generalizable explanation for nuclear abandonment, and offers

large sample evidence that this explanation helps explain nuclear abandonment in a large number of cases.

This study's second major contribution to the literature is theoretical. The nuclear abandonment literature tends to examine nuclear abandonment using scholarly international relations (IR) paradigms. Two examples that these studies provide include the following: that states do not acquire nuclear weapons because they do not wish to threaten their neighbours and create a security dilemma, and that states refrain from acquiring nuclear arms because of a social prohibition against nuclear weapons. These two explanations fit nicely into the broad realist and constructivist camps, respectively. Another prominent argument combines liberal peace logic with the pressures of domestic politics to claim that national leaders refrain from acquiring nuclear arms to appease their supporters in order to stay in office.

This study does not adopt any of the classical academic IR paradigms (roughly speaking, realism, constructivism, liberalism, and their variants) as a foundation for its inquiry. Instead, in an effort to explain why states abandon their nuclear weapon activities, this study draws from a broad range of literature that includes the study of how government bureaucracies affect foreign policy outcomes. It then links organizational choices – namely by identifying natural variation in the type of organizations that have conducted nuclear weapon activities (i.e. specialized nuclear science organizations versus other state organizations with mandates and priorities that supersede their nuclear weapon mandate) – to the conditions under which countries are more (or less) likely to end their nuclear weapon activities. In levels-of-analysis language, this study concentrates primarily on the state-level, or more accurately, on the sub-state organizational-level. The existing literature, on the other hand, does not so much examine nuclear weapon activities, as it does the countries and the broad international political and social contexts in which these

activities occur. While international system-, state-, and program-level events and conditions all likely influence a government's decision to retain or abandon their nuclear weapon activities, this study highlights the role of program-level attributes in determining whether a state abandons its nuclear weapon activities. In other words, this study draws a direct line between the way that states have acted on their nuclear weapon policies and the likelihood that those policies were ultimately abandoned.

1.3 Three Types of Nuclear Weapon Organization

This study's argument is straightforward, but also challenges some of the prevailing wisdom about the relationship between organizational imperatives and nuclear weapons. The nuclear proliferation literature claims that organizational imperatives – namely funding requirements, bureaucrats' desire for influence over policy, and the quest for prestige that accompany a nuclear weapons program – can cause organizations within states (such as nuclear science agencies or armed forces) to become advocates for nuclear weapons, and encourage governments towards acquiring nuclear weapons. Organizational incentives, according to this line of argument, can cause states to acquire nuclear weapons.

1.3.1 Defining "Government Organization"

For the purposes of this thesis, the term "government organization" refers to the specialized divisions of a country's public service which are empowered by (and responsible to) the ruling political administration (e.g. the head of government and cabinet) to execute specific public policy tasks. In this study, government organization is not necessarily synonymous with the term "ministry," which tends to connote an organization led by a cabinet minister that manages a broad (but related) range of public policy activities. However, in some countries,

nuclear weapon organizations have taken on the dimensions and structure of what observers would typically recognize as a ministry (such as in the USSR and Russia, which this chapter covers later).

Government organizations are typically staffed by professional government employees. The major exception to this definition is the small number of cases of nuclear weapon organizations overlapping with the executive branch of government (e.g. the office of the head of government and their cabinet). In this study, government organization(s) does not refer to a country's legislature or judiciary. The thesis spells out any references to those specific government organs.

A final important element of defining government organizations is identifying clear boundaries between entities. Governments are often structured in a hierarchical manner, and specialized offices often exist to support another office. A simple hypothetical example is an accounting office inside of a foreign ministry.¹⁷ Such an accounting office exists to serve the larger organization – the ministry – and its managers report to the professional leadership of the ministry. Both the office's mandate and its managerial structure place it firmly within the boundaries of the foreign ministry. For the purposes of this study, such an office would not be considered a "government organization."

An example of an agency that does satisfy this study's definition is the South African Atomic Energy Board (AEB) and later Atomic Energy Corporation (AEC). The AEB/C was ultimately responsible to the Minister of Mineral and Energy Affairs (alternatively the Minister

¹⁷ This example is drawn from Canada's foreign ministry. Directories describing the organizational hierarchy of Canadian federal government agencies can be found at Government of Canada, *Government Electronic Directory Services (GEDS)*, < <http://sage-geds.tpsgc-pwgsc.gc.ca/en/GEDS>>.

of Mines).¹⁸ However, the AEB/AEC had its own board of governors (appointed by the cabinet) and a clearly defined mandate that did not involve the general activities of the Ministry. So while the AEB/C's management may have been ultimately politically responsible to the Minister of Mineral and Energy Affairs, the boundaries – in this case set by the AEB/C's management structure and its mandate – between it and the Ministry are clear, and treating it as a distinct government organization makes sense.

In some cases, nuclear weapon organizations have sub-contracted specific activities to other government agencies. These cases are rare, but examples include South Africa in the 1980s (where Armscor used some of the AEC's specialized services), South Korea in the early 1970s (where an office located in the Korean executive branch managed a nuclear weapon effort that involved efforts from several different departments), and in Iran in the 1990s and early 2000s, where it appears that the ministry of defence conducted weapon-specific activities, but may have been coordinating with the Atomic Energy Organization of Iran (AEOI) in order to ensure a readily available supply of fissile material. In these cases, there is a clear functional relationship between the two (or more) organizations, where one is supporting the activities and policy program of the other.

At times, this thesis uses the term “bureaucracy” interchangeably with “organization”. When this study uses the term “bureaucracy” (or any of its variants) the term is neither meant to simply refer to administrative offices, nor is it meant to be pejorative. Instead, as described in the preceding paragraphs, “bureaucracies,” at least for the purposes of this thesis can include government organizations that engage not just in administrative duties, but also in scientific research and development and even manufacturing efforts. While bureaucracies can be the sites

¹⁸ J.D.L. Moore, *South Africa and Nuclear Proliferation* (New York: Palgrave Macmillan, 1987), pp. 78-79; Atomic Energy Board (South Africa), *Nineteenth Annual Report* (Pretoria: Atomic Energy Board, 1976).

of “insider political intrigue,” this thesis does not subscribe to that connotation.¹⁹ Instead, this study takes for granted that bureaucracies are a necessary part of government, and hypothesizes that the character of those bureaucracies can affect final policy outcomes. Whether the effects of bureaucracies on policy outcomes are a good or a bad thing is beyond this study’s scope.

1.3.2 Characterizing Nuclear Weapon Organizations

This study accepts the premise that organizations within states can have their own agendas and interests that do not always align with the goals and preferences of the ruling politicians. It also accepts the premise that being in charge of a nuclear weapons program could confer some material advantages to a government organization. Where this study diverges from the preceding logic is that it offers a hypothesis and evidence that suggest that organizational imperatives do not necessarily lead to states acquiring nuclear weapons. Instead, organizational imperatives can be an important determinant of whether a state abandons its nuclear weapon activities. This is for two reasons: first, nuclear weapons and nuclear weapon research and development programs are not the only way that a government organization may promote its interests. It may be simply one option among many. The second reason is that government organizations usually have a specific mandate: they exist to perform a specific task for the government and the state. Government departments and agencies, when looking to preserve their role in government, face strong incentives to focus their financial, technological and human resources, and political influence, on their statutory mandate first, and deprioritize other goals and activities.²⁰ In the nuclear weapons realm this means that while some organizations may see

¹⁹ David A. Welch, “A Positive Science of Bureaucratic Politics?,” *Mershon International Studies Review* 42.2 (1998): 210.

²⁰ This does not mean that organizations only axiomatically pursue their statutory objectives. Organizations can, of course, pursue other goals and objectives, and there are many examples of mandate drift or “creep” among government organizations. However, it is not unreasonable to assume that organizations will typically pursue and protect their statutory objectives first, and are more likely to pursue other objectives once their core mandate and goals are secure.

a nuclear weapons program as an opportunity to increase their budget or political influence, if managing a nuclear weapons program detracts from (or interferes with) their chief mandate, they may deprioritize or neglect the nuclear mission, creating the conditions for abandonment. This thesis seeks to determine when this is likely to happen.

Specifically, this study characterizes the types of organizations that have conducted nuclear weapon activities on behalf of their governments along a single dimension, namely the degree to which conducting nuclear weapon activities is at the core of their organizational mandate. The differences among various organizations that have conducted nuclear weapon activities for their governments can be thought of as falling along a one-dimensional spectrum, with a Weberian ideal type-like construct at each end.²¹ The first ideal type is the specialized nuclear weapon organization. A specialized organization is one that has no duties other than researching, producing, and/or assembling nuclear weapons. In other words, the nuclear weapons mission is the core, fundamental reason for the organization's existence, and any other tasks the organization does are done to support its nuclear weapons mission. At the other end of the spectrum are general organizations where not only is researching/designing/producing nuclear arms not the organization's core duty, but it is simply one of many (possibly unrelated) missions that organization is undertaking. For these organizations, their nuclear weapons activities are simply one part of their mandate, and the organization does not exist in order to conduct nuclear weapon activities. This sort of organization will have some other duty which is more directly tied to its organizational mandate, or in other words, it has a core duty, and its nuclear weapons

²¹ A Weberian ideal type is an abstract heuristic device for exploring real-world phenomena. Weber described an ideal type as "formed by the one-sided accentuation of one or more points of view and by the synthesis of a great many diffuse, more or less present and occasionally absent concrete individual phenomena, which are arranged according to those one-sidedly emphasized viewpoints into a unified analytical construct." Ideal types (also called pure types) provide an abstract, exaggerated description of a real-world social phenomenon, so as to emphasize the importance of a given attribute to that phenomenon. See Max Weber, "'Objectivity' in social science and social policy," in Max Weber, ed., *The Methodology of the Social Sciences* (Glencoe, IL: The Free Press, 1904 [1949]), 49-112.

mission not only does not clearly support its core duty, but it may be incompatible with a that duty as well. In the middle, between these two extremes, is the mixed organization. Like general organizations, researching/designing/building nuclear weapons is not the mixed organization's principal duty. However, it is a relatively logical fit given its other missions (examples include research and development offices within armed forces, or arms manufacturers), and the nuclear weapon activities are an important task for the organization, but not its first priority.²²

This typology differentiates between organizations using a concept similar to what Halperin *et al.* call “organizational essence.”²³ Organizational essence is “the view held by the dominant group within the organization of what its missions and capabilities should be.”²⁴ Halperin *et al.* offer the United States Air Force (USAF) as an example to explain the concept: at its simplest: an air force's “organizational essence” is to fly aircraft in various roles that support its country's military policy. The exact nature of that essence can change at the margins. Before the Cold War, for example, Halperin *et al.* suggest that within the USAF, there was a consensus that its organizational essence was to “fly combat air missions.” As the Cold War progressed, factions of the Air Force came to believe that conducting strategic bombing missions was the USAF's essence. However, at the core of either organizational essence was still the fact that it was the Air Force's job to fly military aircraft, whether to shoot down other aircraft or to drop bombs and launch cruise missiles. While this study does not examine the perspectives and beliefs

²² Some nuclear weapon organizations have outsourced specific tasks to other government organizations and even private firms, such as in the case of the US' Manhattan Project (MP).

The MP itself hired many subcontractors that took on specific tasks, however the MP was housed and organized as part of the US Army Corps of Engineers. The parent organization was thus the Engineer Corps; one level up it would be the Department of the Army, then up one more level, the US Department of War. So while the MP might have drawn resources from other parts of the government, it was ultimately a part of the US Army Corps of Engineers. Elements of the MP, such as the Los Alamos labs, were for the duration of the MP, directly under its supervision, and part of the Engineering Corps. The nuclear weapon activities in this case are therefore treated as being housed in the US Army Corps of Engineers, and the Corps would be treated as a mixed organization.

²³ Morton H. Halperin, Priscilla A. Clapp, and Arnold Canter, *Bureaucratic Politics and Foreign Policy*, 2nd ed. (Washington, D.C.: Brookings Institution Press, 2006), 27.

²⁴ Ibid.

of individual members of nuclear weapon organizations, or explore the factions within national nuclear weapon efforts, it does differentiate among the organizations that have conducted nuclear weapon activities according to what that organization's overall mission and role within the government is.

Some examples of how various historical cases compare to one another helps clarify the concept. Close to the specialized ideal-type organization is the Soviet Union's Ministry of Medium Machine Building (MMMB), which existed from 1953 until 1989. When the Soviet government established the MMMB, its core mission was to research, design, and produce nuclear weapons, while civilian energy applications were handled by the Russian Academy of Sciences and a slew of individual laboratories.²⁵ Later, responsibility for some civilian applications (such as power generation) was handed over to a number of separate ministerial entities.²⁶ It would only be a mild exaggeration to call the MMMB a "nuclear weapon ministry."²⁷

Close to the general end of the spectrum are the early days of South Korea's nuclear weapon program. Initiated by President Park Chung Hee in the early 1970s, South Korea's nuclear weapon activities began under the auspices of the Weapons Exploitation Committee (WEC), which was composed of high ranking officials from a range of ministries and other government organizations, and was directly attached to the president's office.²⁸ Notably, rather

²⁵ C.M. Johnson, "The Russian Federation's Ministry of Atomic Energy: Programs and Developments," Pacific Northwest National Laboratory, Department of Energy, 2000, 1.

²⁶ Arnold Kramish, "Atomic Energy in the USSR," *Bulletin of the Atomic Scientists* 15.8 (1959): 322-328; Gloria Duffy, "Soviet Nuclear Exports," *International Security* 3.1 (1978): 83-111.

²⁷ The MMMB (and its successor organizations) had direct jurisdiction or owned the various weapon labs, reactors used for plutonium production, reprocessing, and enrichment facilities that together constituted the USSR's nuclear weapons program, with the MMMB researching, designing, manufacturing components (and building the necessary infrastructure to do so), and taking on final assembly of weapons, before delivering them to the armed forces. See Cochran, Norris, and Bukharin in the works cited for an overview of some of these issues.

²⁸ U.S. House of Representatives, Committee on International Relations, *Investigation of Korean-American Relations* (Washington, D.C.: U.S. Government Printing Office, 1978), 79.

than charge Korea's Atomic Energy Department (established in 1958)²⁹ with the mission of researching and developing nuclear arms, Park used his own office as the organizational basis for South Korea's nuclear weapon policy. While the Blue House eventually handed responsibility for South Korea's nuclear weapons program over to the Agency for Defense Development ((ADD), a research and development organization attached to the Ministry of National Defense), from roughly 1970 to 1974, nuclear weapon policy was managed and coordinated out of Park's office, to the point where the organization resembled a general contractor and subcontractors, with Park's office directing funding at specific projects in the ADD or the Korea Atomic Energy Research Institute (KAERI). While specific agencies had specific tasks within the Blue House program (a small number of individuals in the ADD were assigned to design a weapon, while KAERI and the Korea Nuclear Fuel Development Corporation were both given instructions to acquire the means to produce fissile material), the organization that directly administered the project was the president's office.

Comparing these two examples highlights an important difference. The MMMB was essentially a purpose-built, ministerial-level organization that existed to produce nuclear weapons. While it also designed reactors (as a function of its need to produce fissile material) that were used for civilian purposes, and eventually branched into researching and developing laser technology (which could be used to support a laser-isotope-separation uranium enrichment program, and thus has obvious nuclear weapon applications), the MMMB more-or-less existed to produce nuclear bombs. If the USSR's leadership had stripped away the parts of the MMMB that had to do with nuclear weapons, there would have been little left of the organization. The Blue House, on the other hand, was and is the executive office of the Republic of Korea, and the

²⁹ Sungyeol Choi, Eunju Jun, Il-Soon Hwang, Anne Starz, Tom Mazour, Soon-Heung Chang, and Alex R. Burkhart, "Fourteen lessons learned from the successful nuclear power program of the Republic of Korea," *Energy Policy* 37.12 (2009): 5494-5508.

President of Korea has a host of statutory responsibilities and duties, none of which include managing a nuclear weapon program. A change (i.e. to stop designing, producing, or upgrading and maintaining nuclear weapons) in the USSR's nuclear weapon policy would have tremendous effects on the MMB, while a change in South Korea's nuclear weapons policy would have a relatively small effect on the Korean presidency, and the other downsides of cancelling the program were distributed among several organizations. In sum, Park's Blue House program was a single part of the larger executive branch. It also does not appear that the Park program developed capacities to execute the nuclear policy from inside the executive branch. Take away the nuclear weapon program from the Blue House, and the Blue House would continue to exist, since the executive branch had (and has) many other functions.

Between these two extremes exists a range of other organizations. For example, the Pakistan Atomic Energy Commission (PAEC), when it conducted Pakistan's nuclear weapon activities from 1972 to 2001, was closer to the ideal type of the specialized nuclear weapon organization than it is to the idealized general organization. While the PAEC did (and does) conduct research and development work for peaceful nuclear applications, it also researched, designs, and manufactures Pakistan's nuclear warheads.³⁰ So, while it had multiple mandates and priorities, all of those goals and mandates were in nuclear science and engineering.

An organization that sits between the two ends of the spectrum, and is close to the mixed organization ideal is South Africa's Armscor (1979-1990). During this period, Armscor was a

³⁰ Precisely identifying what proportion of PAEC's work is exclusively military-oriented, and how much of its work is civilian in nature is difficult. However, evidence suggests that in PAEC's early years (i.e. before 1971), its work was heavily weighted towards civilian activities. After 1971, PAEC certainly increased the amount of activity (in relative terms) that was specifically aimed at weapon design and manufacturing. So while reliable data about the precise quantity of civilian work and military work that PAEC has conducted at any given time in its history is hard to come by, this study's data coding, described in chapter four, helps overcome this challenge. Specifically, this thesis uses an ordinal (three-point scale) which sacrifices some precision in order to gain accuracy. This means that the ordinal coding does not precisely identify the absolute differences in organizational specialization from case-to-case, but it does accurately categorize organizations according to their relative differences in specialization.

state-owned military equipment manufacturer. Its principal customer was the South African Defence Force (SADF), and Armscor and its subsidiaries made everything from pistols and rifles to armoured vehicles, anti-tank missiles, and artillery. The South African government took responsibility for the nuclear weapons program away from South Africa's Atomic Energy Board in 1979, and gave it to Armscor that year. However, while Armscor was designing, refining, and producing nuclear weapons, it was also engaged in its existing business lines, and even began positioning itself as a major arms exporter during this period. Armscor had a statutory responsibility to produce nuclear arms, but doing so was not the organization's essence. Running a nuclear weapons program was compatible with the organization's overall mandate as an arms designer and producer (and, as will be discussed in chapter five, Armscor appears to have treated its nuclear weapons program in a similar fashion to its other weapons programs, albeit more secretively), but it was ultimately only one of Armscor's many tasks.

Table 1.2 describes the two ideal types and the mixed type of organization. Ultimately, these categories are crude simplifications of reality. There are, in fact, many gradations between different organizations. However, for the purposes of analysis, I am using a simplified three-point ordinal scale, which characterizes organizations as being highly specialized or quite general in their mandate, or falling somewhere between the two extremes.

Table 1.2 Nuclear Weapon Organization Types

General organization	Mixed organization	Specialized organization
<ul style="list-style-type: none"> • Researching, designing, and building nuclear arms is not the organization's principal task and the organization has a broad mandate that may be incongruent with managing nuclear weapon activities • Examples: Blue House; French-Italian-German nuclear arrangement 	<ul style="list-style-type: none"> • Researching, designing, and building nuclear arms is not the organization's principal task, but it is congruent with the organization's overall mandate • Examples: Armscor; Ministry of Supply (United Kingdom); programs housed in armed forces (e.g., Brazil, Sweden, Switzerland, Taiwan) 	<ul style="list-style-type: none"> • Researching, designing, and building nuclear arms is the organization's only task, or it is a disproportionately large part of the organization's mandate • Examples: MMMB; PAEC; Atomic Energy Board (South Africa)

1.4 Central Argument

This study's fundamental argument is that the organizational choices a government makes when starting and continuing nuclear weapon activities can, in fact, create conditions that make abandoning those nuclear weapon activities relatively more likely. This conclusion stands in contrast to the common wisdom about organizational imperatives and nuclear proliferation, which argues that organizational interest, if anything, causes states to continue to seek to acquire nuclear arms once embarked on a program. This study does not reject the possibility that in some cases, narrow organizational interest can help explain the onset of nuclear weapon activities, but instead offers evidence that the type of organization that runs a state's nuclear weapon activities can and does substantively affect the likelihood that the government will ultimately abandon or continue those activities. In short, organizational imperatives and interests can make nuclear abandonment more likely, rather than always acting as a barrier to it.

This study also helps shed some light on the role of what are called bureaucratic interests in the policy process, and offers a clear counterpoint to the claim that nuclear weapons are a

product in part of narrow organizational interests. On the first point, it uses variation in sub-state units to identify when organizational (or “bureaucratic”) interests might help create a certain outcome. This stands in contrast to the simple argument that organizational interests in and of themselves explain policy outcomes, since all governments, for the sake of efficiency, have to empower agents to implement government policy. This is because by creating a specialized organization to implement and execute a specific policy (or policies), government executive branches or legislatures essentially overcome some of the significant costs associated with the need to coordinate civil servants’ labour and efforts. Thus, it is difficult to attribute policy outcomes simply to the fact that government organizations may have their own interests that are not fully aligned with the interests of the executive branch or the government as a whole. If policy outcomes vary, any explanation for that variation that relies on bureaucratic interests as its primary cause needs to identify some sort of variation in those bureaucratic interests. This study uses variation in the overall mission of sub-state organizations to identify when certain outcomes (i.e. nuclear abandonment) are more likely than others (i.e. nuclear retention). On the second point, this study argues and provides evidence that certain types of organizations that are often thought of as being “bomb lobbyists,” such as armed forces, may in fact be rather ambivalent about nuclear weapons. While sub-state organizations certainly can be advocates for nuclear weapons, they can also de-prioritize acquiring nuclear arms in favour of other priorities.

1.5 Goals and Scope

As noted earlier, this study’s basic goal is help answer the question why countries stop their nuclear weapon activities, once they have begun. To achieve this goal, this study puts forward a hypothesis about when, on average, nuclear abandonment is more or less likely to

occur. The study's goal is not to perfectly explain every case of nuclear abandonment. Instead, it is seeking to determine if the hypothesized relationship between organizational imperatives and nuclear abandonment appears to be a predominant pattern, rather than the artefact of one or two cases. This study investigates a potentially important element in understanding nuclear abandonment.

Additionally, while this study focuses the majority of its efforts on a single concept, this is because one of the study's fundamental assumptions is that international politics and foreign policy decision making are complex. Focussing on a single construct and hypothesis is a way of bracketing the analysis: recognizing that there are likely a large number of factors influencing a government's decision to abandon or retain a nuclear weapon program, and another group of factors that affect the likelihood that their decision will be successful once made, this study attempts to control for those factors while focussing the majority of its analytical efforts on assessing the relationship between the phenomenon of interest (nuclear abandonment) and the variation in the organizations that manage a state's nuclear weapon activities. Bracketing the analysis in this manner is a necessary step to deal with the complexity of the real world, by focussing our thinking on what we believe are salient or important aspects of a phenomenon.

Furthermore, this study's analysis and findings only apply to cases where a state has initiated its own indigenous nuclear weapon activities. The analysis is not meant to explain, for example, why states continue to participate in the NATO nuclear sharing program. Likewise, the argument that this study puts forward is not meant to apply to the decisions of the Belorussian, Kazakh, and Ukrainian governments to rid themselves of the nuclear arms they "inherited" when the USSR dissolved. These three cases were unique in the sense that these three governments never established programs designed to research, design, acquire or produce nuclear arms.

Instead, due to an accident of history, these three countries found themselves with nuclear arms in their territory despite not aiming to acquire them. Since this study's principal contention is that the nature of the organization that conducts the state's nuclear weapon activities has a material effect on the likelihood that nuclear abandonment will occur, these three cases do not fall in the study's domain. Belarus, Kazakhstan, and Ukraine did not charge existing organizations to acquire nuclear arms (nor did they establish a purpose-built organization for this mission), which means that these three cases lack a necessary scope condition for this study's hypothesis to apply.

1.6 Correlation, Causation, Methods, and Nuclear Abandonment

This study's goal is not to disprove or debunk any specific explanation for why a country gives up its nuclear weapons program. Instead, the study's main contention – that the type of organizations that conduct nuclear weapon activities can be an important determinant of whether a country ends its nuclear weapon activities – may be compatible with other explanations. Instead, this study focusses on identifying what is potentially a generalizable, partial explanation for nuclear weapon activity abandonment.

Second, this study, by analysing the relationship between organizational choices and the likelihood of abandonment, is interested in contextual conditions that make abandonment more-or-less likely. In other words, this study presents a probabilistic – rather than a deterministic – explanation for nuclear abandonment.

It is also not trying to identify the proximate event(s) that trigger the decision to abandon nuclear weapon activities. The list of potential proximate causes of nuclear weapon activity abandonment is lengthy. They range from new governments with anti-nuclear preferences being

ushered in (Brazil may be an example), to diplomatic and political pressure from an ally (such as the United States engaging in direct diplomacy with South Korea and Taiwan), to the end of the Cold War (as in the South African case). There are also many examples of events that could have been proximate causes, but were obviously insufficient to cause nuclear abandonment. Examples include the political pressure the US put on Israel in the 1960s, or America's multiple efforts to threaten and bribe the Pakistani government to stop their nuclear weapon program, or Israel and Iran's airstrikes on Iraqi nuclear facilities in the 1980s.

This list of potential proximate causes also poses some methodological challenges. First, if we look for proximate causes, we can find a large number of candidates. There is also a tremendous amount of heterogeneity among these potential proximate causes. They range from diplomatic efforts to persuade states to change their nuclear policies with promises of future rewards, to firmer threats of sanctions, to threats (and acts of) violence. There are also one-off events, such as the French government's unilateral decision to cancel a tripartite scheme with Italy and West Germany to build nuclear weapons. The heterogeneity of these triggers poses a few serious theoretical and methodological challenges. Developing a single theory that can make sense of how all of these various proximate triggers work (or fail to work) is daunting. Meaningfully comparing them is also difficult. Finally, cataloguing all of the events that may (or may not have) tipped policymakers towards retaining or abandoning their nuclear weapon activities is a remarkably difficult (if not practically unachievable) task. This is in part because of the range of countries that have conducted nuclear weapon activities (creating language barriers), the time periods involved (meaning many of the decision makers are deceased), and the tremendous secrecy that tends to surround these programs. Just one notable example was the executive decision in South Africa to destroy the nuclear weapon program's records in 1989.

Today, former South African nuclear weapon program personnel still face legal sanctions if they discuss certain aspects of the program.

Since this thesis focuses less on the proximate decision(s) to terminate a nuclear weapon program and more on the policy making environment that nuclear abandonment occurs in, it is fundamentally a study that is more about policy development and implementation than decision-making. The organizational dynamics at play create the conditions either where certain types of nuclear policy decisions (i.e. continuation or abandonment) become more or less likely. The precise way in which organizational imperatives help create this environment is still an open question, but chapter five offers at least two possibilities: either by according nuclear weapon activities a relatively low priority compared to other policy activities (resulting in policy stagnation), or by consolidating a financially unimportant nuclear program in order to preserve resources for other goals. Both of these potential mechanisms help create the conditions to make a decision by the executive branch of government to terminate the state's nuclear weapon activities successful.

Finally, this study is primarily – and deliberately – empirical in nature. While there may be no absolute distinction between normative and empirical studies, this thesis does strive to understand why and how nuclear weapon activities end, rather than to judge whether or not states should conduct nuclear weapon activities.³¹ However, this does not mean that this thesis – while it tries to understand and shed light on an important behaviour in international politics – offers a strictly positivist account of nuclear abandonment. Social behaviour – including in foreign policy making – is a complex phenomenon, and there is no lack of debate about its true nature or how to best understand it. This study uses an empirical approach that borrows from the natural sciences

³¹ Steve Smith, “New Approaches to International Theory,” in Steve Smith, Ken Booth and Marysia Zalewski, eds., *International Theory: Positivism & Beyond* (Cambridge, UK: Cambridge University Press, 1996), 172-173.

because such an approach offers a useful tool for simplifying the problem at hand in order to focus on what we suspect are the most salient aspects of nuclear abandonment. Such an approach does not replicate reality, but instead allows us to determine if at least some of our beliefs about the world are approximately true, at least according to the standards of empirical social science. To quote statistician George Box, “essentially, all models are wrong, but some are useful.”³² This study strives to meet Box’s standard of usefulness.

1.7 Outline – What is to Come

The rest of this study will proceed in the following manner. Chapter two will review the scholarly literature that deals with when and why states abandon nuclear weapons. This review will also include literature that deals with the similar question of why states do not acquire nuclear weapons, since this literature often appeals to historical cases where a state did in fact conduct nuclear weapon activities and then ended them in order to make their argument.

Chapter three will develop a hypothesis about how organizational choices – namely, which types of organizations run a state’s nuclear weapon activities – might affect the likelihood that a government ultimately abandons its nuclear weapon activities.

Chapter four will offer a large-*n* test of chapter three’s hypothesis. To test the hypothesis, I collected two original datasets, which I will describe in the chapter.

Chapter five will consist of two case studies: Switzerland and South Africa. These two case studies tell a story that is overall consistent with the organizational imperative hypothesis, and by exploring the details of the decisions to abandon the nuclear weapon activities in Switzerland and South Africa, we can get a preliminary sense of how organizational choices and

³² George E.P. Box and Norman Richard Draper, *Empirical Model-Building and Response Surfaces* (New York: Wiley, 1987), 424.

imperatives helped create favourable conditions for both of these countries to eventually end their nuclear weapon activities.

The Swiss case was selected on the basis of it being a tough test for the hypothesis. According to the existing literature, Switzerland had many reasons to not acquire a nuclear weapon. Throughout the twentieth century, it has had a fairly open economy, and the Swiss banking sector has relied extensively on foreign customers. Switzerland has also been strongly democratic throughout the twentieth century, and thus should be particularly susceptible to anti-nuclear attitudes.³³ During the Cold War Switzerland was also relatively militarily weak (particularly when compared with the USSR, whose military plans preoccupied Swiss policy makers), and thus has ample reason to wish to avoid becoming embroiled in an intensified security dilemma. Yet, as the case study will demonstrate, there is ample evidence that the narrowly defined organizational imperatives of the Swiss armed forces – the organization charged with acquiring Switzerland’s nuclear weapons – played a significant role in undermining the Swiss nuclear weapon program, while Swiss cabinet documents offer scant support for other explanations. In other words, what should be an overdetermined case, upon closer examination, is not. This study’s organizational hypothesis helps shed some light on the Swiss government’s decision to terminate its nuclear weapon activities.

South Africa is a particularly interesting case, as it is still the only state to have indigenously developed a nuclear weapon and then relinquished it. South Africa’s nuclear weapon program was also building bombs for around a decade before the government ended it, suggesting that there was a cadre of scientists, engineers, bureaucrats, and politicians with a significant professional stake in the program, making South Africa’s nuclear weapons program a

³³ Despite not extending the right to vote in federal elections to women until the 1970s, the Polity IV dataset scores Switzerland as highly democratic since 1848. Monty G. Marshall, Ted Robert Gurr, and Keith Jagers, *Polity IV Project: Political Regime Characteristics and Transitions, 1800-2013* (Center for Systemic Peace, 2014).

tough one for the government to cancel. However, the South African cabinet, rather than facing tremendous internal opposition, found that Armscor (the state-owned company in charge of the weapons program) was amenable to abandoning the nuclear weapon program in 1989.

Ultimately, Armscor – because of its organizational mandate and well-established conventional arms business – had little to lose by giving up its nuclear weapon activities. Despite being in the business of researching, designing, building, and selling military hardware, South Africa's nuclear weapons program was not a source of major largesse for the company, giving Armscor few incentives to lobby on the program's behalf.

2 Literature Review - What do We Know about Nuclear Abandonment?

This chapter will review the political science and international relations (IR) literature that attempts to explain nuclear abandonment. This literature review's goals are two-fold. First, this chapter aims to survey the literature that examines when and why states abandon nuclear weapon activities. The second goal is to assess to what degree the various explanations that the literature offers are generalizable. That is to say, how confident should we be that the literature's explanations apply wholly or in part to all cases of nuclear abandonment, or are many of these explanations instead better at explaining a small number (or certain types) of cases?

The literature review is organized according to the sorts of analytical assumptions and theoretical mechanisms that the author(s) and analyst(s) use to motivate and frame their studies. This means that the review often groups studies together into categories that resemble "standard" international relations paradigms such as realism, neoliberalism, or constructivism. This choice was made largely for matters of convenience and clarity.

The rest of this review will proceed as follows: first, it will outline some of the broad contours of the nuclear abandonment literature. It will then assess the literature according to four broad theoretical themes: explanations based on states' security environment and the use of military and economic power; explanations based on domestic political considerations; explanations based on norms and psychology, and; explanations based on politics inside of the government. While this last grouping of works shares its focus on the behaviour of government organizations and employees with this study, as the review will show, not only is this study's hypothesis dissimilar to the existing works that focus on government organizations, but it makes some novel predictions that the existing literature does not. The chapter will then review several studies that do not comfortably fit in the preceding four categories. The review will conclude

with a brief summary of the empirical methods that the nuclear abandonment literature uses, and explain why these methods make it difficult to be confident that many of the nuclear abandonment cases the literature identifies do in fact hold for a large segment (or the entire population of) cases.

2.1 Nuclear Abandonment

Since this study aims to develop and test a general hypothesis to explain nuclear abandonment, the literature review largely focusses on work that has a similar (implicit or explicit) goal. This means that it principally concentrates on work from the political science/international relations literature that seeks to offer a general explanation for nuclear abandonment, rather than narratives about a single country's nuclear history. It will however, occasionally mention various histories and accounts of individual nuclear weapon programs if they have particular bearing on the issue at hand. It also means that this review concentrates on empirical – rather than theoretical or philosophical – studies of nuclear abandonment and decision-making.

Thus, most of the books, articles, and theses addressed in this review fall within the category of “‘normal’ social science,” or what is more widely understood as the scientific method.³⁴ While sometimes considered to be synonymous with the philosophy of positivism, the two concepts are distinct.³⁵ This is important to keep in mind, since the works in this review that use constructivist theories to explain nuclear decision-making still use what is essentially a

³⁴ David Dessler, “Constructivism within a positivist social science,” *Review of International Studies* 25.1 (1999): 124.

³⁵ For a useful comparison of the scientific method and positivism, see Malcolm Williams, “Positivism,” in Victor Jupp, ed., *The SAGE Dictionary of Social Research Methods* (London: SAGE Publications Ltd., 2006), 229-231.

scientific method.³⁶ Even if those authors argue that the subjects of their studies (e.g. national leaders making decisions about nuclear policy) understand the world in a subjective fashion, the authors' analyse their subjects using approximately scientific methods.

So while there are other ways to generate knowledge about the world other than engaging in empirical studies, since this study's principle analytical goal is to generate a generalizable explanation for nuclear abandonment and to test that explanation in an approximately scientific manner, this review deliberately engages principally with studies with similar goals. Perhaps the sole exception to this rule is Jasper's analysis of Switzerland and Libya's nuclear weapon policies. Jasper uses a pragmatist approach to understand how members of the Swiss and Libyan governments made their nuclear policies, an approach which she explicitly contrasts with "positivist" analyses of nuclear weapons proliferation.³⁷ Yet, on closer examination, it appears that Jasper is more so rejecting aspects of realist IR theory and philosophical materialism than positivism or epistemological realism. As Jasper puts it, one of her goals is to "shed new light on possible mechanisms of nuclear reversal."³⁸ Despite using pragmatist thinking, Jasper still abides by many principles of the scientific method, offering an explanatory, evidence-based effort to get at the "truth" of how the Swiss and Libyan nuclear weapon programs ended.³⁹

Therefore, this literature review engages with the empirical nuclear abandonment literature with a critical eye on understanding the methods each author used to come to their conclusions, and with an effort to determine how generalizable those conclusions are.

³⁶ This merits explicit mention since colloquially constructivism is sometimes described as being incompatible with scientific empirical methods, a claim that many scholars working with constructivist theory have rejected. See Dessler for elaboration.

³⁷ Jasper, 9-10.

³⁸ Jasper, 45.

³⁹ Williams, 231.

As noted in the introduction, there is a body of political science/IR literature that studies cases where states have either not acquired nuclear weapons, have restrained their nuclear weapon capabilities (i.e. not developed weapons when they appear to have had the obvious means to do so), or have initiated and then stopped nuclear weapon activities (what this study refers to as “nuclear abandonment”). This literature review will cover all three of these bodies of work. While this review could solely focus on literature that explicitly seeks to explain why states abandon nuclear weapon activities, expanding its scope to cover additional literature is warranted. This is because many of the countries that analysts have investigated when trying to determine why states do not acquire nuclear weapons or practice nuclear restraint are in fact countries that have initiated, and then abandoned, nuclear weapon activities. Those two questions – why states do not acquire nuclear weapons and why states practice “restraint” – are also similar enough to this study’s core question for meaningful insights to be drawn from them. Still, readers should be aware that sometimes assessing these studies purely as explanations of nuclear abandonment does not always shed much light on the subject. Take for example, Rublee’s argument that when the NPT entered into force in 1970, it ushered in a global anti-nuclear norm that broadly affected state behaviour.⁴⁰ Rublee explores (among other cases), the Japanese government’s nuclear weapon policy from the 1950s into the early 2000s. While Japan briefly conducted nuclear weapon activities within this period, her empirical assessment focusses more on why Japan has continued to abide by a no nuclear weapons policy, than why the Japanese ended their nascent program in the late 1960s. So while there is a literature examining the similar questions of what causes nuclear restraint and what causes nuclear abandonment, the two questions are at times different enough to generate distinct answers.

⁴⁰ Maria Rost Rublee, *Nonproliferation Norms: Why States Choose Nuclear Restraint* (Athens, GA: University of Georgia Press, 2009).

An additional characteristic of these bodies of literature that the reader should be aware of is that authors often situate their studies on nuclear abandonment or restraint in the context of broader debates within international relations. The “nuclear abandonment” literature thus tends to mirror the nuclear proliferation literature (i.e. the literature explaining the onset of nuclear weapon activities and/or the acquisition of nuclear weapons) in that it is regularly organized around prominent IR paradigms (e.g. realism, liberalism, and constructivism) and questions about the appropriate level-of-analysis (e.g. the international system-, state-, and individual-levels). Given the influence of classic IR on the writing on this subject, much of the work in this subfield is about whether classic concerns about “power” and security, injunctive norms for state behaviour, or domestic politics are really the key cause of decisions to end nuclear weapon activities. Accordingly, there is relatively little in the way of middle range theory for explaining nuclear abandonment. Instead, analysts have often used nuclear abandonment cases as empirical evidence in order to implicitly test larger theories of IR.

Despite these tendencies in the overall body of literature, one of the earliest notable examples of the “nuclear abandonment” literature, Reiss’ *Bridled Ambition*, is a relatively atheoretical study.⁴¹ Using several case studies, Reiss highlights what appeared to be a global slowing and reversal of the spread of nuclear weapons. While some of the cases he examined have become oft-cited examples of nuclear abandonment (Argentina, Brazil, and South Africa), others (namely India, North Korea, and Pakistan) have gone overtly nuclear since its publication, and others (Belarus, Kazakhstan, and Ukraine) represent a theoretically important but unique subset of cases (i.e. states that never had their own nuclear weapon program, and did not intend

⁴¹ Mitchell Reiss, *Bridled Ambition: Why Countries Constrain Their Nuclear Capabilities* (Washington, D.C.: The Woodrow Wilson Center Press, 1995). This review’s commentary and analysis of *Bridled Ambition* applies more-or-less equally to Reiss’ earlier work, *Without the Bomb: The Politics of Nuclear Nonproliferation* (New York: Columbia University Press, 1988).

to acquire nuclear weapons, but nonetheless ended up possessing some). Thus, it is unclear how convincing Reiss' various causes of restraint really are. It is by no means clear that the end of the Cold War changed global thinking on nuclear weapons and delegitimized them.⁴² Reiss' argument that that the financial costs of the Soviet and American programs deterred other states from acquiring nuclear weapons is intuitive, but also questionable (after all, not every nuclear arsenal must number in the tens of thousands and be mated to a globe-spanning land, sea, and air-based triad, and of course, no state had ever tried to replicate the USSR or USA's arsenals in size, scope, or sophistication).

In addition to these major causes, Reiss lists a number of other factors that he argues contributed to the halts, slowdowns and reversals in nuclear policy he observed. These include: changes in government, diplomatic interventions and promises of rewards to the countries that abandoned their nuclear arsenals, and "political personalities and the quality of leadership."⁴³ Overall, Reiss does not focus on any specific hypothesis or explanation, and assess how well (or poorly) it explains nuclear abandonment in general. Instead, he offers a well-researched and detailed description of a number of interesting and important cases, which offer a number of potential general causes and correlations.

In short, Reiss' early cut at the subject lacks a specific theory or hypothesis to guide the analysis, suffers from poor operationalization of the dependent variable and an ambiguous research question. Reiss also selects on the dependent variable (only studying countries where governments appeared to have abandoned or paused their nuclear activities), throwing additional

⁴² In fact, other analysts, such as Rublee (2009) and Müller and Schmidt (2010) suggest that the delegitimization of nuclear weapons began with the NPT, which entered into force two decades before the end of the Cold War. See Harald Müller and Andreas Schmidt, "The Little-Known Story of Deproliferation: Why States Give Up Nuclear Weapons Activities," in William C. Potter and Gaukhar Mukhatzhanova, eds., *Forecasting Nuclear Proliferation in the 21st Century, Volume 1* (Stanford, CA: Stanford University Press, 2010): 124-158.

⁴³ Reiss, 3.

doubt on the general validity of some of his conclusions.⁴⁴ Nevertheless Reiss does an admirable job of engaging the general questions of why do states that have weapons or weapon programs abandon those programs or why states might slow their effort to acquire nuclear arms, and provides a thorough list of potential general causes, without glossing over the detail and variation among his selected cases.

2.2 “Traditional” International Relations Explanations for Nuclear Abandonment

In one of the earlier works that deliberately uses major IR paradigms to frame its analysis, Costanzo explores seven cases in the 1990s – Argentina, Belarus, Brazil, Kazakhstan, North Korea, South Africa, and Ukraine – where a country appears to have stopped its efforts to build nuclear weapons, repatriated weapons it inherited during the dissolution of the USSR, or gave up weapons it had built.⁴⁵ Costanzo’s study draws its hypotheses from the “standard” schools of IR thought and their variants, and tests explanations based on realist, constructivist, and liberal thinking. The basic model that implicitly underpins Costanzo’s study is that governments are more-or-less rational actors. They have preferences, and they try to satisfy their preferences in a difficult international environment.⁴⁶ Thus, implicit question that Costanzo asks is how are these governments’ preferences ordered? What goals matter most to these governments? When these states are prodded by a stimulus, what sort of stimuli cause nuclear

⁴⁴ In particular, when Reiss cites global causes, such as his claim that the end of the Cold War partially delegitimized nuclear weapons and made them less “prestigious” to own, and hold this up as a cause of nuclear abandonment in countries that halted/slowed/terminated their nuclear weapon programs, but does not examine those states that continued to conduct nuclear weapon activities or hold on to their existing nuclear arms.

⁴⁵ Charles E. Costanzo, “Returning from the Brink: Is There a Theory-based Explanation for the Attenuation of Horizontal Nuclear Proliferation?,” PhD diss., University of Alabama, 1998.

⁴⁶ The basic logic that Costanzo works from is both implicitly and explicitly used by authors in some newer analyses. These include analysts using constructivist theory, such as Long and Grillot (2000) and Rublee (2009), who explicitly describes states as reacting to social “incentives”. See William J. Long and Suzette R. Grillot, “Ideas, beliefs, and nuclear policies: The cases of South Africa and Ukraine,” *Nonproliferation Review* 7.1 (2000): 24-40; Rublee (2009), 5.

abandonment? Is it threats to national security by another state? Is it economic challenges that depress government revenues? Conforming to some sort of social expectation that they should eschew nuclear arms?

In the end, Costanzo argues that none of the three IR schools are particularly useful for explaining all seven cases.⁴⁷ Instead Costanzo concludes that each school explains some cases better than others, and that nuclear abandonment is likely a “multifarious” phenomenon.⁴⁸ While at first glance an unsatisfying conclusion, later analyses, such as Paul’s and Levite’s come to similar conclusions: there is no simple, univariate explanation for nuclear abandonment.⁴⁹ Like Costanzo, Paul suggests that in order to offer an explanation that works across multiple cases, one has to borrow concepts from both the realist and neoliberal IR paradigms. Levite goes further, suggesting that at its core, there are many distinct and non-exclusive ways for nuclear abandonment to happen, and notes that the literature has found neither the necessary nor the sufficient conditions for nuclear abandonment to occur.⁵⁰

Despite Costanzo’s pessimism about the usefulness of IR theory for explaining nuclear abandonment, much of the nuclear abandonment literature that has followed hews to those

⁴⁷ Costanzo, 301. Jasper would echo this critique much later, characterizing much of the nuclear proliferation literature as “arguing endlessly over whether systemic threats *or* hostile identities *or* universal norms *or* economic considerations tipped the scales in favour of or against the acquisition of nuclear weapons.” See Ursula Jasper, *The Politics of Nuclear Non-Proliferation* (New York: Routledge, 2014), 25.

⁴⁸ Costanzo, 301.

⁴⁹ T.V. Paul, *Power Versus Prudence: Why Nations Forgo Nuclear Weapons* (Montreal: McGill-Queen’s University Press, 2000), 14; Ariel Levite, “Never Say Never Again: Nuclear Reversal Revisited,” *International Security* 27.3 (2002-3): 59-88. Jasper also suggests that “grand theories” (e.g. generalizable claims) are not useful for understanding nuclear proliferation and abandonment. Jasper, 182, 185, 198-199.

⁵⁰ It should be noted that Solingen claims that governments that rely on a coalition of “liberalizing” sectors of society to stay in power constitute a sufficient condition for nuclear abandonment (except when that government acquires nuclear weapons before it comes to rely on a liberal-internationalizing coalition, and except when a state has inward looking neighbours that are also seeking nuclear arms); Etel Solingen, *Nuclear Logics: Contrasting Paths in East Asia and the Middle East* (Princeton, NJ: Princeton University Press, 2007), 18-19. Tagma suggests that according to realist theory, nuclear abandonment can only occur under two necessary conditions: first, a state must not face an existential threat, and second, no state in the international system can have a secure nuclear second-strike capability (i.e. submarine launched nuclear-armed ballistic missiles). See Halit Mustafa Emin Tagma, “Realism at the Limits: Post-Cold War Realism and Nuclear Rollback,” *Contemporary Security Policy* 31.1 (2010): 165-188.

epistemological lines. Three landmarks of the literature are T.V. Paul's *Power Versus Prudence*, which provides a defensive realist explanation; Etel Solingen's *Nuclear Logics*, which provides an explanation rooted in domestic politics and economic liberalization, and; Maria Rost Rublee's *Nonproliferation Norms*, which offers a constructivist explanation. While these are not the only studies explaining nuclear abandonment using each respective IR "school" to explain why nuclear abandonment happens, they do stand out in a sub-field with few monographs. These three works also offer approximately monocausal explanations for nuclear abandonment, and as noted, clearly draw from specific IR traditions, making them convenient signposts to organize the rest of the literature review around.

2.2.1 Security, Power, and Realist Explanations

In *Power Versus Prudence: Why Nations Forgo Nuclear Weapons*, T.V. Paul uses several case studies to argue that some "technically capable states" (a concept that is unfortunately not operationalized) will refrain from acquiring nuclear weapons, since doing so will cause their security environment to deteriorate (due to the classic security dilemma). Paul implicitly assumes that nuclear weapons are threatening; ergo, only states in intense security competitions will build nuclear arms (presumably because their benefits outweigh the costs of the intensified security dilemma). Accordingly, only states in conflict zones and with enduring rivalries with other states, or great powers (which have global interests), will acquire nuclear arms.⁵¹ Overall, Paul's argument is consistent with a larger body of defensive realist literature which argues that states seek military power as a means to an end (physical security from other national militaries) and not as an end unto itself.⁵²

⁵¹ Figures estimated by the author using data from the Maddison-Project, <http://www.ggd.net/maddison/maddison-project/home.htm>, 2013 version.

⁵² For an overview of defensive realist logic, please see Jeffrey W. Taliaferro, "Security Seeking under Anarchy: Defensive Realism Revisited," *International Security* 25.3 (2000): 128-161.

While Paul provides a parsimonious argument drawn from a venerable strand of IR literature, some of his methodological choices are unsatisfying. Paul's analysis only applies to a narrow range of cases. He explicitly states that his hypothesis does not apply to "great powers," since great powers make their nuclear weapon policy according to their "interaction with other great powers."⁵³ While clearly delimiting a hypothesis' scope is an appropriate and necessary step, Paul's use of the term "great power" is analytically troubling and pushes his argument towards tautology. He does not operationalize the term, but claims the five nuclear weapon states are great powers.⁵⁴ Arguably, if China, France, Russia, the UK, and the US are all great powers in the post-1945 period, for some of them it is at least in part because they have nuclear weapons, rather than vice-versa.⁵⁵ There are also reasons to suspect that Paul implicitly believes that owning nuclear weapons is at least part of what makes a country a "great power." For example, Paul suggests that Brazilian leaders saw nuclear arms as a route to being "a major power," and that since Indian leaders want to make India a world power, they have an important reason to retain their nuclear weapons.⁵⁶ However, according to Paul, because Brazil ultimately decided not to become a great power, it did not acquire nuclear arms.⁵⁷ This begs the question, had Brasilia acquired nuclear weapons in the early 1990s, would Brazil then be a great power? If Paul's "great powers" achieved such status even in part because they acquired nuclear weapons, then Paul's hypothesis may be unfalsifiable.

⁵³ Paul, 17.

⁵⁴ Paul, 4.

⁵⁵ Christopher Layne, "The Unipolar Illusion: Why New Great Powers Will Rise," *International Security* 17.4 (1993): 5-51; Lawrence Freedman, "Great Powers, Vital Interests and Nuclear Weapons," *Survival* 36.4 (1994): 35-52; Andrew Hurrell, "Hegemony, Liberalism and Global Order: What Space for Would-Be Great Powers," *International Affairs* 82.1 (2006):1-19; Hymans also points out that some analysts have argued that acquiring nuclear weapons is a means to achieving "great power" status. See Jacques Hymans, *The Psychology of Nuclear Proliferation: Identity, Emotions, and Foreign Policy* (New York: Cambridge University Press, 2006), 43.

⁵⁶ Paul, 110, 132.

⁵⁷ Paul, 146.

It is not possible to determine if there is tautological reasoning at work though, since Paul does not define the term, “great power.” This omission would not be critical if the term had a standard, commonly accepted meaning. However, political science scholars have not come to a consensus about what constitutes a “great” or “major” power, and definitions (and lists of what countries are great powers) vary from author to author.⁵⁸ Nevertheless, there is a general implicit consensus that any definition of “great power” should include at least one (if not all three) of the following elements: material capabilities (a combination of military and economic potential and capacity); a broad geographic scope of interests, and; some sort of social status where other countries recognize a state as a “great power.”⁵⁹

Yet, even with these criteria in mind, it is difficult to identify Paul’s great powers *a priori*. Take, for example, the economic dimension of great power status. In 1964 (the year of China’s first nuclear test), the Chinese economy accounted for roughly 4% of global GDP. The American and Soviet economies were 24% and 10% of global GDP (six times and two and a half times greater), respectively. Germany and Japan both had larger economies than China, India’s was nearly as large, and Canada’s was about half in absolute terms, and much more in per capita terms. While it is possible to conceive of a definition of great power that includes a non-nuclear China, Paul does not provide that definition. Instead, he simply asserts that the five nuclear weapon states are great powers. This use of the concept of great power undermines Paul’s argument, as it avoids explaining why France, the UK, and China were not prone to the same pressures as other states. Instead, it is simply asserted that because great powers make national security decisions with other great powers in mind, they do not abandon their nuclear weapon activities for fear of an intensified security dilemma. Whether this is because all great powers are

⁵⁸ Vesna Danilovic, *When the Stakes are High: Deterrence and Conflict Among Major Powers* (Ann Arbor, MI: The University of Michigan Press, 2002), 26-46.

⁵⁹ Danilovic, 225.

in severe security competition with each other, or because great powers are better able to wield nuclear weapons (and thus gain advantages that offset the insecurity nuclear arms cause), or some other explanation, is neither explored nor mentioned.

Paul's key operational variable – a state's regional security environment – is also poorly operationalized. He defines a state's security environment by the number of militarized interstate disputes (MIDs) a state and its neighbours are involved in, without identifying how many MIDs must occur in a given period of time for a state to be in a low, medium, or high-conflict region.⁶⁰ This makes it difficult to evaluate the appropriateness of Paul's coding decisions: Cold War Eastern Europe, for example, is coded as a high-conflict zone, while Western Europe, during the same time period, is a low-conflict zone. Paul codes Brazil as being in a medium-conflict zone (Brazil was involved in six MIDs from 1953 to 2001), while Switzerland is in a low-conflict zone (five MIDs over the same period).⁶¹ The small but subtle differences in Brazil and Switzerland's security environments may in fact have influenced their nuclear decision making. However, if an analyst does not define and operationalize their key variables, their hypotheses are difficult to test, and it is therefore difficult for readers to accept claims that a study's hypotheses are in fact consistent with empirical patterns.

These critiques aside, Paul still offers an interesting argument.⁶² To reiterate, he argues that states refrain from building nuclear weapons – even when they can – for fear of alarming

⁶⁰ Quantitative researchers define MIDs as a threat or use of force by one state against another, short of war (which requires at least 1,000 battlefield deaths).

⁶¹ Glenn Palmer, Vito D'Orazio, Michael Kenwick, and Matthew Lane, "The MID4 Data Set: Procedures, Coding Rules, and Description," *Conflict Management and Peace Science*, forthcoming 2015.

⁶² It should be noted that Paul actually offers two explanations for why states will not acquire nuclear weapons. Though Paul frames the study as a test of the hypothesis that states refrain from acquiring nuclear arms in order to prevent escalating security dilemmas with neighbours and/or potential rivals, he includes the attitudes and behaviour of allies as another determinant of a country's nuclear behaviour. So, for example, he explains Japanese and South Korean behaviour by noting that the United States preferred that both these states not acquire nuclear arms. While Paul argues that this is explained by the concept of "security interdependence," which is "the degree of mutual vulnerability and the resultant anticipated sensitivity in their relationship with states with which they are connected

their neighbours, intensifying their security dilemmas, and putting the brakes on regional cooperation. This implicitly suggests multiple nuclear weapon equilibria: situations where a state is better off not building nuclear weapons, and situations where a state is already insecure, so it nuclearizes. However, for this relationship to hold, one should be able to observe a state's security environment begin to deteriorate upon proliferating (or being suspected of trying to build a nuclear weapon). If states become more secure, or in other words, pay no costs for nuclearizing, then Paul's causal mechanism becomes far less persuasive. Whereas Hymans suggests that national leaders do not know what the payoffs of nuclearization are, Paul basically suggests that they are generally undesirable, since they intensify threat perceptions and alarm neighbours.

Overall, Paul's argument can be simplified: if states refrain from acquiring nuclear weapons because they do not wish to create security threats for other countries, but do acquire nuclear weapons when they feel (sufficiently) threatened by an enduring rival, then in essence states acquire nuclear weapons as a response to threat. The risk with Paul's argument remains though that if one country acquiring nuclear weapons creates insecurity for another country (and

most closely in the region (henceforth "significant states"), both allies and adversaries," his core explanation for "nuclear forbearance" is still that it occurs when states "seek to avoid a security dilemma situation involving other significant states or states whose behaviour most seriously impinges on their security." (p. 15) However, Paul concludes that in South Korea, it was "the active U.S. military and security guarantees...that obviate the need for a nuclear capability in this enduring-rival state." (p. 124) Thus, Paul concludes that South Korea did not need nuclear weapons because it could free-ride off of the U.S.' security guarantee. Seoul's nuclear abstinence was therefore not a function of the Korean government's concern that acquiring nuclear bombs would worsen its security situation by antagonizing North Korea, but instead a simple result of the lack of incentives for acquiring nuclear weapons. Just like Paul's core hypothesis, this is a reasonable explanation for why South Korea did not acquire nuclear weapons, but explains relatively little about why the Park government began a nuclear weapon program and then terminated it. Pollack and Reiss' and Hersman and Peters' explanations of Seoul's nuclear abandonment decision directly contrasts with Paul's: both suggest that American threats to withdraw security guarantees encouraged Seoul to seek a nuclear weapon, and the Korean government's fear that the US might follow through on these threats ultimately helped tip the scales towards abandonment. See Rebecca K.C. Hersman and Robert Peters, "Nuclear U-Turns: Learning from South Korean and Taiwanese Rollback," *Nonproliferation Review* 13.3 (2006): 539-553; Jonathan D. Pollack and Mitchell B. Reiss, "South Korea: The Tyranny of Geography and the Vexations of History," in Kurt M. Campbell, Robert J. Einhorn, and Mitchell B. Reiss, eds., *The Nuclear Tipping Point: Why States Reconsider Their Nuclear Choices* (Washington, D.C.: Brookings Institution Press, 2004): 254-292.

thereby presumably inviting retaliation), then nuclear weapons can then create conflict. This would then in turn invite more proliferation. Accordingly, Paul's world can be thought of as having two stable equilibria: the first is where countries do not nuclearize, since doing so would cause insecurity and further self-help efforts to attenuate this insecurity. The second is a nuclear weapon equilibrium, where one country acquires nuclear weapons and causes insecurity for another state, which in turn acquires nuclear weapons to deter the first state. In other words, nuclear weapons acquisition begets more nuclear arms. In this regard, Paul's argument reads as a reformulation of the "nuclear domino" argument that Bleek critiques: countries acquire nuclear weapons to counter the nations that already have nuclear weapons.⁶³

It is not, however, a satisfying explanation for why a nuclear weapon program might stop once started, unless abandonment is a simple function of a declining threat environment. Then we can reasonably and simply conclude that nuclear weapon onset is a reaction to threat, and nuclear abandonment is a reaction to a decline in threats. No other theorizing is necessary.

Tagma offers what appears at first to be a different "realist" explanation for nuclear abandonment.⁶⁴ Using a series of standard realist assumptions about state behaviour and the nature of the world, Tagma develops two hypotheses about when states will abandon their nuclear weapons.⁶⁵ Specifically, he argues that three conditions must be present for a state to disarm itself of its nuclear arms. The first is that a nuclear-armed state must not face an existential threat (which Tagma defines as the presence of a geographically proximate, economically and militarily powerful state with malign intentions). Tagma also argues that for

⁶³ Bleek.

⁶⁴ Tagma.

⁶⁵ It is worth noting that because Paul's hypothesis does not apply to countries he defines as "great powers," his empirical analysis largely pertains to states that never acquired nuclear arms. Tagma's hypotheses, since they are only purported to hold for states that have acquired nuclear arms, constitute a complementary set of explanations to Paul's hypothesis.

nuclear abandonment to occur, a nuclear-armed state must not have a history of territorial disputes with potential aggressors, and the nuclear-armed state must lack allies and must not have a secure, second-strike nuclear capability (SSSC, e.g. submarine-launched nuclear ballistic missiles).

Tagma's logic echoes Paul's: namely, that if a country does not face an existential threat, "the security costs of holding on to nuclear weapons outweighed any advantage of keeping them in those countries."⁶⁶ When states have nuclear weapons, according to this logic, other nuclear-armed states have a reason to attempt a first-strike that cripples their nuclear capabilities. According to Tagma, giving up nuclear arms (or in Paul's analysis, deciding not to acquire them) removes the incentive for other states to attack the nuclear-armed state with nuclear weapons, and leads to a net improvement in a state's security environment. Tagma's second hypothesis – that states which do not face an existential threat, but have a secure second-strike capability will not give up their nuclear arms – fills in the gap in Paul's analysis. This secondary hypothesis argues that since an aggressor cannot reliably destroy a country's secure second-strike capability in a pre-emptive attack, an attack on a state with such a capability would invite a nuclear response. Having a secure second strike capacity nullifies the risk that having nuclear weapons invites aggression. While this is not the logic that Paul articulates (recall, he suggests "great powers" will not abandon their nuclear arms due to the unique set of incentives they face), the set of states that – according to Tagma – both lack an existential threat and have a SSSC (France, Russia, the United Kingdom, and the United States) maps nearly perfectly onto Paul's "great powers."⁶⁷

⁶⁶ Tagma, 173.

⁶⁷ Paul claims that China, France, Russia, the United Kingdom and the United States are great powers.

Paul and Tagma's explanations share a number of common elements. Both hypothesize that nuclear arms, under certain conditions, are net contributors to a state's insecurity, and that governments therefore have a clear and evident reason to discard them. This explanation is more satisfying for a state such as Ukraine – which Paul and Tagma both claim support their arguments – which never sought to acquire nuclear arms, but by an accident of history obtained them. It is a less satisfying explanation for nuclear abandonment in general, since it requires governments to not consider the consequences of their actions when developing nuclear arms. Specifically, states that set out to acquire nuclear arms would presumably assess how other governments might react to that policy. If a state is in a relatively low-conflict region, and is secure, and concludes (or knows) that acquiring nuclear arms will invite hostility where none already exists, we would not expect them to begin nuclear weapon activities in the first place. While foreign policy decisions are made under imperfect information, and governments might have to begin a nuclear weapon program in order to accurately determine how much a nuclear weapon program will benefit or harm them (i.e. when country A conducts nuclear weapon activities, country B's reaction reveals country B's preferences), neither Paul nor Tagma discuss that possibility, and both implicitly treat states as making decisions in the presence of perfect (or near perfect) information.

While neither Paul nor Tagma study the Libyan government's decision to abandon its nuclear weapon activities in the early 2000s, some of their logic appears consistent with what we know about the Libyan case. Braut-Hegghammer's account of Libya's decision to get rid of its nuclear weapon program concludes that the Gadhafi government concluded that as their relations with the UK and US improved in the late 1990s (with the settlement of the Lockerbie issue),

nuclear weapons were becoming less important for guarantee the regime's security.⁶⁸ According to Braut-Hegghammer, when the United States adopted an aggressive foreign policy stance after the September 11, 2001 attacks, Tripoli was also concerned that the US might use military force against Libya. When the US continued constructive diplomatic relations with Libya after 9/11 – while singling out Iraq, Iran, and North Korea as potential threats – Braut-Hegghammer contends that the Libyan government saw an opportunity to get rid of a weapons program that was of dubious military value, and cement an improved relationship with the US.⁶⁹ Libya, according to this account, abandoned its nuclear weapon activities for two reasons: first, its relationship with the US and UK had improved significantly, reducing the need for nuclear weapons. Secondly, if Libya continued its nuclear weapons activities in a post-9/11 strategic environment, Tripoli risked damaging that newly improved relationship with Washington, which would pose a new threat to the Ghadafi government. Braut-Hegghammer's explanation of Libya's nuclear abandonment decision thus combines elements of both Paul's explanation (a fear that nuclear arms will create a security dilemma) and Tagma's claim that the lack of a major state-based threat is necessary for a state to abandon its nuclear efforts.

Another paper that comes to a similar conclusion to Paul's, is Bergner's study of four cases – South Korea, Argentina, Brazil, and Libya – that concluded that the decision to abandon nuclear weapon activities in each country was well explained by events in each state's security environment.⁷⁰ His conclusions further echo Paul's in that he finds the NPT and its associated verification and monitoring regime had little effect on these four cases. Overall, Bergner's explanation resembles, in many ways, an inductive version of Paul's. Bergner sets out to

⁶⁸ Målfrid Braut-Hegghammer, "Libya's Nuclear Turnaround: Perspectives from Tripoli," *Middle East Journal* 62.1 (2008): 71.

⁶⁹ Ibid.

⁷⁰ Jonathan D. Bergner, "Going Nuclear: Does the Non-Proliferation Treaty Matter?," *Comparative Strategy* 31.1 (2012): 84-102.

determine if the NPT helped nudge countries towards nuclear abandonment, and instead, through a reading of the secondary literature, determines that in each case national security policy dictated the fate of the nuclear weapon program. In South Korea, American pressure was decisive. In Argentina, resolving the Beagle Channel dispute with Chile and numerous confidence building measures with Brazil made the difference. Bergner does not offer a single, generalizable logic for his four cases, but nevertheless comes to some similar conclusions to Paul, Tagma, and Braut-Hegghammer.

Overall, explanations for nuclear abandonment that focus on countries' security environments and their overarching national security policies and goals draw some reasonable conclusions. The claim that nuclear weapons are often threatening and often unnecessary for national security purposes is wholly reasonable and intuitive. What that explanation lacks, however, is a clear line between why states start nuclear weapon activities despite the inappropriateness of nuclear arms for their policy goals. Of course, security environments can change. States might resolve disputes and end conflicts while they are conducting nuclear weapon activities, and thereby make their nuclear weapon activities obsolete. A clearer picture of how big a change must occur in a state's security environment before it abandons its nuclear weapon activities, and if the effect of that change is constant across states or varies depending on other factors (such as the character of the government, or a history of previous armed conflict with another state) would be welcome. Ultimately, these security-based explanations of nuclear abandonment are unsatisfying, since the analysts often describe countries facing different security challenges all coming to the same policy conclusion. According to this body of work, Switzerland abandoned its nuclear weapon activities due to concerns that the USSR would target it with its own arms. South Korea gave up its activities due to American diplomatic pressure and

threats that Washington would revise its Korea policy. Brazil and Argentina gave up their activities due to a deliberate *rapprochement* between the two states. Libya abandoned its in order to ingratiate itself with the US. In short, while all these explanations can be reasonably characterized as policy choices driven by security concerns, on close inspection, the logic that binds them is not particularly evident.

2.2.2 Domestic Politics

An additional, secondary argument that Paul, Braut-Heghammer, and Bergner all implicitly make is that policy makers often trade off their nuclear weapon activities in order to maintain (or establish new) trading and economic relationships with other states. According to these accounts, not only do nuclear weapon programs menace other states and invite hostility, they may also invite economic sanctions, and thereby interfere with commercial relations. Thus, when matters of national prosperity are on the line, nuclear weapon activities may be worth abandoning. This line of argument reflects classic neoliberal reasoning: if states can identify a mutually beneficial deal, they will, all other things being equal, make that bargain. Etel Solingen, in *Nuclear Logics*, offers a fascinating twist on classic neoliberal/peace-through-trade logic by combining it with the claim that nuclear weapons acquisition (and abandonment) is really about the political survival a country's ruling elite.⁷¹ Specifically, Solingen argues that rulers who rely on a coalition of nationalist, atavistic individuals with large financial interests in import-substituting industries to remain in power are more likely to acquire nuclear weapons than rulers who rely on a coalition of cosmopolitan, internationalist sectors of society with interests in export-oriented economic sectors. This is because Solingen assumes that other states (and presumably financial actors) will sanction, isolate, and deny market access to nuclear proliferators. Since this will harm outwardly-oriented parts of society, leaders that rely on those

⁷¹ Solingen (2007).

groups to rule will not build nuclear arms. On the other hand, a nuclear weapon program gives governments an opportunity to funnel financial resources towards the sectors of society that keep them in power. For example, Solingen argues that Iraq's nuclear weapon program was ultimately, at its core a form of patronage, which helped keep Saddam Hussein in power.⁷² By spending millions (or even billions) of dollars on the program, Hussein created another sector of society (like his Tikriti clan, or the Iraqi armed forces) that relied on his rule for their livelihoods.

While Solingen provides an appealing argument, it is difficult to assess how well her claims fit with the empirical record. This is in part because Solingen does not clearly define, operationalize, and offer measures of how dependent a ruling cadre is upon outwardly/inwardly-oriented constituencies to maintain their hold on power. While the manner in which Solingen classifies countries is generally intuitive, in some cases the lines are fuzzy. Take for example Egypt, which Solingen describes as inwardly-oriented under Nasser, and outwardly-oriented under Sadat. Other scholars, such as Michael Barnett, have argued that in fact the liberalization of Egypt's economy began under Nasser's rule.⁷³ Solingen's lack of a clear definition for her key independent variable also becomes apparent when studying South Korea's nuclear program under President Park Chung Hee. While Park's Korea pursued an export-oriented economic growth strategy, the Korean government – rather than the private sector – led and directed that strategy, and relied on the armed forces and intelligence services as the core of their domestic political base.⁷⁴ An additional complexity is that the original impetus for economic reform came, to some extent, from Washington D.C., which was worried about the cost of propping up South

⁷² Solingen (2007), 156-157.

⁷³ Michael Barnett, *Confronting the Costs of War: Military Power, State, and Society in Egypt and Israel* (Princeton, NJ: Princeton University Press, 2012), 212-225.

⁷⁴ Stephen Haggard, Byung-Kook Kim, and Chung-in Moon, "The Transition to Export-Led Growth in South Korea, 1954-66," *World Bank Policy, Research, and External Affairs Working Papers* 546 (1990): 1-48; Taehyun Kim and Chang Jae Baik, "Taming and Tamed by the United States," in Byung-Kook Kim and Ezra F. Vogel, eds., *The Park Chung Hee Era: The Transformation of South Korea* (Cambridge, MA: Harvard University Press, 2011): 58-84.

Korea's economy and armed forces. In turn, the US was often willing to turn a blind eye to Park's repressive domestic policies, so long as economic and political reform continued.⁷⁵ While the difference between a government that relies on a liberal constituency and one that relies on an autarkical one is clear at the extremes, some of the governments in Solingen's key cases – such as Park's South Korea – could easily be thought of as relying on complex coalitions that include both camps.

Statistical evidence also fails to offer much support for Solingen's argument. In *Nuclear Logics* Solingen approvingly cites Singh and Way's finding that on average, the more a state trades with the rest of the world (operationalized as percentage of GDP represented by trade), the less likely they are to acquire nuclear weapons.⁷⁶ While at first blush this appears to be a powerful piece of evidence in support of Solingen's hypothesis, not acquiring nuclear weapons and abandoning nuclear weapon programs are not the same thing. Furthermore, as chapter four of this study shows, there is little evidence that standard measures of economic openness are systematically related to nuclear abandonment.

There are also some outlying cases that Solingen could better explain. Take India, for example, which loosened its capital controls and increased its reliance on foreign investment at the same time New Delhi conducted the Pokhran-II nuclear bomb tests.⁷⁷ While Solingen argues that her regime survival logic may not hold when a state faces an existential threat, the fact that countries have successfully developed nuclear weapons (or practiced vertical proliferation) while attracting international capital and foreign trading partners does pose a challenge to Solingen's

⁷⁵ Kim and Baik, 80.

⁷⁶ Solingen (2007), 275, 307, 345.

⁷⁷ Vijay Joshi, "India and the Impossible Trinity," *The World Economy* 26.4 (2003): 555-583; Stephen Shulman, "Nationalist Sources of International Economic Integration," *International Studies Quarterly* 44.3 (2000): 365-390. Similarly, the Pakistani government launched a series of policy reforms in the 1980s that sought to increase inflows of FDI, and by the 1990s, over 50% of gross fixed capital formation in Pakistan came from foreign sources. See Anjum Aqeel and Mohammed Nishat, "The Determinants of Foreign Direct Investment in Pakistan," *Pakistan Development Review* 43.3 (2004): 651-664.

causal logic.⁷⁸ Interestingly, Jacob's study of the effects of economic sanctions on states seeking nuclear weapons found that sanctions seem to be most effective at helping end nuclear weapon activities when they are applied in situations where the proliferator is already facing a security challenge.⁷⁹ When an ally or an adversary imposes (or threatens to impose) economic sanctions on the proliferator, the sanctions (or threat) send a clear message that the sender is willing to harm themselves, and is willing to inflict pain and create further insecurity for the proliferator in order to stop their nuclear weapon activities. Jacob thereby provides an explanation for a specific sub-set of cases that is based on similar mechanisms as Solingen's explanation, but Jacob's explanation works in precisely the cases where Solingen claims her explanation does not apply.

Solingen's research design also raises some questions about the general validity of her findings. She compares East Asia and the Middle East after 1968 and characterizes her research design as pseudo-experimental.⁸⁰ Both areas, she argues, were nationalistic and economically inward-looking before 1968, but after that year East Asia (less North Korea) liberalized and denuclearized, while the Middle East remained inwardly-oriented and nuclearized.⁸¹

There is, however, at least one major difference between the two regions that Solingen does not control for. The United States has boasted a large economic and military presence in East Asia since 1945, particularly when compared with the Middle East. At times, the US

⁷⁸ It also begs the question: what constitutes an existential threat? Solingen's cases include South Korea and Taiwan, both of which have long-standing, serious conflicts with neighbours they went to war with in the past. Taiwan's rival – the People's Republic of China – has also had nuclear weapons since 1964 and has enjoyed quantitative superiority in conventional weapons over Taiwan for longer still.

⁷⁹ Neerada Jacob, "Understanding Nuclear Restraint: What Role do Sanctions Play?," PhD. diss., American University, 2012.

⁸⁰ Solingen (2007), 9.

⁸¹ Solingen's measurement of "nuclearization" is debatable. In East Asia, the DPRK, ROK, ROC, and Japan all explored and/or considered nuclear arms after 1968, and North Korea has built nuclear explosives. In the Middle East, Israel went nuclear around 1968, while Iran, Egypt, Iraq, and Libya have had (or have) nuclear programs. Egypt ended its activities just after Nasser's death, and Libya terminated its program in the early 2000s. It is unclear if the Middle East has been significantly more "nuclearized" than East Asia since 1968. In sum, each region has one case of a state acquiring and retaining nuclear weapons since 1968; East Asia has three cases of states that have at least considered nuclear arms since 1968, and then abandoned that policy; the Middle East has four such cases, and the indeterminate case of Iran.

presence in East Asia verged upon hegemonic dominance of the area.⁸² In four of Solingen's five cases of denuclearization, the denuclearizing state either had strong military and economic ties to the US, or was seeking out a new relationship with America (Japan, South Korea, Taiwan, and Sadat's Egypt).⁸³ Given the long history of American nuclear non-proliferation efforts, and the large American military and political presence in post-war East Asia, it is reasonable to suspect that American policy efforts may have had some important effect in some of Solingen's cases.⁸⁴

These critiques do not invalidate Solingen's argument. They do, however, raise doubts about its general applicability and about the claim that nuclear abandonment is overwhelmingly a product of domestic politics and that foreign policy considerations play only a minor role in nuclear decision-making. While it is entirely plausible that a government's need to placate domestic constituents plays a role in the decision to abandon a nuclear weapons program, it is by no means clear that this is the sole or predominant cause.

2.2.3 Norms and Individual Psychology

Along with realist and liberal explanations for nuclear abandonment, scholars have also offered a host of explanations based on variations in constructivist thought. Rublee's

⁸² Michael Mastanduno, "Incomplete Hegemony: The United States and Security Order in Asia," in Muthiah Alagappa, ed., *Asian Security Order: Instrumental and Normative Features* (Stanford, CA: Stanford University Press, 2003), 141-170; G. John Ikenberry, "American Hegemony and East Asian Order," *Australian Journal of International Affairs* 58.3 (2004): 353-367.

⁸³ The fifth case is Libya's denuclearization. The Libyan case can be interpreted as being consistent with the suggestion that it is American preferences that drive denuclearization, since there is indeterminate evidence that Gaddafi used his nuclear and chemical weapon programs as a bargaining chip in negotiations to secure a new political relationship with the US and UK. Braut-Hegghammer's, Helfstein's, and Jentleson and Whytock's accounts of Libya's nuclear abandonment decision all cite American diplomatic pressure and Libya's desire to improve its relationship with Washington as important factors in the case. See Scott Helfstein, "Friends Don't Let Friends Proliferate," *Political Science Quarterly* 125.2 (2010): 281-307; Bruce W. Jentleson and Christopher A. Whytock, "Who 'Won' Libya? The Force-Diplomacy Debate and Its Implications for Theory and Policy," *International Security* 30.3 (2005): 47-86.

⁸⁴ In fact, Solingen does acknowledge that American diplomats did attempt to dissuade Taipei from continuing its nuclear weapons program; Solingen (2007), 108. Mehta's quantitative assessment of efforts by the United States to induce or coerce countries to abandon their nuclear weapon activities is also consistent with this line of thinking: Mehta finds that instances of abandonment are often associated with large increases in American conventional military aid to would-be proliferators. See Rupal N. Mehta, "Deproliferation Dynamics: Why States Give Up Nuclear Weapons Programs," PhD diss., University of California, San Diego, 2014.

Nonproliferation Norms uses constructivist theory to suggest that an anti-nuclear norm has emerged since 1968 and that it has influenced policy makers in some states towards nuclear forbearance. Rublee first constrains her universe of cases by identifying states that both neighbour a nuclear weapon state, and engage in “nuclear activity” (that is have an operating power or research reactor, or export nuclear materials).⁸⁵ These states, in theory, have both the motive and means to build a nuclear weapon. Rublee then argues, on the basis of five cases, that an anti-nuclear norm helped push Libya, Sweden, and Egypt towards abandoning their nuclear weapon programs, and kept Germany and Japan from seeking them in the first place.

While Rublee’s case studies are impressively detailed, two aspects of *Nonproliferation Norms* cast some doubt on the overall robustness of her conclusion. The first aspect is methodological. Rublee selects her cases on the dependent variable, analyzing five countries that never acquired nuclear weapons. This begs the question, if these norms exist and influence policy makers, why did they not work in this fashion in South Africa, India, Pakistan, or North Korea? Rublee makes a bold argument that global nuclear norms influenced Muammar Gadhafi’s decision to denuclearize. Thus, there is no reason, without further specifying the theory, to claim that these norms can have no effect in North Korea, or the other eight countries with nuclear arms, for example. If nuclear norms interact with other variables, or require antecedent conditions to maximize their effect, ideally these interactions or conditions should be specified. Arguing that policymakers ought to reinforce antinuclear norms may be generally sound advice, but better yet would be describing the conditions under which norm reinforcement is likely to have the strongest effects, and when conditions make it likely to be futile.

The second is theoretical: Rublee tends to uncritically assume that the NPT’s effect is purely independent. In this context that means that by virtue of a country

⁸⁵ Rublee (2009), 30-31.

signing/ratifying/acceding to the NPT, the state becomes influenced by it. In fact, Rublee asserts that if “the NPT collapsed, the social costs and benefits associated with it may no longer exist, potentially leading to a reassessment of a state’s nuclear posture.”⁸⁶ An independently effective NPT is at odds with some of her explanations for how social norms cause states to forego nuclear weapons. For instance, she argues that injunctive norms and subjective norms respectively work on the basis of one state admonishing another, and on the basis of policymakers believing that “important others” (such as another country or a domestic constituency) want a state to behave in a certain fashion.⁸⁷ In the case of nuclear abandonment, both of these norm mechanisms can work without the NPT. In fact, Rublee’s injunctive norm works specifically on the basis of a norm entrepreneur – such as a state or civil society group – lobbying a country to abandon its nuclear weapon activities or forego nuclear arms. Both the United States and United Kingdom had domestic anti-nuclear weapon civil society movements years before the NPT was negotiated, and the US and USSR both indicated their preference for a world with fewer – rather than more – nuclear-armed states when they began exploring ideas for a non-proliferation treaty as early as the late 1950s.⁸⁸ The UK’s Campaign for Nuclear Disarmament and the US’ Women Strike for Peace organization can both be easily understood as injunctive norm entrepreneurs, and both made their cases in a world without the NPT. Likewise, long before the NPT was formalized, the US government in particular made efforts to limit the spread of nuclear weapons part of its foreign policy.⁸⁹ The NPT may have been a way for states to formalize the fact that they do not

⁸⁶ Maria Rost Rublee, “Taking Stock of the Nuclear Nonproliferation Regime: Using Social Psychology to Understand Regime Effectiveness,” *International Studies Review*, 10.3 (2008): 422. See Rublee, “Scholarly research on nuclear exits: the role of civil society,” *Medicine, Conflict and Survival* 30.2 (2014), s35-45 for a similar claim.

⁸⁷ Rublee (2009), 44.

⁸⁸ Some analysts argue that the US publicly outlined the basic policy ideas that would eventually make their way into the NPT as early as 1946, when it presented the Baruch Plan to the United Nations. See George Bunn and John B. Rhinelander, “Looking Back: The Nuclear Nonproliferation Treaty Then and Now,” *Arms Control Today* 38.6 (2008). <https://www.armscontrol.org/act/2008_07-08/lookingback>

⁸⁹ Joseph S. Nye, “Nonproliferation: A Long-Term Strategy,” *Foreign Affairs* 56.3 (1978): 601-623.

want other states to develop nuclear arms, but it is unclear why the NPT ought to be analytically treated as an independent normative force. Instead, it reflects the preferences of the states that negotiated, implemented it, and maintain it. Ultimately, Rublee's subjective and injunctive norm mechanisms can be reasonably understood as classic diplomacy: states nudging and persuading each other to change their policies.⁹⁰ While Rublee is likely correct that governments do not only succumb to this diplomacy because of the material sticks and carrots that a state might offer, but also because they identify with the state doing the diplomacy, then it is the influence of diplomats, and not the independent effect of the NPT that is at work.

This distinction is important where normative pressure and "traditional" diplomatic pressure are both potentially present. Take, for example, Hersman and Peters' account of the decisions by South Korea and Taiwan to abandon their nuclear weapon activities.⁹¹ Hersman and Peters conclude that American diplomatic pressure, and in particular, threats to remove (or reconsider security guarantees) had an important effect in Seoul and Taipei, ultimately helping convince both governments to stop their nuclear weapon activities. Clearly distinguishing between when it is the influence of a specific country that is changing government minds and when a broader social expectation is at work (or indeed if they are working together) is critical for governments that make diplomacy a central plank of their non-proliferation policy.

Rublee is not the only scholar to explicitly argue that the NPT causes states to abandon their nuclear weapon activities. Müller and Schmidt make an ambitious argument that

⁹⁰ Even when Rublee argues that the NPT itself sent a normative message to Japan, she invokes the role of other states. According to Rublee, "for Japan, the creation of the NPT did influence nuclear decision-making. After the Chinese nuclear test of 1964, the Japanese elite considered whether to acquire a nuclear option. Officials knew that the United States was negotiating for a global nuclear arms control agreement and that a Japanese nuclear weapons program would not go over well." In similar fashion, she claims that it is the Japanese people that keep Japan from acquiring nuclear arms. Rublee relays the opinion of one Japanese Ministry of Defense official who believes that Abe Shinzo "probably does want nuclear weapons privately, but he would never express it," due to concerns about how the Japanese public might respond. See Rublee (2009), 78, 88.

⁹¹ Hersman and Peters.

democratic countries – and particularly those that were established as sovereign states after 1960 – are more likely to abandon their nuclear weapon programs than autocratic states.⁹² Müller and Schmidt’s study stands out in the literature for two reasons. First, it is one of the few academic studies to explicitly offer an explanation for nuclear abandonment (rather than using the broader concept of nuclear forbearance). Second, Müller and Schmidt use a simple quantitative empirical method to substantiate their claims. Given that this study uses a similar question and empirical method, Müller and Schmidt’s effort merits a relatively thorough critique and assessment. While Müller and Schmidt make some bold and testable claims, overall their hypotheses could be better specified, and their empirical work leaves much to be desired.

At the core of Müller and Schmidt’s argument is their claim that Ireland’s 1961 UN General Assembly resolution (1665), which called for states to conclude an agreement to prevent the further acquisition and spread of nuclear weapons, had a profound effect on the global normative environment. In sum, they argue that for states that became independent after 1961, not owning nuclear weapons was a *sine qua non* of good global citizenship, and the Irish Resolution established an injunctive norm that profoundly influenced those states. They also assert that it did not have the same effect on states that were established before the Irish Resolution. According to Müller and Schmidt, states that became independent after 1961 almost exclusively have not begun nuclear weapon activities *because* they achieved independence after the General Assembly passed resolution 1665. They do not, however, explain why this should be the case. They offer no explanation for why it is when a state was established, and not, for example, when its first generation of leaders were born or entered politics that should determine the effect of the Irish Resolution. Müller and Schmidt also fail to discuss the fact that as early as 1957, the United States (along with Canada, France, and the United Kingdom) had submitted a

⁹² Müller and Schmidt.

package of proposals to the United Nations Disarmament Commission which included (among other provisions) restrictions on the transfer of nuclear weapons and fissionable material, and a monitoring system to verify compliance.⁹³

Nevertheless, according to Müller and Schmidt, the NPT further reinforced the UNGA 1965 norm, helping to create a legal and social environment where owning nuclear weapons or conducting nuclear weapon activities was (and is) seen as unacceptable. This anti-nuclear norm also interacts with democracy to cause nuclear abandonment. Authoritarian regimes, according to Müller and Schmidt, are less sensitive to global norms than democratic countries. However, authoritarian regimes, if they liberalize even incrementally, will become more likely to abandon their nuclear weapon activities.

To substantiate their claims and to evaluate some alternative hypotheses, Müller and Schmidt offer a number of tests. Their tests are largely informal, involve before-and-after comparisons (i.e. comparative statics) and are bivariate. As a consequence, their methodological choices lead to unconvincing findings for at least two reasons. The first reason is that given the lack of formal tests of variance and significance, it is hard to determine if they report anything other than random variation. The second reason is that by using bivariate tests (e.g. tests that look for a relationship between a country's nuclear status and a single other factor, such as its security environment) – rather than multivariate tests – Müller and Schmidt may be reporting some spurious correlations.

⁹³ United Nations Disarmament Commission, "Canada, France, United Kingdom of Great Britain and Northern Ireland and United States of America: working paper Proposals for Partial measures of disarmament," 29 August 1957, DC/SC.1/66; see also United Nations, "Disarmament Commission Official Records Supplement for January to December 1957," (France: 1957), 74-79. For details on the negotiations between the US and its allies, see David S. Patterson, ed., *Foreign Relations of the United States, 1955-1957, Regulation of Armaments; Atomic Energy*, Vol. XX (Washington, D.C.: United States Government Printing Office, 1990).

One illustrative example of the shortcomings in Müller and Schmidt’s empirical methods is Table 2.1, which reproduces their work.

Table 2.1 Reproduction of Müller and Schmidt’s NPT Hypothesis

	Before NPT	After NPT
Nuclear Weapon Activity (NWA) Start	41.38% (24 of 58)	15.66% (13 of 83)
Nuclear Weapon Activity (NWA) Stop	12.5% (3 of 24)	67.65% (23 of 34)

The data in the four cells is as follows: cell 1 (upper left) is the proportion of “economically capable” states that initiated nuclear weapon activities before 1970. Cell 2 is the proportion of “capable” states that initiated nuclear weapon activities after 1970 (the numerator does not include states that initiated activities before 1970 but did not abandon them before 1970). Cells 3 and 4 (lower left and right) are the proportion of states that abandoned their nuclear weapon activities during that period. Critically, Müller and Schmidt present this data as evidence that the NPT caused states to abandon their nuclear weapon activities because the treaty created an anti-nuclear norm. Müller and Schmidt do not consider the possibility that the NPT may have had other effects, such as reducing the availability of fissile materials and technical assistance, or raising concerns in some states that inspectors might detect their efforts to build nuclear arms.

One of these alternatives – that the NPT and its associated regime made nuclear technology less available to states – can easily be tested using Müller and Schmidt’s method. In 1975 a number of technologically advanced states formed the Nuclear Suppliers Group (NSG). These states established the NSG in response to India’s nuclear weapon test in 1974, and as a group of states with advanced nuclear industries, they intended the NSG to restrict the availability of nuclear technologies and materials to states that ratified the NPT and were abiding by its requirements. One could easily hypothesize that the NSG made acquiring the necessary

nuclear technology and materials for building nuclear weapons more difficult (compared to the pre-NSG period), and consequentially we should see few countries start nuclear weapon activities after 1975 and see large numbers of states abandon them after 1975. If we reproduce Table 2.1, using Müller and Schmidt's data to reflect abandonment rates before and after the establishment of the NSG, we get Table 2.2.

Table 2.2 Nuclear Suppliers Group Hypothesis

	Before NSG	After NSG
NWA Start	45.16% (28 of 62)	10.84% (9 of 83)
NWA Stop	28.57% (8 of 28)	62.07% (18 of 29)

The NSG hypothesis, at least by Müller and Schmidt's criteria, performs well. According to Table 2.2, the NSG hypothesis is better than the NPT hypothesis at predicting when states will begin nuclear weapon activities, and nearly as effective at explaining nuclear abandonment. Ultimately, however, this is a weak test. Comparative statics, like this test, that take only a single independent variable into account, are robust to measurement errors, but unconvincing since they offer no reason to suspect that the results are not spurious.

An additional weakness with this sort of test is the data structure. According to Müller and Schmidt's data, the number of states with ongoing nuclear weapon activities peaked around 1985.⁹⁴ This is largely a function of a number of nuclear weapon programs that had been initiated years earlier surviving into the 1980s. Towards the end of the 1980s, a wave of nuclear abandonment occurred. The decline in the number of states conducting nuclear weapon activities from the 1985 peak can be plausibly explained by simply assuming that nuclear weapon program duration approximately follows a geometric distribution. Thus, even if a nuclear weapon program survives one year, there is a chance that it will be abandoned the next year. Even if the

⁹⁴ Müller and Schmidt, 185.

risk of being abandoned is the same every year, so long as the program exists, it can be abandoned. Over time the cumulative likelihood that it will be abandoned grows. To put it simply, Müller and Schmidt, by dividing their data into pre-NPT eras and post-NPT eras make it difficult to exclude the possibility that the relatively large number of states that abandoned their nuclear weapon activities after the creation of the NPT is a simple function of there being more instances of countries with nuclear weapon activities in the years after 1970 than beforehand.⁹⁵

Finally, Muller and Schmidt's UNGA 1665/NPT hypothesis is as much (or more so) about nuclear weapon program onset as it is about abandonment. They claim that UNGA 1665 had a major effect on nuclear proliferation on the basis that only one country that became independent after UNGA 1665 launched nuclear weapon activities. This is a better explanation for why states do not begin nuclear weapons activities in the first place, rather than an explanation for nuclear abandonment. Rublee makes a similar claim, ultimately hypothesizing that states are less likely to start nuclear weapons programs after the NPT entered into force than before.⁹⁶

In addition to studies that draw a direct connection between global norms and nuclear abandonment, there is also small body of literature that looks at "nuclear decisions" and their

⁹⁵ An additional anomaly in Müller and Schmidt's data is their definition of "nuclear weapon activities". They reject Sing and Way and Jo and Gartzke's ordinal scaling of exploration, pursuit, and acquisition, and prefer to instead use a binary measure: either a state is conducting nuclear weapon activities, or it is not. Muller and Schmidt's decision to use a binary, rather than an ordinal coding, is logical and methodologically sound. However, they use a low threshold for defining "nuclear weapon activities" and do not appear to apply that threshold consistently. For example, they code West Germany as conducting nuclear weapon activities from the period of 1956-60 to 1966-70. While my own reading of the history concurs with their assessment of 1956-60 (Germany was part of a tripartite plan with Italy and France to build nuclear weapons), their 1966-70 coding is based on the claim that they learned that some subsidiaries of the Fraunhofer Society conducted research that could be used to build nuclear weapons, such as relatively sophisticated explosive engineering experiments. They argue that Franz Josef Strauss – who is widely regarded to have held the belief that West Germany should acquire nuclear weapons – "shielded" these activities. However, they admit they cannot furnish any documentation that describes these experiments, and cite Harald Müller, "Germany and WMD Proliferation," *Nonproliferation Review* 10.2 (2003): 1-20. In that article, Müller only mentions Strauss in regard to the 1957 French-German-Italian nuclear scheme, and there is no mention of the Fraunhofer Society.

⁹⁶ Rublee (2009), 78.

relationship with individual leaders' beliefs and identities. Of these works, two studies stand out: Hymans' *Psychology of Nuclear Proliferation* and O'Reilly's *Beliefs and the Bomb*.⁹⁷ Both Hymans and O'Reilly only analyse cases where a government has already crossed a policy threshold where they have demonstrated at least an interest in acquiring or building nuclear weapons.⁹⁸ According to both authors, the decision whether to build a nuclear bomb or stop is ultimately a function of the beliefs of a country's leader. Hymans argues that this decision is determined according to a leader's National Identity Conception (NIC), while O'Reilly uses the concept of the "operational code" (a set of basic beliefs about, among other things, how conflictual the world naturally is and how politics "works"). Both Hymans and O'Reilly place heads of government at the centre of their arguments, and basically argue that whoever leads a national government has a tremendous effect on the likelihood that a given state acquires a nuclear weapon.

Both Hymans and O'Reilly border on offering "great man" theories of nuclear proliferation. In getting rid of one analytical simplification, such as the unified state actor assumption, they (perhaps unwittingly) adopt another analytical simplification, which in this case is the critical decision maker, who unilaterally shapes major policy outcomes.⁹⁹ Both authors

⁹⁷ Hymans (2006); K.P. O'Reilly, "Beliefs and the Bomb: The Role of Leaders' World Views and Strategic Interactions on Proliferation Decisions," PhD diss., University of Southern Carolina, 2009. See also Kelly P. O'Reilly, *Nuclear Proliferation and the Psychology of Political Leadership: Beliefs, Motivations and Perceptions*. Routledge, 2014.

⁹⁸ The sole exception to this is Hyman's case study of Argentina. Hymans maintains that Argentina never had a nuclear weapons program. The widely held belief that Argentina was at least investigating nuclear weapons throughout the 1970s and 1980s is, according to Hymans, a product of Western (largely American) misreading of Argentina's peaceful nuclear energy program. See Jacques Hymans, "Of gauchos and gringos: Why Argentina never wanted the bomb, and why the United States thought it did," *Security Studies* 10.3 (2001): 153-185.

⁹⁹ Of course, theories that use individual traits to explain larger social outcomes are not confined to political science and international relations literature. Those that study organizational leadership and business practices, for example, have generated a large literature that looks for the correlates of effective leadership. The research has found that both "innate" and "learned" characteristics matter. In other words, it is neither purely personality or inborn beliefs, or acquired skills that make an individual an effective leader. See Brian J. Hoffman, David J. Woehr, Robyn Malagen-Youngjohn, and Brian D. Lyons, "Great Man or Great Myth? A Quantitative Review of the Relationship Between

justify this simplification in a similar fashion, arguing that the decision to build a nuclear bomb (or, presumably, abandon such an effort) is a “big decision” characterized by incomplete information, novelty, and the participation of a relatively small number of individuals.¹⁰⁰

As is the case with many of the studies cited in this review, Hymans and O’Reilly also tend to conclude that their leader’s preferences hypothesis is a better fit (or the “best” fit) than other, competing explanations.¹⁰¹ Neither author provides particularly robust or compelling tests of alternative hypotheses though. This, in and of itself is not particularly important if one makes the assumption that nuclear abandonment and proliferation are caused by a combination of factors that add up or interact to create any given outcome. However, if an analyst is looking for the “best” explanation in terms of statistical leverage or the most satisfying or empirically “correct” explanation, then it is incumbent upon the analyst to rigorously and thoroughly assess competing hypotheses.

Hymans and O’Reilly’s works would benefit from more thorough tests of alternative hypotheses, since both essentially argue that individual government leaders’ beliefs and personalities are the most important factor in determining political decisions. This claim practically rejects the possibility that the environment that political leaders live in can have its own substantive effects by conditioning them to believe certain things about the nature of international politics. This leads to some unsatisfying conclusions: O’Reilly, for example, provides compelling evidence that B.J. Vorster, who formally authorized South Africa’s nuclear weapon program, had a preference for pro-active policy measures and believed that he could meaningfully shape South Africa’s political environment through such efforts. However,

Individual Differences and Leader Effectiveness,” *Journal of Occupational and Organizational Psychology* 84.2 (2011): 347-381 for a brief overview of this literature.

¹⁰⁰ O’Reilly (2009), 30-31.

¹⁰¹ O’Reilly (2009), 116, for example.

O'Reilly also admits that South Africa's security environment, in the early 1970s probably played an important role in the proliferation decision.¹⁰²

Similarly, in Hymans' study, NICs that are associated with nuclear proliferation are found among national leaders whose countries were involved (either at the time or in the recent past) in major international disputes which were associated with major armed conflict. Given France and Germany's history in the 19th and 20th centuries, Hyman's finding that Charles de Gaulle and Pierre Mendès France were both "oppositional nationalists" (the NIC that Hymans argues is most likely to turn to nuclear weapons) towards Germany, is hardly surprising. Hymans' work essentially begs the question: to what extent does history shape a politician's view of the world, and to what extend do politicians alone shape their environment. Hymans wavers between arguing that NICs are exogenous (i.e. they are the creations of national leaders who "market" them to their populace) and that NICs are formed when individuals collect and modify existing ideas about national identity.¹⁰³ Of course, reality is probably a combination of the two, but if certain historical events (such as long-standing hostile relations that lead to war between two states) are, *ceteris paribus*, associated with certain NIC types, Hymans' claim that beliefs about national identity are an independent cause of nuclear weapon acquisition (or a lack thereof) is unsatisfying. It is plausible that politicians in countries that have conflicts with other states are simply more likely to adopt an oppositional nationalist NIC. In other words, Hymans' finding could be spurious: both nuclear weapon acquisition and oppositional nationalists NICs could be, at least in part, caused by a country's history and security environment.

Nonetheless, Hymans and O'Reilly offer a useful reminder that it is fallible human beings, who exhibit an array of cognitive biases, who ultimately interpret their environment and

¹⁰² Ibid.

¹⁰³ Hymans (2006), 19.

make decisions accordingly. Assuming that the people who design, set, and execute nuclear weapon policy are perfectly rational may be analytically convenient but also difficult to defend on empirical grounds.

Long and Grillot provide a different explanation for nuclear abandonment that relies on the concept of a national identity. Their explanation, however, uses a national identity construct that is broadly shared and accepted by a society as a whole, rather than national identity as subjectively defined by an individual government leader. Long and Grillot's argument is essentially one about preferences: they accept the assumption that states are rational utility maximizers. Importantly though, Long and Grillot assert that a state's preferences are a function of its national identity (i.e. society's beliefs about itself).¹⁰⁴ Thus, in their two case studies of South Africa and Ukraine, they implicitly argue that both countries abandoned their nuclear weapons in an effort to maximize their utility, which both defined as being – politically and economically – part of the “West”.

Ursula Jasper provides a unique analysis of the Swiss and Libyan cases in *The Politics of Nuclear Proliferation*.¹⁰⁵ Jasper takes an approach that she explicitly claims is an alternative to positivist attempts to explain horizontal nuclear proliferation, and suggests that a “pragmatist” approach to explaining why states abandon their nuclear weapon programs can provide superior answers.¹⁰⁶ Jasper's analysis, like Hymans' and O'Reilly's, draws heavily on the subjective beliefs of politicians to explain why Switzerland and Libya abandoned their nuclear weapon activities. However, where O'Reilly, Hymans, Long and Grillot, and Müller and Schmidt all present subjective beliefs about a state's (or leader's) identity as a fixed factor that can be

¹⁰⁴ William J. Long and Suzette R. Grillot, “Ideas, Beliefs, and Nuclear Policies: The Cases of South Africa and Ukraine,” *Nonproliferation Review* 7.1 (2000): 24-40.

¹⁰⁵ Jasper (2014).

¹⁰⁶ Jasper (2014), 9.

deductively used to make predictions about a state's behaviour, Jasper presents these beliefs as part of a process where politicians, bureaucrats, and others continually reassess major policy decisions.¹⁰⁷ Hence, Jasper is sceptical about positivist approaches to understanding why states abandon their nuclear weapon activities, and instead, she offers dense descriptions of how she believes policy debates in Switzerland and Libya changed over time. Among the broad factors that Jasper cites as important determinants of nuclear policy are policy makers' beliefs about their own national identity, and how their state is supposed to act (e.g. its "role" in the world) with and towards other countries.¹⁰⁸

Ultimately (to paraphrase another analyst), Jasper offers a "rough-and-tumble" approach to explaining nuclear abandonment, narrating the ebb and flow of the political process and inductively coming to conclusions, rather than using deductive theory to make sense of the empirical record.¹⁰⁹ While Jasper's analysis offers a novel approach to understanding nuclear abandonment, because of her methodological choices and epistemological approach, her explanations are essentially idiographic *post hoc* descriptions of the decisions made in Switzerland and Libya. This makes it difficult to use her analysis to develop hypotheses about general patterns of nuclear abandonment, or to make predictions about ongoing or hypothetical future cases of nuclear abandonment or proliferation. However, Jasper's assessment of the two cases offers the very useful reminder that analysts should, to the greatest extent possible, immerse themselves in the history of nuclear weapon decision-making, since policy makers' beliefs about nuclear arms may indeed change significantly over time.¹¹⁰

¹⁰⁷ Jasper (2014), 25-35.

¹⁰⁸ Jasper (2014), 41-42.

¹⁰⁹ Etel Solingen, "The Political Economy of Nuclear Restraint," *International Security* 19.2 (1994): 131.

¹¹⁰ In fact, the Swiss case study in chapter five of this thesis does suggest that the Swiss government's changing beliefs about nuclear weapons in the Swiss government are in fact reflected in the Swiss case study in chapter five of this thesis. However, this study finds that it was the Federal Council and military's changing beliefs about nuclear weapons' prevalence and military effectiveness that helped shape the final abandonment decision, rather than

Despite the numerous efforts to use social expectations, subjective beliefs, and constructivist concepts to explain nuclear abandonment, the fairly obvious hypothesis that nuclear abandonment may be a function of the world's nuclear non-proliferation regime continuously reinforcing an anti-nuclear norm is absent from the literature. While Müller and Schmidt and Rublee both make claims that the NPT plays a role in nuclear abandonment, both their principal works frame the effect of the NPT in binary terms: once the treaty came into being it exerted its anti-nuclear effect. This formulation of how the NPT affects government policies ignores the large body of legal instruments that proscribe testing nuclear weapons, the IAEA's associated safeguards, the various bilateral treaties between the US and USSR/Russian Federation that limit the size of each nation's arsenal, and other formal efforts by states to limit the spread of nuclear arms (such as nuclear-weapon-free zones). One could reasonably hypothesize that together, these treaties, agreements, and institutions continuously socialize policymakers to the point where politicians and bureaucrats broadly and genuinely hold a reflexive belief that states should not acquire or possess nuclear arms.¹¹¹ However, even if one accepts the proposal that the dense network of treaties, informal agreements, and arms control institutions can have an effect on the social acceptability of possessing nuclear weapons, this perpetual cycle of reinforcing anti-nuclear norms is probably a better explanation for why states do not have nuclear weapons (or do not attempt to acquire them), rather than why states abandon established nuclear programs.¹¹² As noted, some existing explanations that appeal to the

changing beliefs about the morality of nuclear weapons or their relationship to Switzerland's identity as a "neutral" country. See Japser, 102-103.

¹¹¹ For example, Nina Tannenwald cites the United Nations, other multilateral fora, and "an array of international agreements and regimes" (p. 436) as playing an important role in delegitimizing the notion of using nuclear weapons. See Nina Tannenwald, "The Nuclear Taboo: The United States and the Normative Basis of Nuclear Non-Use," *International Organization* vol. 53 no. 3 (1999): 433-468.

¹¹² This form of the norm hypothesis would also have to convincingly explain why these norms are insufficient to cause the nine states that are currently armed with nuclear weapons to abandon their nuclear programs.

normative effect of the NPT are likewise better explanations for nuclear abstinence than explanations for nuclear abandonment.

2.2.4 Bureaucracies and Managers as Determinants of Nuclear Success and Failure

The subset of literature that this study shares the most in common (at least with regard to theory) is a group of studies that argue that politics within a government are an important determinant of nuclear abandonment. Three studies stand out in particular, as each offers a different explanation for how bureaucrats can affect nuclear weapon policies. The three explanations are, briefly, classic bureaucratic self-interest causing either nuclear retention or abandonment; bureaucratic entrepreneurs “selling” the idea of nuclear weapons to political leaders, and; managerial incompetence leading to failed nuclear weapon programs.

James Walsh draws a clear and direct link between bureaucratic politics and nuclear weapon activities that never produce nuclear arms. Walsh hypothesizes that states either acquire or do not acquire nuclear weapons because the “bureaucratic” actors (e.g. the people and organizations that make up a country’s government and public agencies, such as the armed forces, or foreign affairs ministry) that stand to benefit from their acquisition (or renunciation) advocate for (or against) nuclear weapons.¹¹³ Walsh does not specify *a priori* who has pro-nuclear bomb preferences and who opposes them within a state.¹¹⁴ As with most analyses that rely on the bureaucratic politics paradigm, each bureaucratic actor (e.g. government organization) is assumed to act in their own interests, and in doing so reveal their true

¹¹³ James Walsh, “Bombs Unbuilt: Power, Ideas, and Institutions in International Politics,” PhD diss., Massachusetts Institute of Technology, 2001, 37.

¹¹⁴ It is also not apparent that military establishments are always in favour of nuclear weapons. The French military, for example, was opposed to France developing nuclear weapons in the early 1950s. The French army at the time was embroiled in a counterinsurgency in Algeria, where it felt that nuclear weapons would be useless. The French military establishment was specifically concerned that any budget given to the French nuclear establishment to develop nuclear weapons would come at least in part out of the military’s finances, reducing the budget for personnel and conventional weapons that were needed in Algeria and to meet the defence requirements of France’s other colonies. See Lawrence Scheinman, *Atomic Energy Policy Under the Fourth Republic* (Princeton, NJ: Princeton University Press, 1965), 98-99.

preferences. Walsh's Australian case study hews closely to this conventional wisdom: his archival work suggests that some of the most forceful advocates of Australia acquiring a nuclear bomb were principally in the armed forces (with some support from the Australian Atomic Energy Commission), while the most dedicated opponents were in the foreign affairs ministry (presumably because nuclear weapons could complicate relations with Australia's "great and powerful friends,") and finance ministries (because nuclear weapons could cost a substantial sum).¹¹⁵

While Walsh offers a clear statement about why Australia never acquired nuclear weapons, the version of the bureaucratic politics argument he offers borders on confusing the process by which Australia and Egypt stopped their nuclear weapon activities with the reasons for the decision. Specifically, Walsh hypothesizes that "states seek nuclear weapons, because organizations that would benefit from their acquisition pursue them; states reject or renounce nuclear weapons, because organizations that benefit from rejection or renunciation push for that policy."¹¹⁶ In essence, Walsh argues that Australia stopped its nuclear weapons programs because the Australian government decided to abandon it.

In Australia though, there were both pro- and anti-bomb ministers and personnel within government organizations. These included, on the pro- bomb side, elements in the prime minister's office, and the defence and supply ministries, in addition to Australia's Atomic Energy Commission.¹¹⁷ Thus, the implicit question that Walsh's research begs is what determines whether a country's pro-bomb or anti-bomb forces get their way? He suggests that part of the answer lies in who is involved in the policy debate. If more anti-bomb voices are involved than bomb advocates, then an anti-bomb policy is more likely to prevail. Again, this is

¹¹⁵ Walsh (2001), 126.

¹¹⁶ Walsh (2001), 37.

¹¹⁷ Walsh (2001), 130.

intuitive, but is not wholly satisfying. After all, we should expect that if a government abandons a policy, then someone in that government made the argument that they ought to abandon the policy. This explanation is also useful if we assume that different parts of government are involved in policy debates at random. However, if we assume that government agencies choose to involve themselves in policy debates that they believe are important, then this is a less satisfying explanation. If, for example, a state's security environment dictates that a nuclear weapon program would be useless or even harmful to the state's interests, then we would expect that relatively more government organizations would enter a debate to argue against a nuclear program.

The samples that Walsh uses to substantiate this claim are also quite small. In the Australian case he identifies three periods of nuclear policy debate (1954-63, 1964-67, and 1968-70). In the first phase, pro-bomb participants outnumbered anti-bomb participants three to one; in the second phase, three to two, and; in the third phase, four (including PM John Gorton) to three.¹¹⁸ So while Walsh provides an excellent account of the policy debates within the Australian government, his explanation for how the debates produced the anti-nuclear outcome are based on a small sample of observations where pro-nuclear actors always outnumbered their opponents, but still failed to carry the day.

Finally, in the Australian case, Walsh identifies the federal government making 35 nuclear weapon-relevant policy decisions between 1954 and 1973 (when Australia ratified the NPT). He codes eight of those decisions as anti-nuclear weapon in nature. The other 27 are pro-nuclear weapon.¹¹⁹ So despite pro-nuclear weapon advocates outnumbering anti-nuclear weapon advocates in each period of Australia's nuclear weapon activities, and the Australian government

¹¹⁸ Walsh (2001), 130.

¹¹⁹ Walsh (2001), 80.

making significantly more pro-nuclear than anti-nuclear weapon policy decisions over those periods, Australia never acquires a nuclear weapon. The key event in ending Australia's nuclear weapon activities may in fact have been the election of Gough Whitlam to the prime minister's office in 1973. The Whitlam administration ratified the NPT within a week of taking office, apparently without consulting the defence ministry (or conducting any sort of policy study), and Whitlam may have personally driven the effort to ratify the treaty.¹²⁰ However, in Walsh's narrative Whitlam's move to legally bind Australia to not acquire nuclear arms is overshadowed by the author's focus on the different policy preferences of Australia's various federal departments.

Walsh's analysis is very useful, and he provides strong evidence that organizations within governments hotly contest nuclear weapon policies (rather than national security threats causing governments to automatically and reflexively adopt pro-nuclear weapon policies). Walsh's focus, however, on these debates in Australia and Egypt, however, come at the cost of not explaining why different individuals and organizations within a government have such wildly differing policy preferences and beliefs about the world, and why certain preferences prevail. While Walsh's claim that organizational interests influenced the nuclear weapon policy of Australia from the 1950s to the 1970s is correct, the logic he offers is incomplete. This study offers a complementary logic which explains why *de facto* nuclear weapon organizations may not always be as strongly pro-nuclear as the conventional wisdom states.

Braut-Hegghammer offers another potential answer to Walsh's implicit question. She suggests that successful nuclear weapon programs (i.e. programs that produce nuclear bombs) have "nuclear entrepreneurs," who argue to their national leaders that nuclear weapons can solve some of their country's foreign policy challenges, and in turn convince their governments to fund

¹²⁰ Walsh (2001), 89, 127-128.

and sustain a nuclear weapon program.¹²¹ In many ways, Braut-Hegghammer's explanation hews closely to the standard "bureaucratic politics"/nuclear myth-maker argument about how nuclear weapons programs are initiated.¹²² Namely, individuals in the government identify an opportunity (whether that opportunity is created by external political events, or the maturation of a state's nuclear science establishment) to convince political leadership of the necessity of a nuclear weapons program and use that opportunity to lobby and convince leadership to support such an endeavour. The nuclear entrepreneurs then must work to maintain the tacit (or explicit) agreement between scientists, politicians, and others that keeps the nuclear enterprise going.

Braut-Hegghamer, essentially argues that the presence of "nuclear entrepreneurs" is akin to a necessary condition for building nuclear weapons. They need to exist in order to keep the executive branch funding the nuclear effort, and to stop attempts by other members of government to end the state's nuclear program. However, the evidence that Braut-Hegghammer offers, for example, to explain how Libya abandoned its nuclear weapon activities in the 2000s tends to focus on a host of other reasons that the Libyan government's interest in nuclear weapons waned (rather than a lack of entrepreneurs). These reasons ranged from internal strife and domestic uprisings (which nuclear weapons could not address), to major economic challenges caused by rapid population growth, international sanctions, and declining oil production.¹²³ Ultimately, these factors appear to be the reasons that pro-nuclear weapon organizations and individuals inside Libya lost the nuclear debate, rather than because of a lack of competent nuclear entrepreneurs themselves.

¹²¹ Malfrid Braut-Hegghammer, "Nuclear Entrepreneurs: Drivers of Nuclear Proliferation," PhD diss., London School of Economics, 2009.

¹²² See Steven Flank, "Exploding the Black Box: The Historical Sociology of Nuclear Proliferation," *Security Studies* 3.2 (1993): 259-294; Fuhrmann; Sagan, (1996-7): 54-86; Braut-Hegghammer's (2009) discussion of the origins of Iraq's nuclear weapon program on pp. 60-65 is a particularly good example.

¹²³ Braut-Hegghammer (2009), 151-155.

Braut-Hegghammer thus provides an interesting twist on the argument that nuclear weapon programs are often the result of organizations or individuals within the state advocating in favour of initiating a nuclear program by extending the logic to claim that those individuals are also necessary to keep a program alive. It is not a particularly convincing explanation for why states fail to acquire nuclear weapons though. In the case of Iraq, which Braut-Hegghammer spends considerable space analyzing, she argues that acquiring nuclear weapons was simply not a priority for the Hussein government in the late 1980s and early 1990s.¹²⁴ It is by no means clear that the failure of the crash program was due to a lack of an alliance between Iraq's nuclear scientists and Iraq's political leadership: instead, a great deal of the program's failure falls on the fact that other priorities were dominating the Hussein government's agenda. Braut-Hegghammer's Iraq case highlights what is perhaps the major challenge in her work: she wishes to present a generalizable cause of nuclear abandonment, but relies on a small number of cases, two of which (Iraq and Libya) she presents in considerable detail.¹²⁵ However, in presenting these two cases in such detail, she provides a host of other reasons why the governments decided to abandon their nuclear weapon efforts. After all, reality rarely conforms strictly to theory. It is therefore difficult to assess how much the "nuclear entrepreneurs" matter compared to other factors, and difficult to determine if there is a general pattern of weak entrepreneurs leading to nuclear abandonment. Braut-Hegghammer's short, additional cases (Australia, Egypt, India, and Pakistan) are also unconvincing, especially when she omits instances of major infighting between nuclear scientists and political leadership in the Indian and Pakistani cases.

¹²⁴ Braut-Hegghammer (2009), 78-86.

¹²⁵ Braut-Hegghammer (2009), 18.

None of this is to say that Braut-Hegghammer does not provide some insight into why nuclear abandonment might occur. However, her conclusions are stretched beyond what the evidence can support.

Hymans, in *Achieving Nuclear Ambitions*, provides a novel explanation rooted in bureaucratic politics. Namely, he claims that states do not abandon their nuclear weapon activities, but instead, their nuclear weapon activities fail. That means instead of making a choice to continue a program or to abandon it, some programs fail so miserably to master the necessary technology required to build a nuclear weapon that the government is left with no choice: the program will not succeed in building a nuclear weapon, thus the government abandons it. Hymans' explanation for why some programs simply fail is that some nuclear weapons programs are simply badly managed.¹²⁶ Specifically, in some cases, the executive branch or their agents directly intervene in the day-to-day activities of the scientists, technicians, engineers, and tradespeople who do the work of researching, designing, and building nuclear weapons. This tends to happen in states with patrimonial governments. The nuclear programs in these environments, argues Hymans, are hierarchical, and managers tend to use crude incentives to motivate their employees (such as demonstration firings or arrest) and deny their technicians the autonomy they need to experiment and be successful. These managers also often act as central hubs: all of the nuclear program's decisions must pass through them, and employees are discouraged from collaborating without management's involvement. In other words, the managers of these nuclear programs are political hacks and micro-managers who undermine the professional spirit and capacity of their employees. Hussein Kamel, who took over Iraq's nuclear weapons program in the late 1980s and moved it from the Iraq Atomic Energy Commission to

¹²⁶ Jacques E.C. Hymans, *Achieving Nuclear Ambitions: Scientists, Politicians and Proliferation* (Cambridge, UK: Cambridge University Press, 2012).

the Military Industrial Commission, exemplified these tendencies: he personally (and unilaterally) set timetables and deadlines for his engineers, and bullied, intimidated, and terrorized his subordinates.¹²⁷

On the other hand, argues Hymans, nuclear programs that produce nuclear bombs are led by good managers. In this context, this means the managers allow horizontal communication between departments. These managers are not mercurial, rely less on intimidation and fear to motivate their employees, and instead try to persuade them with rewards, or appeal to their patriotism, as China's Nie Rongzhen did. Rongzhen was respectful in his dealings with his scientists, and often asked them for suggestions as how to improve the program's efficiency.¹²⁸ Overall, Hymans claims these managers behave in a "Weberian legal-rational" fashion, while those like Kamel behave in a "neo-patrimonial" manner.¹²⁹

While Hymans offers a fascinating argument, the precision of his argument is not always matched by the precision of his data. Hymans ultimately is providing a micro-level explanation for nuclear abandonment, and rather than seeking to explain a general correlation, he seeks to describe a specific chain of events. The historical record is not always so clear-cut and unambiguous. Take, for example, his claim that Pakistani PM Ali Bhutto meddled incessantly in his country's nuclear weapon program. He offers only one clear-cut example of such meddling though, and other accounts of Pakistan's nuclear program suggest that Bhutto did in fact, tend to take a hands-off approach to the program, allowing the technocratic Munir Ahmad Khan relative autonomy.¹³⁰ In fact, Feroz Khan - in *Eating Grass: The Making of the Pakistani Bomb* –

¹²⁷ Hymans (2012), 102-107.

¹²⁸ Hymans (2012), 140-141.

¹²⁹ Hymans (2012), 71.

¹³⁰ Hymans (2012), 246; Feroz Hassan Khan, *Eating Grass: The Making of the Pakistani Bomb* (Stanford, CA: Stanford University Press, 2012), 93-138; Shahid ur-Rahman, *Long Road to Chagai* (Islamabad: PrintWise Publication, 1999), 35-37.

suggests that Pakistan's military ruler Muhammad Zia-ul-Haq subjected the Pakistani bomb program to intense surveillance, played Munir Khan and Abdul Qadeer Khan against each other, and hinted to Munir Khan that he would meet the same fate as Bhutto (i.e. death by hanging) if he did not meet Zia's deadlines.¹³¹ Feroz Khan's portrayal of Bhutto and Zia is virtually the opposite of Hymans' characterisation of Bhutto as meddling and Zia as "respectful" of Pakistan's nuclear engineers, a state of affairs which Hymans attributes to the "Weberian legal-rational institutionalization of the Pakistani military," which was an inheritance from the British Raj.¹³²

While Hymans' explanation for why nuclear weapon programs succeed or fail is elegant and appealing, the evidence that he marshals is at times unconvincing. When the empirical record does not perfectly correlate with Hymans' predictions, he relies on untestable counterfactuals to bolster his argument. This is exemplified by his account of Kamel's tenure as the leader of Iraq's nuclear program. Under Kamel's imperious management, Iraq's nuclear weapon program developed a working prototype gas centrifuge in roughly three years. Hymans, rather than identifying this as a success for the program, interprets it as evidence that Iraq's nuclear program was failing, due to the decisions Kamel made in pursuit of a working centrifuge. These included rushing his engineers (leading to failed prototypes); intimidating employees to the point where their deteriorating mental health forced them off the project, to making demands that forced his team to engage in risky, black-market, off-the-shelf purchases of certain components.¹³³ All of this – writes Hymans – was evidence that "the project's fast progress came increasingly at the cost of tearing up the foundation for *sustained* progress."¹³⁴

¹³¹ Khan, 152.

¹³² Hymans (2012), 246-247.

¹³³ Hymans (2012), 105-111.

¹³⁴ Hymans (2012), 106-7.

While Hymans makes a compelling case that Kamel was a less-than-ideal manager, he relies on a counterfactual assertion that Kamel's bad management – had it been allowed to continue – would have ultimately left Iraq's nuclear program in utter ruins. In other words, because Kamel's process was bad, chances are his results would have been disappointing. This is a perfectly reasonable probabilistic hypothesis, but Hymans presents it with deterministic certainty. The fact is, in 1990, after the invasion of Kuwait, Saddam Hussein ordered a crash program that would have used safeguarded fissile material to build a bomb. This program was ultimately derailed by Iraq's defeat in the Gulf War. Without a clear control case, or a hypothetical version of the Iraqi case built upon estimated parameters, it is hard to say whether Kamel's short-term successes were coming with the price of long-term failure. Hymans offers a fascinating hypothesis, but one that would benefit from fine-grained data beyond what memoirs and the historical record can provide.

This study provides a complementary explanation to Hymans' managerial incompetence hypothesis. There is no reason that neo-patrimonial managers cannot be part of the reason a government abandons its nuclear weapon activities. However, this study also makes different predictions than Hymans'. Specifically, this study provides evidence that organizations that appear to have competent, rational management that works in a productive fashion with its subordinates may in fact have good reasons to want to abandon their nuclear weapon activities. The Swiss Federal Department of Defence and South Africa's Armscor (which are profiled in chapter five) are both organizations that appear to have the qualities of Hymans' ideal-type Weberian legal-rational management team, but they are also organizations that had weak incentives to sustain their nuclear weapon activities. While Hymans focuses on the competencies and character of individual managers, this study characterizes the organizations that conduct the

nuclear weapons programs as a whole. So, while the two hypotheses are in principle compatible, this study argues that nuclear abandonment can and has occurred in the presence of Hymans' legal-rational managers. In other words, while this study and Hymans' both hypothesize that variation in specific aspects of the organizations (or the people that staff the organizations) should have a measurable effect on the likelihood of nuclear abandonment, this study argues that it is the overall functional purpose of the organization that determines the risk of nuclear abandonment over the long run, rather than the management style of its leaders.

2.2.5 Other Theoretical Approaches

Of course, analysts have offered other explanations for nuclear abandonment that cannot be easily characterized as realist, neoliberal, or some variety of constructivism. However, many of these explanations are more accurately characterized as descriptive accounts of a single case, rather than as attempts to provide a generalizable explanation of nuclear abandonment. When these single-case accounts draw on generalized theory, the results can be interesting, but are not always convincing. Take, for example, Jonter and Rosengren's explanation of why Sweden never acquired nuclear arms. They cite at least four different reasons for Sweden's decision to abandon its nuclear weapon program. These include: tensions between Sweden's civilian and military programs; opposition to the military program within and outside of parliament; efforts by the US and USSR to establish a non-proliferation treaty, and; a change in Swedish thinking about nuclear weapons, "from a situation where nuclear weapons were seen as tools for protection and deterrence...to a policy that considered them as threats to international security."¹³⁵ All of these explanations seem plausible, and the evidence that Jonter and Rosengren offer is not obviously inconsistent with their claims. However, Jonter and Rosengren

¹³⁵ Thomas Jonter and Emma Rosengren, "From Nuclear Weapons Acquisition to Nuclear Disarmament – the Swedish Case," *Medicine, Conflict and Survival* 30 supplement 1 (2014): s48.

do not offer these four explanations as hypotheses, and thus do not test them. It is therefore difficult to identify how robust these claims are: all seem plausible, and none seem definitive. It is also difficult to assess the relative importance of multiple factors when analysing a single case.

This methodological problem is common to many studies that structure their observations in terms of “cases” (if we define a case as the observation of the behaviour of a single country over a given time frame). Unless analysts break cases into multiple observations (as Walsh does), the analyst is confronted with a situation where they have more independent variables or explanations to test than observations to test them against. A study that analyses one case (such as Cole’s *Sweden Without the Bomb*, Liberman’s *The Rise and Fall of the South African Bomb*, or Purkitt and Burgess’ *South Africa’s Weapons of Mass Destruction*) can offer several explanations (i.e. hypotheses) for why a government abandoned its nuclear weapon activities.¹³⁶ Yet, without any comparison cases with which the analyst can hold one important factor (such as a state’s security environment, or the subjective beliefs or culture of its decision-makers) constant while varying the other factors of interest, there are few broadly accepted methods for accepting or rejecting a given hypothesis. As such it is probably more accurate to consider these works as analytical, theoretically-informed descriptions of specific nuclear weapon activities, rather than empirical tests of generalizable, falsifiable explanations of nuclear abandonment.

Like Müller and Schmidt, and Rublee, Jonter and Rosengren assume that the negotiations between the US and USSR, and the subsequent NPT only had normative effects (i.e. the NPT was only a statement about the social unacceptability of nuclear weapons), and do not entertain the possibility that the verification and enforcement regime that accompanied the treaty may

¹³⁶ Paul M. Cole, *Sweden Without the Bomb: The Conduct of a Nuclear-Capable Nation Without Nuclear Weapons* (Santa Monica, CA: RAND, 1994); Peter Liberman, “The Rise and Fall of the South African Bomb,” *International Security* 26.2 (2001): 45-86; Helen E. Purkitt and Stephen F. Burgess, *South Africa’s Weapons of Mass Destruction* (Bloomington, IN: Indiana University Press, 2005).

have had any effects. They also do not entertain the possibility that states may have interpreted the NPT as a strong signal of American and Soviet desire and intent to limit the spread of nuclear arms, which may have changed the cost-benefit calculation for nuclear proliferators.

A final grouping of analyses worth mentioning are a handful of works that are best described as using middle-range theory to explain nuclear abandonment, but these studies focus their analysis more on specific foreign policy options than on explaining nuclear abandonment. They are, in essence, tests of the efficacy of specific policy tools (or explanations for when those policy tools are used), rather than explanations of nuclear abandonment. Jentleson and Whytock, for example, use Libya's decision to abandon its nuclear weapon program as a test for some hypotheses they derive from the literature on coercive diplomacy.¹³⁷ Helfstein, on the other hand, claims that economic sanctions are effective at causing nuclear abandonment when the state that is imposing the sanctions is a friend or ally of the proliferating state (such American sanction threats against South Korea and Taiwan), or when the sanctioning state makes some effort to improve relations with the proliferator (such as the US did with Ukraine and Libya).¹³⁸

Kreps and Fuhrmann briefly assess five efforts to stop a country's nuclear weapon program by bombing its nuclear facilities (their five cases are Israel's bombing of Syria's al-Kibar reactor; Israel's attack on Iraq's Osirak reactor; Iran's attacks on the Osirak reactor; American attacks on Iraqi facilities in 1991 and 1993, and; allied attacks on Nazi Germany's nuclear infrastructure during the Second World War).¹³⁹ They find no consistent pattern: in some instances, such as Israel's bombing of Osirak, they argue destroying nuclear infrastructure may have slowed the state's nuclear efforts, while in other cases, they find little in the way of an

¹³⁷ Jentleson and Whytock.

¹³⁸ Helfstein.

¹³⁹ Sarah E. Kreps and Matthew Fuhrmann, "Attacking the Atom: Does Bombing Nuclear Facilities Affect Proliferation?," *Journal of Strategic Studies* 34.2 (2011): 161-187.

observable effect.¹⁴⁰ However, their sample is small, since military attacks on nuclear facilities are rare. As a consequence of their small sample, and the complex political environments that these attacks do occur in, Kreps and Fuhrmann also have few degrees of freedom to work with. This makes it difficult to develop counterfactual scenarios or meaningfully compare the Osirak episode or attacks on Nazi Germany's facilities to cases where no attacks occurred.

2.3 Nuclear Abandonment and Empirical Methods: Strengths and Weaknesses

Political science and IR researchers have clearly generated a substantial body of work that tries to explain why states end their nuclear weapon activities. What is less evident is how generalizable many of these claims are. There are at least three clear reasons, which are all consequences of the empirical methods that these authors use. The first reason is the use of case study comparisons as the sub-field's dominant method. This is in and of itself not a problem, but it leads to the second challenge, which is that there is a tendency among researchers in this sub-field to make rather broad inferences from these cases. Finally, these two aspects (small samples and overly broad inferences) exacerbate a third aspect of the research, namely a tendency to look for necessary or sufficient causes or the best fitting (or exclusive) explanation for nuclear abandonment. Together, these three characteristics of the literature are grounds to raise some doubts about the robustness of many of its findings.

The dominant method in the rollback literature is qualitative cross-case comparisons (save for Müller and Schmidt, and Mehta), which means that researchers are often working with relatively small numbers of observations. In some studies, this means two cases (such as Long and Grillot and Hersman and Peters' works), an as many as fourteen (in Paul's *Power Versus Prudence*). This of course, does not include analyses of single cases, such as Braut-

¹⁴⁰ Braut-Hegghammer disputes the claim that bombing Osirak slowed Iraq's efforts to acquire a nuclear weapon, and instead, was an impetus for the Iraqi government to increase their efforts. See Målfrid Braut-Hegghammer (2011).

Heghammer's and Jentleson and Whytock's analyses of Libya. The challenges of identifying patterns that extend to an entire population on the basis of a small number of observations does not need to be elaborated upon. While it is certainly possible, it requires researchers to deliberately sample observations which they believe are representative of the entire population. This in turn requires at least some analysis of the entire study population. In the nuclear abandonment literature, the small samples challenge is compounded by the fact that researchers have often selected these samples using opaque criteria. Long and Grillot's analysis is a clear example: they offer little rationale for comparing South Africa and Ukraine's decisions to give up their nuclear weapons. They suggest both cases are "dramatic" (presumably meaning they strongly manifest the phenomenon of interest) but otherwise there is little reflection on why the two cases are important, why they are comparable, or why conclusions drawn from them can be generally extrapolated.¹⁴¹ Similarly, Hersman and Peters likewise offer little rationale for comparing Taiwan and South Korea. In fact, their characterization of the two cases results in a comparison where the cases' independent variables are virtually identical (both states were in hostile security environments, faced considerable military threats, relied on US support, and were diplomatically pressured by the US to stop their nuclear weapon activities). The outcome on the dependent variable is unsurprisingly nearly identical: both states gave up their nuclear weapon programs, though the exact form of how they did so differs. With two similar cases, one would expect to find similar outcomes. Without comparisons to other cases with different values on the independent or dependent variables, such a comparison does little to help identify or eliminate candidate necessary causes. Even Paul (who covers a relatively large number of fourteen cases) offers little in the way of explaining his selection criteria. Given Paul's focus on

¹⁴¹ Long and Grillot, 24.

a state's security environment and relative power, an explanation as to why North Korea, Taiwan, and Iraq (among others) were left out of the analysis would be useful.

One of the shortcomings of the qualitative and small-*n* methods that many authors and analysts have used in this field is that the conclusions that these studies arrive at often cannot be reliably inferred from their data. Take Walsh's conclusion, for example, that "level of [security] threat and nuclear policy do not correspond to one another."¹⁴² Walsh comes to this conclusion because, he argues, Australia's government pursued nuclear weapons most vigorously when it enjoyed "its highest level of security," and despite the existence of the Australia, New Zealand, United States Security Treaty.¹⁴³ Walsh makes a statement about nuclear abandonment as a general phenomenon on the basis of the history of a single country's nuclear weapons policy. It may in fact be true that generally states do not conduct nuclear weapon activities when they face relatively high military threats. However, Walsh does not test that hypothesis. Instead, he infers a general rule from a deep but narrow dataset.

In a similar fashion, Rublee, who extends her NPT-norm explanation in later work to argue that anti-nuclear civil society groups are an important conduit for the anti-nuclear norm to affect policy, generalizes from a few cases selected on the dependent variable. She asserts "that peace groups and the international non-proliferation norm made a potent combination in democracies,"¹⁴⁴ and cites the cases of Japan, Sweden, and West Germany. Rublee's mention of Japan and West Germany in particular confuses the issue, since she cites time periods in both countries where the governments had already abandoned their nuclear weapon activities and public opposition to nuclear weapons appears to been more important as a barrier to restarting

¹⁴² Jim Walsh, "Surprise Down Under: The Secret History of Australia's Nuclear Ambitions," *Nonproliferation Review* 5.1 (1997): 14.

¹⁴³ Ibid.

¹⁴⁴ Rublee (2014): s39-40.

activities, rather than a definitive cause of the original decision to abandon them.¹⁴⁵ Nevertheless, she does indicate that there was domestic opposition to nuclear weapons in Japan and West Germany at the time of the 1970 and 1958 nuclear abandonment episodes, so it is entirely plausible that this opposition contributed to the abandonment decisions in both cases. Where her argument is analytically much weaker is in her omission of anti-nuclear movements in democracies that started and maintained nuclear weapon activities. The UK's Campaign for Nuclear Disarmament emerged in the 1950s, but was insufficient – even in the presence of a global anti-nuclear norm – to end the UK's nuclear weapon activities. Likewise, she makes no mention of the opposition to Israel's nuclear weapons program in the 1950s amongst Israel's academic and scientific community.¹⁴⁶ Rublee also omits any mention of the US anti-nuclear weapon movement, which has involved dozens of organizations over the decades, and at times led to large protests (such as the 1961 Women Strike for Peace protest against nuclear weapons, which involved as many as 50,000 people).¹⁴⁷ These examples are in and of themselves not reasons to reject the hypothesis that anti-nuclear civil society movements are associated with nuclear abandonment. They do however suggest that either the relationship between civil society attitudes and nuclear abandonment is probabilistic, or that public attitudes are not the only factor shaping nuclear policy in democracies. Any statements about the empirical relationship between public attitudes and changes in nuclear weapon policy should at least be qualified along those lines.

¹⁴⁵ See Rublee (2008), 434-435; Rublee (2009), 194-197.

¹⁴⁶ Avner Cohen, *Israel and the Bomb*, (New York: Columbia University Press, 1998), 70-72, for an example. Israel also currently has a small anti-nuclear weapon movement. Its most visible and famous leader is likely Gideon Spiro, who chaired the Israeli Committee for a Middle East Free from Atomic, Biological and Chemical Weapons.

¹⁴⁷ Amy Swerdlow, *Women Strike for Peace: Traditional Motherhood and Radical Politics in the 1960s* (Chicago: University of Chicago Press, Ltd., 1993), 15.

These two examples also point to another broad pattern among studies of nuclear abandonment: a tendency to frame debates about causes in either/or terms. What this means is while analysts are testing various hypotheses to compare how well they fit the data, they tend to conclude that the best fitting explanation is *the* explanation for nuclear abandonment.¹⁴⁸ Thus, they frame the empirical question in terms of whether it is security, or domestic political survival, or norms, or national identity that is causing states to abandon their nuclear weapon activities.

As Goertz and Mahoney argue, researchers in the qualitative empirical tradition often focus on specifying small numbers of tightly defined causal paths, with strict, precise relationships between causes and effects. Paul's, Solingen's, Rublee's, and Hymans' (2012) works all reflect this research style. Consequentially, each author tends to (even if inadvertently) provide a monocausal (or univariate) explanation, i.e. this variable is the critical one to understand if one wishes to know why states do not build nuclear weapons.¹⁴⁹ Solely relying on monocausal cases as a research method presents a serious challenge for efforts to understand nuclear abandonment if nuclear abandonment is like nuclear proliferation: not just a function of security, bureaucratic politics, or national pride/status, but instead a function of a combination of the three.¹⁵⁰ It is entirely plausible that there is no one way to give up a nuclear weapons program, and the relative effects of different variables may differ from case-to-case. Levite has hinted at this possibility by emphasizing the apparent variety of causes of nuclear abandonment

¹⁴⁸ For example, Long and Grillo claim that their explanation – that states abandon nuclear activities in order to conform to a normative expectation – fits the empirical record better than explanations that argue nuclear abandonment is a response to a state's security environment, or Solingen's regime survival explanation.

¹⁴⁹ Solingen, in a later work, admits that domestic regimes in and of themselves are not determinative, and in fact what scholars need to do is identify how much each variable matters in a given case. See Etel Solingen, "Domestic Models of Political Survival: Why Some Do and Others Don't (Proliferate)," in Potter and Mukhatzhanova (2010): 44-45.

¹⁵⁰ Sagan (1996-7), 85-86.

(a point repeated in Cortright and Väyrynen's overview of several cases),¹⁵¹ while suggesting American security guarantees and pressure helped end some of these programs.

Given the literature's focus on small numbers of causal paths, and its efforts to identify the best fitting explanation for a given case (or cases), it is reasonable to conclude that the literature has implicitly and informally looked for necessary and sufficient causes of nuclear abandonment. Unfortunately, necessity and sufficiency are two difficult criteria to meet. Necessity explicitly means that "Y [nuclear abandonment] occurs *only if* X is present."¹⁵² It is easy to identify trivial necessary conditions for nuclear abandonment (e.g. a country must be conducting nuclear weapon activities in order for abandonment to occur). Identifying substantive necessary conditions is on the other hand, quite difficult.¹⁵³ After all, if one adheres to a strict definition of necessity, if one observes a single case where abandonment occurs but the purported necessary condition is not present, then that purported necessary condition is, in fact, not necessary.¹⁵⁴

Sufficiency, on the other hand, means that if X is present, Y *must* follow. One way to think about necessary and sufficient conditions is as parts of logical sets. If a country must have a nuclear weapon program in order to abandon that nuclear weapon program, then country-years where nuclear weapon activities take place are a superset of nuclear abandonment. These are high hurdles to pass, since, strictly speaking, if we observe one case where a supposed sufficient

¹⁵¹ David Cortright and Raimo Väyrynen, *Towards Nuclear Zero* (London: Routledge, 2010).

¹⁵² Bear F. Braumoeller and Gary Goertz, "The Methodology of Necessary Conditions," *American Journal of Political Science* 44.4 (2000): 846.

¹⁵³ One definition of a substantive necessary condition is that when comparing two necessary conditions, the less typical one is the more substantive or important one. For example, some political scientists have described the presence of oxygen as a necessary condition for war on Earth. This may be true, but it is trivial. A more substantive necessary condition would be the presence of weapons or armed forces, since it is comparatively scarce. See James Mahoney and Rachel Sweet Vanderpoel, "Set Diagrams and Qualitative Research," *Comparative Political Studies* 48.1 (2015): 65-100.

¹⁵⁴ Some methodologists, such as Charles Ragin, suggest that even if small deviations from strict sufficiency or necessity may occur, the language and concepts of necessary and sufficient conditions may still be useful for describing some relationships. See Charles C. Ragin, "Set relations in social research: Evaluating their consistency and coverage," *Political Analysis* 14.3 (2006): 291-310.

condition exists, and nuclear abandonment does not happen, then in fact, we have not found a strictly sufficient condition. Many of the examples of this body of literature are essentially looking for a single cause of nuclear abandonment, and only occasionally does the literature allow for several causes to add up in a given case and probabilistically tip the scales towards either retaining or abandoning a nuclear weapon program. This search for (near-) necessary and sufficient causes of nuclear abandonment may help explain the proliferation of explanations (some of which are listed in Table 2.3), since a single nonconforming case can always act as fertile ground for inductive theorizing.

A final critique of the existing body of literature is the manner in which several authors present their findings. Specifically, they tend to overstate the significance of the absence of confirmatory data for competing hypotheses. Rublee's work provides a clear example: her research is largely based on secondary (i.e. previously published) sources and a number of interviews with scholars and government employees. This is in and of itself unobjectionable. However, when she does not discover "smoking gun" evidence to support an alternative (e.g. realist or neoliberal institutional) hypothesis, she claims that these alternative hypotheses have failed the empirical test.¹⁵⁵ Given the level of secrecy that typically surrounds nuclear weapon activities, and the long time frames involved in some cases, conducting a thorough and exhaustive historical case study is exceptionally difficult. Simply because Rublee did not find a book, article, or document that expressly stated that Japanese policymakers rejected nuclear weapons because they feared acquiring nuclear arms would make them the targets of nuclear arms (which is one of the alternative realist hypotheses that Rublee mentions) is not sufficient

¹⁵⁵ Stephen van Evera, *Guide to Methods for Students of Political Science* (Ithaca, NY: Cornell University Press, 1997), 31.

evidence to reject the hypothesis.¹⁵⁶ If an analyst finds a lack of evidence to substantiate a hypothesis, that does not mean they should reject that hypothesis or claim that the hypothesis failed the empirical test (recall the aphorism, “the absence of evidence is not evidence of absence”). This is particularly true when dealing with researching secretive national security issues where the historical paper trail may be decades old.

Rublee is not the only scholar to make this analytical error. Paul, Solingen, Long and Grillot, and Bergner do so as well. This tendency should undermine confidence in the validity of their core findings if they present their chief hypothesis as an exclusive cause of nuclear abandonment, or as the most important/influential cause, since their basis for rejecting alternative explanations is weak. Alternatively, if researchers are simply interested in demonstrating that their hypothesis passes a certain evidentiary bar, or that their proposed cause of nuclear abandonment complements other causes, weak tests of alternative hypotheses should not cast too much doubt on their findings. However, if analysts present a study’s core hypothesis as an exclusive/overwhelming/major cause of nuclear abandonment, to the exclusion or at least marginalization of other potential causes (such as Paul’s study, which essentially dismisses the NPT and its associated regime as a cause of nuclear abandonment) then weak tests of alternative explanations should temper a reader’s confidence in the study’s chief claims.

2.4 A Catalogue of Nuclear Abandonment Causes

In sum, the literature offers numerous potential causes of nuclear abandonment. Table 2.3 below lists the potential causes of nuclear abandonment, as the literature presents, either implicitly or explicitly. Unfortunately, as noted, most of the literature does not differentiate

¹⁵⁶ Rublee (2009), 87.

between proximate causes (i.e. events that subsequently “trigger” nuclear abandonment) and probabilistic conditional causes (i.e. social, economic, technological, or political conditions that make nuclear abandonment relatively more or less likely to occur in a given time period). The second column of Table 2.3 preliminarily classifies the various causes according to these two categories.

Table 2.3 Catalogue of Potential Causes of Nuclear Abandonment

<i>Cause</i>	<i>Conditional, Proximate, or Both?</i>
Change in government towards greater democracy	Proximate cause
Change in a government’s chief executive	Proximate cause
Coercive policy measures by a foreign government	Proximate cause
Government relies on an economically liberal coalition to stay in power	Conditional cause
Existence of an anti-nuclear weapon injunctive norm	Conditional cause
Desire to abide by a “Western” identity	Conditional cause
Desire to avoid creating a security dilemma	Both
State lacks major state-based security threats and a secure second-strike capability	Conditional cause
Diplomatic pressure from an allied state/superpower	Proximate cause
Diplomatic pressure from a hostile or ambivalent state/superpower	Proximate cause
Change in policymakers’ beliefs about utility or morality of nuclear arms	Proximate cause
Inability of policymakers to justify nuclear weapons	Conditional cause
Opposition within government/bureaucracy to nuclear weapons	Both
Incompetent management of the nuclear program	Both
A lack of nuclear “entrepreneurs”	Conditional cause
Nuclear weapons are too expensive for a state to develop	Conditional cause

As Table 2.3 suggests, political scientists and analysts have offered a reasonably large number of explanations for nuclear abandonment. Despite the relatively small number of countries (around 30 to 33, depending on the burden of proof) that have conducted nuclear weapons activities at some point in the 20th and 21st centuries, this still constitutes a universe of more than 700 country-year observations. While not an enormous universe of data, it is sufficiently large to suspect that there is evidence that at least substantiates many of the literature's claims. However, as this review has highlighted, the literature, as it stands, gives few reasons to suspect that the causes listed in Table 2.3 are general causes or average tendencies. Many of these causes may in fact occur in reality, but may require a complex combination of unobserved factors to fully take effect.

Given the state of the field, it would be unproductive to begin searching for exclusive (or necessary or sufficient) causes of nuclear abandonment. Claiming that one hypothesis is a better explanation than another not only requires an analyst to reject the null hypothesis for the second hypothesis. It also requires them to thoroughly investigate competing hypotheses in order to reject them. As this literature review has discussed, while many empirical studies of nuclear abandonment have claimed that some hypotheses fit the data better than others, they have typically used small samples, and rarely (if ever) subject competing hypotheses to any sort of rigorous empirical test. Even Müller and Schmidt, who do test alternative hypotheses, use bivariate tests that are too weak to confidently accept the null hypothesis. Instead, future research efforts on the causes of nuclear abandonment could be productively spent assessing the extent to which various causes are generalizable and which factors have substantive effects across the universe of cases.

The rest of this study therefore focusses its efforts to develop and assess the validity of a single hypothesis, while assuming that this hypothesis works alongside other causes of nuclear abandonment. This thesis' goal, therefore, is not to evaluate the empirical validity of all existing hypotheses about nuclear abandonment, but instead to develop one strand of thinking on the subject and to test that thinking while assuming that existing explanations are at least conditionally valid. Thus this study's hypothesis – that the sort of organization that conducts a state's nuclear weapon activities is correlated with the likelihood of abandonment – is a complement to existing explanations (such as those in Table 2.3) of nuclear abandonment. Chapter three will develop an argument about organizational imperatives in broad terms (in order to offer a flexible and generalizable hypothesis), while chapter four will provide large-*n* evidence in support of that hypothesis. Chapter five will conclude the empirical portion of the study by offering two case studies that provide additional nuance and detail to chapter three's hypothesis and chapter four's findings.

3 Organizational Imperatives and Nuclear Abandonment

Can organizational imperatives help explain why states abandon their nuclear weapon activities? While analysts have used the behaviour of government employees and organizations – specifically efforts by individuals and organizations to influence policy outcomes – to explain why states seek and acquire nuclear weapons, the possibility of a relationship between organizational imperatives and nuclear abandonment is relatively unexplored. This chapter will develop an argument that claims the manner in which a state organizes its nuclear weapon activities can affect the likelihood that it will abandon those activities. Specifically, it will argue that organizational imperatives probabilistically contribute to the conditions under which nuclear abandonment becomes more likely. These organizational imperatives do not, however, constitute a proximate (or “trigger cause”) of nuclear abandonment. This chapter’s hypothesis is also complementary to the host of explanations for nuclear abandonment that chapter two surveys.

This chapter’s hypothesis also shares common ground with some existing explanations. Like Solingen and Walsh’s explanations, this chapter does not assume that states are unified actors. Instead, this chapter’s analysis begins with the assumption that the various organizations that together constitute a national government (and set and implement public policies, including foreign and defence policies) may have different interests and preferences. While a government’s various branches and divisions may all want the “best” outcome for their government and nation, they may have different views as to how to achieve that outcome, and during policy debates, may advocate for a policy that best suits their competencies, professional needs and interests.

Take the example of the policy debate in Australia during the 1950s and 1960s, where Walsh has shown that the military and the civilian nuclear establishment often advocated that Australia develop nuclear weapons, while the treasury and the foreign ministry generally

opposed the project.¹⁵⁷ Walsh argues that “traditionally understood,” Australia’s defence department and the Atomic Energy Commission would both stand to benefit from a nuclear weapons program, since it would potentially boost their budgets, jurisdiction, and autonomy within the government.¹⁵⁸ On the other hand, the treasury could lose jurisdiction (as a nuclear weapon production program would be a classified affair and the treasury might not be allowed to oversee its finances) and a large, expensive program could complicate its core mission of managing the nation’s public finances.¹⁵⁹ Meanwhile, the foreign ministry opposed the project presumably because if a nuclear weapon program strained relations with Australia’s allies and neighbours, this would complicate External Affairs’ daily tasks.¹⁶⁰ Simply put, through the 1950s and 1960s, Australian politicians, government scientists and military officials had significant differences of opinion about whether Australia should acquire nuclear weapons. According to Walsh, the fact that those who opposed Australia acquiring nuclear weapons prevailed was the eventual reason that the Australian government abandoned its nuclear weapon activities.

Analysts have also used this same basic empirical fact (that different organizations within the same government may have different policy preferences) to make claims about why states acquire nuclear weapons. The nuclear proliferation literature clearly argues that governments have, at times, begun nuclear weapon activities or acquired nuclear weapons in part due to advice and advocacy coming from various government agencies. In other words, while many policies are often set at the "top" (typically by the executive branch of government), the content of those policies can be determined – if only in part – by pressures emanating from "below". Scholars often refer to this process as the "bureaucratic" explanation of policy formation and

¹⁵⁷ Walsh (2001), 44-77.

¹⁵⁸ Walsh (2001), 125.

¹⁵⁹ Walsh (2001), 125-6.

¹⁶⁰ Walsh (2001), 125, 128.

outcomes. In the case of nuclear arms acquisition, the literature claims that bureaucratic organizations that stand to gain influence, funding, and professional prestige from a nuclear weapons program offer claims about how nuclear arms would be useful for the government to achieve its military or foreign policy goals, thereby influencing the executive branch of government to decide to acquire nuclear arms. The canonical example of organizational interests leading to states acquiring nuclear weapons is India.¹⁶¹

The Australian and Indian examples pose an interesting analytical challenge. Analysts of both cases have explicitly or implicitly used elements of the “bureaucratic politics” theory of policy-making to explain the nuclear policies of the two countries. Authors studying these cases have relaxed the assumption that the state (or government) is a single, unified actor that largely responds to external events.¹⁶² Instead, they assume that the individuals and organizations which constitute a national government will prefer different policies. However, these two examples pose a clear problem: one suggests that organizational interests can help end nuclear weapon activities (because anti-bomb organizations overcome the pro-bomb sectors, such as the atomic energy agencies and defence ministries), while the other describes pro-bomb organizations successfully convincing politicians that the state should acquire nuclear weapons. Obviously both explanations could be true to a certain degree at various times and in some places, but the argument that states acquire nuclear weapons, or abandon their nuclear weapon activities

¹⁶¹ For a general overview of theories of horizontal and vertical nuclear proliferation that include “bureaucratic politics” explanations, see Sagan (1996-7); Sagan (2011), and; Tanya Ogilvie-White, “Is There a Theory of Nuclear Proliferation? An Analysis of the Contemporary Debate,” *Nonproliferation Review* 4.1 (1996): 43-60. For a specific example of a study arguing that bureaucratic pressure can be a general cause of nuclear proliferation, see Matthew Fuhrmann, *Atomic Assistance: How “Atoms for Peace” Programs Cause Nuclear Insecurity* (Ithaca, NY: Cornell University Press, 2012). Three works that describe various aspects of India’s nuclear history and provide descriptions of how Indian government employees lobbied for their country to adopt a nuclear weapons program are Itty Abraham, *The Making of the Indian Atomic Bomb: Science, Secrecy and the Postcolonial State* (London and New York: Zed Books, 1998); Chengappa; Perkovich, and; Sagan (1996/7).

¹⁶² For the Australian case, see Walsh (2001); for the Indian case see Abraham; Chengappa; Perkovich, and; Sagan (1996/7).

because of organizational interests is unsatisfying because it is too general a claim. All governments are made up of organizations that help develop and execute policy. Even if we assume that different parts of the government are constantly competing to influence final policy decisions, this is an unsatisfying explanation for the variation in states abandoning their nuclear weapon activities. The fact that governments are made up of sub-units with their own preferences, interests, and beliefs about the world is constant across time and space, and is thus a poor explanation for variance. If organizational preferences can influence governments to both begin and abandon nuclear weapon activities, then determining when those organizational imperatives are associated with abandonment requires us to make more specific claims.

The rest of this chapter will develop such an argument about how organizational imperatives can help determine whether a state abandons its nuclear weapon activities. First it will review the argument about how the preferences and interests of government organizations can influence final policy decisions and analyse the logic underpinning the claim that bureaucracies can help push states towards acquiring nuclear weapons. The chapter will then lay out an argument explaining why some types of government bodies that executive branches have charged with running nuclear weapons program may in fact have relatively little interest in nuclear weapons and help create a policymaking environment that is amenable to nuclear abandonment. The chapter will conclude by offering a general and testable hypothesis about the relationship between organizational imperatives and nuclear abandonment.

3.1 How Do Organizational Imperatives Affect Policy Making?

Before discussing the specific link between organizational imperatives and nuclear weapons, it is worth briefly exploring the topic of “bureaucracy” and foreign policy more

generally, since the bureaucratic politics paradigm, in its simplest form, understands governments as being made up of many constituent parts with different preferences. Allison and Halperin's seminal essay on bureaucratic politics offers a starting point.¹⁶³ Allison and Halperin offer a heuristic characterization of how the various branches of governments and the individuals in them develop, set and then execute policy. Allison and Halperin suggest that the preferences, biases, and short-term goals various departments of a government are significant (but not the sole) determinants of government policy. This "bureaucratic model" stands in contrast to the "inter-state model," where governments set policy largely in reference to external events and their country's overall economic, diplomatic, and military capacity. They use the example of arms races: the inter-state explanation says that one state reacts to the arms build-up of another state because that arms build-up is inherently threatening to it. Instead, Allison and Halperin argue that a bureaucratic explanation can explain more variation in arms races because it takes into account the perspectives and motives of the senior bureaucrats who advise the government about the decisions to acquire specific weapon systems.¹⁶⁴

Allison and Halperin offer three useful assumptions. First, foreign policymaking occurs in basically a hierarchical environment. Some actors have more legitimacy, authority, and decision-making power than others. Presumably, organizations that have a core competency on an issue have more authority on that issue: for example, atomic energy agencies should have relatively more authority on matters relating to nuclear science than, say, finance ministries. The executive branch – especially when its preferences are clear and unambiguous – also enjoys substantial authority when setting policy. Second, policy making is a somewhat competitive enterprise, and different organizations and individuals inside a government hold different views

¹⁶³ Graham T. Allison and Morton H. Halperin, "Bureaucratic Politics: A Paradigm and Some Policy Implications," *World Politics* 24.S1 (1972): 50-79.

¹⁶⁴ Allison and Halperin, 60-64.

and policy preferences.¹⁶⁵ Not every policy can reflect the top preferences and desires of every organization or individual involved in crafting it. Third, policy actors' positions and interests tend to reflect their organization's core mandate: Allison and Halperin use the example of flying aircraft as the core mission of the air force.¹⁶⁶ In the realm of nuclear weapon activities, research and design of nuclear arms could be considered a core mission for a nuclear science establishment. Many of these basic assumptions are echoed in other works on bureaucracy and foreign policy.¹⁶⁷

According to Allison and Halperin's account, the net result of the bureaucratic process is that policy is not produced by a rational, unified actor analyzing a situation and identifying what it believes would be the most effective way to achieve its goals. Instead, policy is often a compromise, parts of which serve the organizational interests and preferences of the various individuals and organizations that were involved in the policy formation process. There is no obvious reason to suspect that states' nuclear weapons policies are not set in a similar fashion to the process Allison and Halperin describe. The exact mix of actors may differ from case-to-case, and due to the secrecy that surrounds most nuclear weapon programs the total number of actors involved in nuclear weapon policy-making is probably more restricted than in other foreign policy-setting exercises. However, the notion that nuclear weapon policy is shaped in part through a process where different parts of the bureaucracy act to influence politicians (and their ultimate policy decisions) so that final policy decisions reflect their organizational preferences (to some degree) seems reasonable.

¹⁶⁵ Allison and Halperin, 49.

¹⁶⁶ Ibid.

¹⁶⁷ See Robert J. Art, "Bureaucratic Politics and American Foreign Policy: A Critique," *Policy Sciences* 4.4 (1973): 467-490; B. Dan Wood and Jeffrey S. Peake, "The Dynamics of Foreign Policy Agenda Setting," *American Political Science Review* 92.1 (1998): 173-184; David A. Welch, "The Organizational Process and Bureaucratic Politics Paradigms: Retrospect and Prospect," *International Security* 17.2 (1992): 112-146.

3.1.1 Nuclear Policy-Making: Ultimately an Executive Decision

While it is reasonable to assume that bureaucracies, because of their specialized knowledge and skills (e.g. the foreign affairs ministry has expertise in diplomacy), insider knowledge (e.g. they know how policy development cycles work), and relative permanence (e.g. public servants may have longer careers than elected politicians), can substantially influence the policy making process, this does not mean that they set policy, particularly when it comes to nuclear weapons. Instead it appears that in the vast majority (if not all) of countries that have conducted nuclear weapon activities, that the authoritative order to commence or abandon activities came from the executive branch of the government (an illustrative list includes the United States, USSR, United Kingdom, China, France, India, Pakistan, South Africa, and Switzerland).¹⁶⁸ The role of the bureaucracy in developing nuclear weapon policy is in helping determine the content of the final policy, but the decision about whether to enact that policy is almost always in the hands of the executive branch. These nuclear-specific examples are consistent with claims that generally a government's executive branch has the final say on many – if not all – foreign and defence policy issues.¹⁶⁹ Aspects of the relationship between the bureaucracy and the executive can be understood in terms of a principal-agent problem: the executive attempts to make the best decision they can, given their imperfect knowledge and lack of specialist expertise. They rely on bureaucrats to craft and execute policy options, but are also

¹⁶⁸ For the USA, see Richard G. Hewlett and Oscar E. Anderson, Jr., *The New World: A History of the United States Atomic Energy Commission, Volume 1, 1939-1946* (US Atomic Energy Commission, 1972); USSR, David Holloway, "Entering the Nuclear Arms Race: The Soviet Decision to Build the Nuclear Bomb, 1939-1945," *Social Studies of Science* 11.2 (1981): 159-197; for the UK, see Margaret Gowing, *Britain and Atomic Energy, 1939-1945* (London: Macmillan, 1965); Margaret Gowing and Lorna Arnold, *Independence and Deterrence: Britain and Atomic Energy, 1945-1952, Volume 1: Policy Making* (London: Macmillan, 1974); China, John Lewis Wilson and Xue Litai, *China Builds the Bomb* (Stanford, CA: Stanford University Press, 1988); France, Hymans (2006); Pakistan, Khan; India, Perkovich; Chengappa; South Africa, Richardt van der Walt, Hannes Steyn, and Jan van Loggerenberg, *Armament and Disarmament: South Africa's Nuclear Experience*, 2nd ed. (Lincoln, NE: iUniverse, Inc., 2005); Switzerland, chapter five of this study.

¹⁶⁹ Stephen D. Krasner, "Are Bureaucracies Important? (Or Allison Wonderland)," *Foreign Policy* 7 (1972): 159-179; Jonathan Bendor and Thomas H. Hammond, "Rethinking Allison's Models," *American Political Science Review* 86.2 (1992): 313-15.

aware that what they believe is in their (or the national) best interest and what is in the interests of some subordinate parts of government may diverge at times. Ultimately, the politicians (elected or otherwise) that constitute the executive branch of the government typically make the final, authoritative decision about nuclear abandonment or proliferation. The preferences, advice and advocacy by the bureaucracy will influence that decision, but the preferences of the political leadership, their need to maintain political coalitions, and external factors (such as the international security environment, economic events, and global politics) will also influence that decision. To reiterate, the role of the bureaucracy in developing nuclear weapon policy is in helping determine the content of the final policy, but the final decision about whether to enact that policy is almost always in the hands of the executive branch.

The primacy of politicians does not mean that they always make fully informed, rational decisions. Government leadership nearly always has to rely on the advice and professional expertise of their bureaucracy when making decisions. For example, Eric Mlyn argues that the decade after the Cold War saw little (if any) change in the US' nuclear weapons doctrine since many of the bureaucrats that worked on nuclear policy in the 1990s were the same people who worked on those issues in the 1980s. According to Mlyn, US President Bill Clinton's lack of knowledge about US nuclear weapon policy meant that the White House was content to take the advice of America's nuclear weapon policy community, rather than demanding new ideas that would mark a significant departure from previous policy.¹⁷⁰ In short, while presidents, prime ministers, and their cabinets have the final word on nuclear weapon policy, they are not making that decision with perfect information and foresight.

¹⁷⁰ Eric Mlyn, "U.S. Nuclear Policy and the End of the Cold War," in T.V. Paul, Richard J. Harknett, and James J. Wirtz, eds., *The Ultimate Weapon Revisited: Nuclear Arms and the Emerging International Order* (Ann Arbor, MI: The University of Michigan Press, 2000): 206-207.

It is also important to understand that legislatures typically do not play a major role in nuclear weapon policy making. Often this is because the national security implications of a nuclear weapon program demand considerable secrecy. Thus, while Indian parliamentarians have treated India's nuclear weapon policy as a useful political target (to either attack the ruling party or the opposition), as George Perkovich puts it the "legislative branch of the Indian government system, has little formal power to affect nuclear policy beyond its roles in questioning government ministers and overseeing financial accounts."¹⁷¹ In Switzerland (as discussed in chapter five) the parliament was largely left out of major defence policy-making debates in the 1950s and 1960s because of residual powers the cabinet retained from the Second World War. This meant that the parliament's role in Switzerland's nuclear weapon activities was to occasionally ask the cabinet to disclose information to the legislature, but little else. In Israel, the policy of strict secrecy about its nuclear weapon program (known as *amimut*) means that even when parliamentarians are allowed in principle to deliberate on nuclear weapon policy, the documents and information they receive are strictly controlled by the security services, and parliamentarians ability to speak with the press is highly curtailed.¹⁷² So even when the Knesset does participate in nuclear weapon policy, it only does so in a highly curtailed manner, where Israel's nuclear weapon complex and executive branch decide what parliamentarians may (and may not) know. The generally limited role of legislatures in the nuclear weapon policy-making process means that the relationship between policy experts in the government and the elected (or otherwise) members of the executive branch is probably more important than in the case of other issue areas.

¹⁷¹ Perkovich, 10.

¹⁷² Avner Cohen, *The Worst-Kept Secret: Israel's Bargain with the Bomb* (New York: Columbia University Press, 2010), 198-200.

Possibly the only exception to the rule that legislatures play little role in nuclear weapon policy is the United States Congress Joint Committee on Atomic Energy (JAEC) which administered the US Atomic Energy Commission (USAEC) from 1946 to 1977. The JAEC boasted legislative and investigative powers, but also “powers of the type generally employed by the executive branch.”¹⁷³ During its existence, the JAEC not only authorized the US Atomic Energy Commission’s budget, but also influenced policy, for example by encouraging the USAEC to accelerate its hydrogen bomb program and encouraging large-scale plutonium stockpiling.¹⁷⁴ The JAEC also had the ability to compel other parts of the government to furnish it with information that the JAEC deemed necessary to do its job, and had the right to be “fully and currently informed” by the USAEC about all the Commission’s activities.¹⁷⁵ This power to compel sensitive secrets from the US’ nuclear weapon organization stands in stark contrast to the Israeli Knesset’s relationship with the Israel Atomic Energy Commission, and makes the JAEC the exception rather than the rule.

3.1.2 Bureaucratic Interests and Nuclear Weapons

A limited sub-set of the nuclear proliferation literature (and Walsh and Braut-Hegghammer in the nuclear abandonment literature) reflect this basic intuition about the role organizational interests play in shaping nuclear weapon policy. In the proliferation literature, Sagan lays out what has become the standard wisdom about the relationship between bureaucracies and nuclear proliferation. He calls it “nuclear pork and parochial interests.”¹⁷⁶ According to this story, nuclear weapons serve the interests of atomic scientists, atomic energy agencies, or militaries because building a nuclear weapon will funnel money and prestige to

¹⁷³ Harold P. Green and Alan Rosenthal, “Fusion of Government Power,” *Bulletin of the Atomic Scientists* 18.6 (1962): 12.

¹⁷⁴ Green and Rosenthal, 16.

¹⁷⁵ Ibid.

¹⁷⁶ Sagan (1996-7), 63.

these actors and organizations.¹⁷⁷ Likewise, Lavoy suggests that if a nuclear “myth maker” can convince national leadership that a nuclear weapon is not just useful but essential for a state’s security, those who are capable of building nuclear bombs become indispensable.¹⁷⁸ In another variation of the bureaucratic politics explanation for nuclear proliferation, a struggling, publicly-owned nuclear science establishment - such as South Africa’s in the 1970s - can find renewed vigour and purpose (and new sources of funding) by making an alliance with the military to use enrichment technology to build bombs.¹⁷⁹ Similarly, Sagan has speculated that failed nuclear electricity programs may lead to nuclear weapon program initiation (or weapon acquisition) more likely. This is because, he argues, if a nuclear power program fails to produce economically competitive electricity, the program managers may become open to supporting “clandestine or breakout nuclear weapons development programs to justify their existence, prestige, and high budgets within their state.”¹⁸⁰

If a nuclear weapon program will bring money and prestige to an organization, maintaining and creating careers in the process, then the hypothetical impetus for atomic scientists or military engineers to become nuclear bomb lobbyists exists. Accordingly, analysts have suggested that among various government agencies, armed forces (air forces and navies in particular) and civilian nuclear agencies are particularly likely to advocate for researching, developing, and building nuclear weapons.¹⁸¹ Habib, for example, argues that these incentives can help keep a state’s nuclear weapon activities going. Specifically, Habib claims that because North Korea’s defence and nuclear energy establishments directly materially benefit from North

¹⁷⁷ Ibid., 64.

¹⁷⁸ Peter R. Lavoy, “Nuclear Myths and the Causes of Nuclear Proliferation,” *Security Studies* 2.3-4 (1993): 192-212.

¹⁷⁹ Flank.

¹⁸⁰ Sagan (2011), 241.

¹⁸¹ Sagan (1996-7), 63-64.

Korea's nuclear weapon policy, they help ensure that Pyongyang will not give up its nuclear weapons.¹⁸² In other words, nuclear weapon programs perpetuate themselves. Since too many people inside the North Korean government would lose too much if Pyongyang ended its nuclear weapon program, the government organizations that currently benefit from the nuclear program will take action to make sure it continues. Walsh's claim that "the biggest proliferation impact of Atoms for Peace may not have been the spread of little reactors but the spread of little Atomic Energy Commissions, many of which became bomb advocates" encapsulates much of the conventional thinking on the issue.¹⁸³

While none of these authors are explicit about the logic that underpins the behaviour of these bomb advocates, they do implicitly draw from Niskanen's formal model of bureaucratic behaviour. Niskanen depicts bureaucracies as budget-maximizing entities. A bureaucrat's salary, prestige, and personal satisfaction are assumed to increase as their organization's budget increases. Thus, the chiefs of an organization will generally act to maximize their organization's budget.¹⁸⁴ This means that government organizations are inefficient in that they may produce more goods and/or services than their government desires. In the case of a hypothetical atomic energy agency, a bit of policy entrepreneurship that convinces national leaders that building a nuclear bomb would be in the national interest would fit Niskanen's general explanation.¹⁸⁵

Walsh's general argument that organizations that would benefit from continuing nuclear weapon

¹⁸² Benjamin Habib, "North Korea's Nuclear Weapons Programme and the Maintenance of the *Songun* System," *Pacific Review* 24.1 (2011): 43-64.

¹⁸³ Matthew Bunn, "Civilian Nuclear Energy and Nuclear Weapons Programs: The Record," working draft, Belfer Center for Science and International Affairs, Harvard University, June 29, 2001, 1, fn. 3.

¹⁸⁴ William A. Niskanen, "Bureaucrats and Politicians," *Journal of Law and Economics* 18.3 (1975): 617-643.

¹⁸⁵ Fuhrmann's study on civilian nuclear cooperation and proliferation, which argues that nuclear technology transferred through peaceful nuclear cooperation agreements makes building a nuclear weapon easier, is certainly consistent with Niskanen's model. Fuhrmann argues that once civilian assistance has been transferred, nuclear scientists may become advocates for nuclear weapons, and national leaders approve of nuclear weapon programs because they believe the prospects for success will be high. See Fuhrmann (2009).

activities (due to increased resources or prestige) advocate for governments to acquire nuclear weapons is also consistent with budget-maximizing bureaucratic logic.

India's nuclear history offers a concrete example for how organizational interests can induce a state to build nuclear weapons.¹⁸⁶ According to the bureaucratic politics explanation of nuclear proliferation, the origins of India's nuclear weapon program are not found in the aftermath of China's 1964 nuclear test. Instead, India's nuclear weapon program originates in India's Atomic Energy Commission (InAEC), headed by Homi Bhabba.¹⁸⁷ A number of authors and analysts have described Bhabba as a tireless policy entrepreneur and nuclear weapon proponent.¹⁸⁸ He was able to parlay his position as InAEC director to lobby the Shastri government for a small nuclear weapon program (Shastri agreed to research in peaceful nuclear explosives), of limited scope, and build up a cadre of pro-nuclear weapon scientists in the AEC.¹⁸⁹ Thus, the AEC had sufficient knowledge and the capability to put together a nuclear explosive in 1974 at the behest of Indira Gandhi. While bureaucratic self-interest was insufficient to explain why India acquired nuclear weapons, it did help create favourable conditions for India to adopt such a policy. In other words, Bhabba was able to convince India's leadership to allow some nuclear weapon activities in the InAEC, which in turn opened the door to other policy possibilities (such as testing a nuclear bomb) when events demanded it.

In sum, there is a clear reason to assume that at times government organizations will benefit from conducting nuclear weapon activities. Nuclear weapon activities, can, in principle, bring financial resources and human resources to an organization, and thus allow an organization to perpetuate itself and potentially increase its influence within government.

¹⁸⁶ India is arguably the single case that has had the most influence on academic thinking about the relationship between organizational incentives and nuclear weapon policy.

¹⁸⁷ Sagan (1996-7), 66.

¹⁸⁸ See Perkovich; Changappa, and; Abraham for examples.

¹⁸⁹ Sagan (1996-7), 66.

3.2 Organizational Imperatives and Nuclear Abandonment

The logic of how organizational imperatives can help bring about the onset of, and perpetuate nuclear weapon activities is relatively clear: organizations that would benefit professionally from the financial and human resources associated with nuclear weapons work to influence policy debates towards pro-bomb outcomes. According to the literature, armed forces and public nuclear science agencies are particularly likely to advocate that national governments initiate and sustain nuclear weapon activities.

However, governments always employ public departments and agencies to service their needs and execute policy, as ultimately determined by the executive branch or legislature. Almost all governments have armed forces. Many have atomic energy agencies. Yet we see considerable variation in nuclear weapon activities: not every state seeks to acquire them, and not every state that begins nuclear weapon activities actually builds nuclear weapons. Arguing that states build nuclear weapons because a government department or agency stands to benefit from it does not provide a great deal of insight into the proliferation decision (the same stands for decisions to abandon nuclear weapon activities). So long as the careers, salaries, and status of employees in some government organization are tied to the research, development, or production of nuclear weapons, then there is, in one narrow sense, always an organizational impetus for a nuclear weapon program. This logic could be further extended to any government policy: as long as it is an organization's mission to carry out a policy, then there are organizational interests at play.

The more difficult question is when do organizational interests matter to the extent that they influence final policy outcomes as decided by politicians? Or in other words, under what

conditions does organizational interest affect the likelihood that political leadership takes a decision to abandon its nuclear weapon activities?

If we accept the assumption that a government organization potentially or actually involved in nuclear weapon activities may seek to maximize its budget and influence, it does not necessarily mean that producing nuclear weapons is the best – or only – way to do so. Different organizations have different missions, and there is no reason to assume that developing nuclear weapons is the default policy option for a government organization that is seeking to increase its budget, prestige, and influence.

Recall, from the introduction, the concept of “organizational essence,” which is what an organization’s members believe what their organization should do, and what capabilities they need to meet that core mission.¹⁹⁰ As Halperin, Clapp, and Kanter claim, government organizations will argue in favour of policies that will make them more important to the government’s overall foreign policy. Organizations will also “struggle” to acquire the material capabilities, human resources, or legal jurisdiction that organization members believe are crucial for executing its essential mission. By this logic, government organizations will also resist efforts to take away capabilities or missions that are part of its essence. Importantly, Halperin, Clapp, and Kanter also suggest that organizations might not care about some of their missions that the executive or another branch of government has tasked them with, particularly if those missions are not seen as part of its “organizational essence.”¹⁹¹ While Halperin, Clapp and Kanter use the examples of the US Army, Air Force, and Navy either coveting certain types of combat missions or equipment (or alternatively, the Air Force and Navy devoting relatively little of their budgets

¹⁹⁰ Halperin, Clapp, and Kanter, 27.

¹⁹¹ Halperin, Clapp, and Kanter, 38-39.

and energy to their airlift and sealift capabilities), their basic logic may apply to organizations that are tasked with nuclear weapon activities as well.

Government organizations have “organizational essences” at least in part because these organizations (usually) exist for a rational reason. Creating and empowering public organizations to take a relatively free hand to pursue the policy goals that the executive or legislature assigns to them helps overcome the large costs imposed by the need to coordinate civil servants’ labour and efforts. Government organizations impose standard operating procedures and establish a managerial hierarchy to facilitate a division of labour in pursuit of their “statutory objectives.”¹⁹² Akin to a private firm, a national government faces considerable incentives to create specialized sub-divisions in order to both acquire and maintain the specialized knowledge and capabilities that are necessary to develop and execute specific policies, and to avoid the transaction costs that would be associated with a disaggregated policy execution effort.¹⁹³ Hence, governments have foreign ministries that specialize in conducting diplomacy and providing advice on international relations to the executive branch (among other tasks). Finance ministries specialize in forecasting economic changes and managing public finances. A state’s military specializes in maintaining standing armed forces and conducting armed combat. While there may be overlap in some of the specific capabilities in these organizations (for example, all three may have their own statistical offices to manage the reams of data they create), in general terms, we can identify substantively different capabilities and goals in all three organizations. Achieving specific policy goals requires organizations to acquire specific skills and resources. Consequentially, so long as a

¹⁹² Krasner, 163.

¹⁹³ R.H. Coase, “The Nature of the Firm,” *Economica* 4.16 (1937): 386-405.

government still wants to achieve specific policy goals, the skills and expertise that government organizations have means that those organizations remain useful to the government.¹⁹⁴

Establishing (semi-) permanent organizations to execute specific policy goals, while efficient in the short-run, creates incentives for individual policy makers to serve their narrow organizational needs before they serve the broader interests of the state as a whole. Leaders in government organizations face a need to continually ensure that they have the resources and capabilities that they believe are necessary to achieve the policy goals that the executive branch assigns to them, now and in the future.

Members of specialized organizations may also sincerely believe that their skills and abilities provide a unique and necessary capability for their government that cannot be easily replaced.¹⁹⁵ For example, David Lilienthal, then chairman of the US Atomic Energy Commission, in testimony before the US congress in 1949, claimed that the US nuclear weapon effort was a matter of grave national interest, and one that had to be pursued given the lack of any international agreement to ban nuclear weapons.¹⁹⁶ While Lilienthal may have been exaggerating the importance of the nuclear project to the legislature, it is also likely that he was reflecting an authentic belief among the members of his organization that researching and developing nuclear arms was in the genuine interest of the United States.

An organization's chief may agitate for the continuation or expansion of a given policy long beyond the point where that policy serves the national interest, and the chief's motive can be a matter of narrow material interest, sincere belief about the utility of their task, or a

¹⁹⁴ The literature on private business organization offers a similar, empirically-derived point: firms are forced to develop specialized subdivisions in order to adequately master and understand the technologies that they use and recombine into new products. See Keith Pavitt, "Technologies, products and organization in the innovating firm: what Adam Smith tells us and Joseph Schumpeter doesn't." *Industrial and Corporate Change* 7.3 (1998): 433-452.

¹⁹⁵ See section 3.3.1 in this chapter for further elaboration.

¹⁹⁶ Joint Committee on Atomic Energy, "Hearing Before the Joint Committee on Atomic Energy," 81st congress, 2 February 1949 (Washington, D.C.: United States Government Printing Office, 1949).

combination of both. This functional differentiation is consistent with the general claim that organizations within the bureaucracy can strongly influence government policy on a specific issue. It also suggests that that even if we assume that bureaucratic organizations will sometimes prioritize their own narrow interests ahead of the aggregate interests of the entire government, different organizations may have different ways of achieving that goal.

Thus, according to the logic of “organizational essence,” simply because an organization conducts nuclear weapon activities does not mean that it will, in a Niskanen-like fashion, relentlessly and automatically produce a “surplus” of nuclear weapon activities. Instead, working from the assumption that organizations will prioritize some of their missions over others, it is reasonable to hypothesize that there should be variation in the behaviour of organizations that conduct nuclear weapon activities. In the case of organizations where the nuclear mission is part of its “essence,” or is relatively important to that organization’s continued existence, then Niskanen-like behaviour should be more likely. In those cases, lobbying and advocacy on behalf of continued or expanded nuclear weapon activities should be relatively common. However, in cases where the nuclear mission is not part of the organization’s essential mission, Niskanen-like behaviour should be relatively less common. Instead, those organizations (such as armed forces that are in charge of a country’s nuclear weapon activities) will still lobby and act to enhance their core mission and capabilities (such as acquiring new conventional weapon systems, or more personnel), while dedicating relatively less effort and political capital to preserving and enhancing its nuclear weapon activities.

In other words, Niskanen offers a simple single-good model of government organizations. When organizations produce a single good, the assumption that they will over-produce that single good is reasonable. However, if an organization produces two or more goods,

the outcome will vary. While classic economic analysis would suggest that the organization will produce two goods until the marginal benefit of producing one more unit of each good is equal, we can assume that the two goods are not in fact perfect substitutes, and that an organization may benefit much more from producing one type of “good” over another.

Assuming that organizations have “essences” and will behave in order to preserve and enhance the capabilities and policies that are tied to that essence offers a way to crudely identify, *a priori*, organizational policy preferences. Recall that the conventional wisdom is that militaries and nuclear science agencies tend to agitate for their governments to authorize nuclear weapon activities. On the other hand, researchers have identified finance ministries, foreign ministries, and even atomic energy agencies and defence ministries as potential opponents of nuclear weapon programs.¹⁹⁷ While anecdotes do not constitute usable data, a few more examples highlight that strictly assuming that certain government organizations will automatically and invariably hold pro- or anti-nuclear preferences is probably foolhardy.

The French military, for example, was opposed to France developing nuclear weapons in the early 1950s. The French army at the time was embroiled in a counterinsurgency in Algeria, where it believed that nuclear weapons would be useless. The French military was specifically concerned that any budget given to the French nuclear establishment to develop nuclear weapons would come at least in part out of the military’s finances, reducing the budget for personnel and conventional weapons that were needed in Algeria and to meet the defense requirements of France’s other colonies.¹⁹⁸

On the other hand, departments that might have anti-nuclear preferences in one country and era might be pro-nuclear in another time and place. Take an example from the debate inside

¹⁹⁷ See, respectively, Liberman (2001); Walsh (2001), and; Hymans (2011).

¹⁹⁸ Scheinman, 98-99.

the Indian government in 1964. In that year Homi Bhabha was advocating that the Indian government formally adopt a policy to develop and build nuclear weapons. According to the US embassy, India's External Affairs minister, Swaran Singh, and S.K. Patil, the railways minister (and who was influential in the then-ruling Congress Party), amongst others, supported Bhabha. The only two major opponents within the cabinet were the ministers for Defence and Food and Agriculture.¹⁹⁹

To summarize, to draw a credible link between organizational imperatives and nuclear abandonment, two things are necessary. First, analysts need to identify when organizational imperatives are more likely to have a substantive effect, and when they are not, since all governments empower organizations to develop and execute policy. Second, there needs to be a way to make assumptions about how organization's preferences for nuclear weapons are distributed. In other words, we need assumptions about to what extent a given organization prefers nuclear weapon activities over devoting its efforts to other tasks. The concept of "organizational essence," which speaks to the statutory objectives and the rational reason why a government organization exists, offers a reasonable basis for making assumptions about an organization's preferences.

3.3 A Hypothesis about Organizational Imperatives and Nuclear Abandonment

Drawing upon the preceding discussion, this section will develop a stylized general hypothesis about the relationship between organizational imperatives, nuclear weapon activities, and the likelihood that a state will either abandon or maintain its nuclear weapon activities.

¹⁹⁹ Perkovich, 70. It is worth noting that while it is difficult to positively determine what M.C. Chagla (Singh's successor in External Affairs) thought of nuclear weapons, he did publically oppose the suggestion that India join the NPT as a NNWS. See Perkovich, 135; A.G. Noorani, "India's Quest for a Nuclear Guarantee," *Asian Survey* 7.7 (1967): 499.

While the theory's logic is not explicitly formal, I will attempt to formulate the theory in falsifiable terms. The theory presented here draws from both the bureaucratic politics literature, and from the nuclear proliferation and abandonment literature discussed in chapter two. The theory argues that once nuclear weapon activities have begun, if those activities are being conducted by a specialized organization, abandonment will be relatively rare.

On the other hand, if nuclear weapon activities are being conducted by an organization that has other core duties or missions, or if the activities are housed in an *ad hoc* organization attached to the executive, the state will be more likely to abandon those activities. Nuclear weapon organizations, in this chapter, refer to the organization that is in charge of researching, designing, building, or planning to build nuclear weapons. It does not refer to the armed forces that deploy nuclear weapons. While in reality the armed forces in nuclear-armed states do play a role in nuclear weapon policy making, for the purposes of developing this hypothesis, armed forces are treated as end users, not as producers of nuclear weapons. The obvious exception to that are cases where the armed forces (or a subsidiary of them) are responsible for the research, design and production of nuclear weapons. These cases are covered by the hypothesis developed below.

Under most conditions, we should not expect states to consider ending their nuclear weapon activities. There are at least three reasons for this. First, the fact that a state is conducting nuclear weapon activities is a strong (though not absolute) indication that the government considers nuclear weapons to be at least marginally useful. Second, governments may succumb to the sunk cost fallacy and attempt to capture the resources that they have already committed to their nuclear weapon policy by continuing to fund the activities, even if the nuclear weapon

activities no longer serve a rational purpose.²⁰⁰ Third, policy momentum tends to be the norm in most states.²⁰¹ This is in part because government organizations which execute policy are necessarily somewhat autonomous (as detailed in section 3.2). Changing policies may mean identifying substitutes for policy that is to be abandoned. If a state is investigating nuclear weapons as a potential route to balance another state's military capabilities, then terminating the nuclear weapon activities would mean that policy makers must identify some other some other balancing policy, such as joining an alliance or expanding the conventional armed forces. This can in and of itself be costly and time consuming. It is therefore reasonable to expect that absent some sort of external or internal shock, we should expect nuclear weapon activities to persist.

However, we do know that nuclear abandonment occurs with some regularity. For the sake of theory, I assume that nuclear weapon program termination is, however, a probabilistic event that can be caused by a large set of factors. In rare cases (namely Nazi Germany and Imperial Japan) a country has lost a war, and the victorious parties have essentially forced the losing state to terminate its nuclear weapon activities. However, in practically the rest of the universe of cases, the government makes a conscious decision to terminate the country's nuclear weapon activities. Even in Iraq, Saddam Hussein had to make the decision to terminate the Iraqi nuclear weapons program (though international weapon inspections heavily influenced that decision).²⁰²

²⁰⁰ Policy momentum may also be explained by appealing to the concept of path dependency, where past choices limit the range of options available to policy makers. See B. Guy Peters, Jon Pierre, and Desmond S. King, "The Politics of Path Dependency: Political Conflict in Historical Institutionalism," *Journal of Politics* vol. 67, no. 4 (2005): 1275-1300 for a broad discussion of the use of path dependency in political science literature.

²⁰¹ See David A. Welch, *Painful Choices: A Theory of Foreign Policy Change* (Princeton, NJ: Princeton University Press, 2005), 31-35.

²⁰² The Duelfer Report claimed that Hussein considered maintaining a residual (or latent) nuclear weapons infrastructure that could be concealed from weapons inspectors and used as the foundation of a new nuclear weapons program once the permanently departed the country. However, it clearly concludes that for all practical intents and purposes, all work on the project stopped and the Iraqi nuclear weapons program ended in the late 1990s.

Once a decision was made, the question is ultimately one of what stimuli influenced that decision. These stimuli can take on many forms. It could be a threat from an ally: the United States put diplomatic pressure on South Korea and Taiwan to terminate their nuclear weapon activities. It could be a threat from a potential adversary. It could be a change in government: for example, Solingen argues that Anwar Sadat's program of economic liberalization in Egypt meant that he had to abandon Nasser's nascent nuclear program.²⁰³ In Brazil, at least one analyst has argued that President Collor gave the order to shut down the country's nuclear weapon program in an effort to demonstrate his resolve to keep major policy decisions in the hands of the civilian government, rather than the armed forces.²⁰⁴ Or policy makers could conclude that a state's nuclear weapon activities outlived their potential military or political utility, as occurred in Switzerland.²⁰⁵ As the study of South Africa in chapter five will show, financial pressures that force organizations to make hard decisions about how to prioritize funding to projects can also be a proximate trigger for nuclear abandonment. In short, this stimulus (or shock) can take on a large number of forms. All that is required is that something occurs that makes abandoning the nuclear weapon activities an attractive or necessary policy choice, and there is no shortage of potential triggers, as Table 2.3 shows. There is no need to conduct a thorough empirical examination of each one of these factors in order to cautiously assume that at least some of these factors will have some substantive effect on a government's decision to either abandon or retain a nuclear weapon program, under some unknown set of conditions. The range of potential causes

See Central Intelligence Agency, *Comprehensive Report of the Special Advisor to the DCI on Iraq's WMD with Addendums*, vol. 2 (Washington, D.C.: U.S. Government Publishing Office, 2004), section two, 3-9.

²⁰³ Solingen (2007).

²⁰⁴ Michael A. Barletta, *Ambiguity, Autonomy, and the Atom: Emergence of the Argentine-Brazilian Nuclear Regime* (University of Wisconsin-Madison, 2000), PhD diss.; Barletta, "The Military Nuclear Program in Brazil," Center for International Security and Arms Control, Stanford University, 1997. In Brazil, the army was in charge of the country's nuclear weapon activities. The air force and navy also had nuclear research programs, but both appeared to have been aimed at non-weapon military applications.

²⁰⁵ In 1988 the Swiss Federal Council determined that Switzerland's nuclear weapon activities were no longer necessary.

that the literature identifies is broad, and there are reasonable, intuitive reasons to suspect many of these factors can contribute to causing nuclear abandonment.²⁰⁶ While this study does not identify any generalizable or common proximate causes of nuclear abandonment, it is certainly possible that a finite number of relatively common proximate triggers may exist.

These shocks are, however, likely insufficient to cause a state to abandon its nuclear weapon activities. As reported in chapter five of this study, in 1956, when the Swiss government publicly announced its intention to possibly acquire nuclear arms, Soviet officials issued rebukes to the Swiss embassy in Moscow. The Soviets angrily insisted that acquiring nuclear weapons would violate Switzerland's neutrality and that Switzerland would aim those weapons at the USSR, which would be unacceptable to Moscow. The Swiss federal council was aware of the Soviet reaction to their nuclear weapon plans, but it does not appear that Switzerland abandoned its nuclear weapon plans due to Soviet opprobrium. An official diplomatic rebuke *could* be a potential shock that could cause a state to change its nuclear weapon policy. Other conditions (including the character of the state's *de facto* nuclear weapon organization) need to be correct for those shocks to translate into nuclear abandonment.

The second assumption is that government organizations will try to reify their policy preferences. Whether a state abandons or sustains its nuclear weapon activities, is to a certain extent (as Walsh puts it), a matter of either pro- or anti-nuclear weapon actors getting their way. The precise mixture of interested actors probably varies from case-to-case: these could include militaries, foreign ministries, nuclear scientists and nuclear energy commissions, and the executive branch. Other actors that may have strong pro- or anti-nuclear preferences include parliaments, academic communities, and mass media actors. However, not all of these actors are

²⁰⁶ Chapter two put forward the argument that the literature's claims that these factors are demonstrably general causes of nuclear abandonment is unsubstantiated. That does not mean, however, that these various factors cannot take effect under certain conditions.

equally important: India and Israel, both being democracies, both witnessed debates over their nuclear policies at various times. It is by no means clear though that the public debate had any substantive effect on policy makers' decisions to initiate, sustain, or terminate nuclear weapon activities.

Therefore, we can reasonably assume that at any given time, a government with a nuclear weapon program could have a number of reasons to abandon that nuclear program. Anecdotally, we can look at the United Kingdom, where policy makers have considered downsizing or getting rid of the UK's nuclear weapons program in the 1960s (and are currently debating downsizing it).²⁰⁷ In Pakistan, President Zia ul-Haq faced at times concerted diplomatic pressure from the United States to slow or halt the Pakistani nuclear weapon program. As noted already in this chapter, when Switzerland announced its nuclear weapon policy in 1956, the USSR communicated its displeasure to the Swiss government.

When confronted with a reason to terminate a state's nuclear weapon activities, the government may attempt to do so, or will at least consider the option. Whether or not this leads to abandonment will depend on a host of factors, including the preferences of the various parts of government, not to mention the intensity of the shock that precipitated the policy review.

To simplify the analysis, I concentrate on the organization that directly administers the state's nuclear weapon activities. Historically, these organizations have included nuclear science organizations, the armed forces, defence research agencies, or specially developed nuclear weapon agencies that have been in charge of nuclear weapon activities. In rare cases, the executive branch has directly administered a state's nuclear weapon activities. Examples of this include South Korea's nuclear weapon program, which President Park Chung Hee managed, or the West German and Italian plans to build nuclear weapons with France. The West German and

²⁰⁷ Hennessy, 91.

Italian cabinets were the direct managers of nuclear weapon activities in those cases. However, generally the executive branch of a government does not directly administer a state's nuclear weapon activities.

How the organization that houses a state's nuclear weapon activities reacts to the decision by the government to review its nuclear weapon policies should be important to determining the final outcome (whether the state abandons its nuclear weapon activities). This is in many ways the heart of the matter. As discussed earlier, the organizational theory of nuclear proliferation assumes that organizations that conduct nuclear weapons activities (or that would benefit from initiating nuclear weapon activities) will more-or-less unconditionally lobby for a nuclear weapon program. The theory does not tell us how hard they will lobby, and is relatively quiet about under what conditions they will lobby for a weapon program.²⁰⁸

I contend that organizations that are tasked with conducting nuclear weapons activities make a more concerted effort to convince political leadership to continue that activity (e.g. the nuclear entrepreneur behaviour seen in India and referred to by Sagan, Flank, Fuhrmann, and others) when nuclear weapon activities are a significant part of the organization's core mission. However, when organizations are not designed to primarily carry out nuclear weapon activities – such as when the state's nuclear weapon activities are largely paper studies that are carried out by the cabinet, as in Australia in the late 1960s and early 1970s, or when a technical program is run out of the executive office, as in South Korea, or when a military organization with other crucial missions also conducts nuclear weapon activities – it will be relatively easy to terminate the nuclear weapon activities. This is because terminating the nuclear weapon activities will not threaten the budget or status of those organizations as much as it will if the nuclear weapon

²⁰⁸ The exception is Fuhrmann (2009), who claims that civilian nuclear assistance makes scientists actors more likely to lobby for nuclear weapons because that civilian assistance can be used in the bomb-building process.

activities constitute a significant (or the sole) mission for the organization. These organizations will not attempt to influence government to preserve their nuclear weapon activities as much as an organization that primarily (or solely) conducts nuclear weapon activities.

Hence, according to the preceding logic, when nuclear weapon activities are not an organization's core mission (or part of their "organizational essence"), then the organizations that house nuclear weapon activities should – all things being equal – be relatively weak advocates for their nuclear weapon programs. It is even possible that organizations in charge of nuclear weapon activities might be ambivalent about continuing their nuclear weapon activities. If, for example, a government begins exploring the possibility of terminating its nuclear weapon activities, an organization that has other major missions may simply decide to accept the decision and support it. Hypothetical examples would be nuclear weapon programs housed inside armed forces or military research and development organizations, which in addition to their nuclear weapon activities, will typically have several other major missions and duties.²⁰⁹ Thus, not only may the standard logic that armed forces are necessarily strong advocates for nuclear weapons be incorrect, in fact, armed forces, if they are responsible for conducting nuclear weapons, may effectively deprioritize that mission.

To summarize, the claim that some organizations within a government may be strongly in favour of their governments researching, developing, and acquiring nuclear weapons is sound. The historical record has produced instances where organizations within the government have been more enthusiastic about nuclear weapons than the government's executive branch may have been, and there is evidence that these organizations have influenced national nuclear policy in some countries. The claim that other actors within a government may have strong anti-nuclear weapon preferences, and may have played a role in convincing some executive branches to

²⁰⁹ The Norwegian and Swedish nuclear weapon programs were both housed in military research institutes.

refrain from acquiring nuclear weapons is also sound. However, both these claims miss an important part of the logic: not all organizations that conduct nuclear weapon activities will necessarily have the same preferences. Just as there is variation in nuclear weapon policy preferences among the entire universe of government organizations, there is also reason to suspect that there is variation in preferences among the organizations that have historically conducted nuclear weapon activities. The historical record is clear: there is considerable variation among the sorts of organizations that states have charged with conducting nuclear weapon activities. These range from specialized ministries (in the case of the USSR) and purpose-built organizations (the United Kingdom after 1956), to pre-existing atomic science and energy organizations (Argentina, Iraq, South Africa before 1979), to military science organizations nested within the armed forces (Brazil, Norway), to extensions of the executive branch or interdepartmental committees or foreign ministries (South Korea, Germany, Japan, Switzerland after 1970).

If we assume that government organizations, at the margins, prioritize their own survival and interests within the government, then assuming that all organizations charged with conducting nuclear weapon activities (whether developing policy plans, conducting basic research, or designing, manufacturing, and testing nuclear arms) will prioritize that nuclear task above all other missions is untenable. Instead, if different organizations have different core functions, then we should assume, for the purpose of argument and testing, that organizations will prioritize core activities over nuclear activities, unless the nuclear activities are in fact that organization's core mandate.

3.3.1 Nuclear Weapon Organizations

For the purposes of analysis, we can think about nuclear weapon activities in terms of whether they are being performed by a specialized organization with its own management, leadership, and resources, if the activities are subordinated within another department, or if they are directly attached to the executive or cabinet. I will refer to the degree to which nuclear weapon activities are housed in a specialized organization as *organizational specialization*. Specialized nuclear weapon organizations should have relatively larger numbers of people with a vested, personal interest in the continuation or success of a state's nuclear weapon activities than organizations that have other missions.

In a specialized organization the staff's employment and professional status will rely on the weapon activities, and thus the organization's leadership will devote more energy and effort to lobby for the continuation of the program. In other words, specialized nuclear weapon programs may have more (or relatively energetic) champions within the government. They may also be more likely to argue that their nuclear activities serve a constructive and useful policy purpose, whether it be nuclear deterrence or maintaining a state's science and technology expertise. For example, in the years preceding India's *Pokhran-II* nuclear tests, one of the arguments that India's nuclear weapons establishment made to justify the tests was that they were necessary to retain and recruit young scientists and engineers (who increasingly were turning to high-paying private sector employment) to the public sector.²¹⁰ Continuing and expanding India's nuclear activity was therefore necessary not just because of the deterrence afforded by nuclear weapons, but because it would help foster the talent necessary to tackle unknown future challenges. In early 1949, before the USSR tested its first nuclear weapon, and while the US still maintained a monopoly on nuclear arms, David Lilienthal, the Chairman of the

²¹⁰ Perkovich, 365.

US Atomic Energy Commission, in testimony before congress, invoked the fact that the US had not yet secured an international agreement to ban the use of nuclear weapons to emphasize the importance of maintaining America's "preeminence" in nuclear science.²¹¹ More recently in 2015, Frank Klotz, the administrator of the US Department of Energy's nuclear weapon activities, testified that funding the agency's nuclear weapon laboratories "supports the vitality of the broader National Security Enterprise [sic]," as doing so "provides basic research funding to foster innovation and to attract and retain young scientific and technical talent."²¹²

Organizational specialization also creates an information asymmetry between a nuclear organization and the government. Building a civilian nuclear reactor or designing a nuclear weapon requires a great deal of specialized knowledge. This places the government at a disadvantage. During policy debates, national leadership may be unable to fully evaluate the claims their nuclear organization makes. This is an example of the classic principal-agent problem. In this case the government cannot fully evaluate the claims of the organization that it has charged with conducting nuclear weapon activities due to a profound difference in specialized knowledge. This inability to fully evaluate the nuclear organization's claims allows the nuclear weapon organization the ability to act in ways that the government would prefer that it does not. While the principal-agent problem is normally used to describe situations where the agent may shirk their duties and impose costs on the principal (the classic formulation is the worker who puts forth little effort at their job, since their manager cannot observe them at all times).²¹³ In the case of nuclear weapon activities, the risk is probably that a nuclear weapon

²¹¹ U.S. Congress, "Hearing before the Joint Committee on Atomic Energy," 2 February 1949, 3.

²¹² U.S. House of Representatives, "Statement of Lt. Gen. Frank G. Klotz, USAF (Ret), Administrator, National Nuclear Security Administration, U.S. Department of Energy, on the Fiscal Year 2016 President's Budget Request before the Subcommittee on Energy & Water Development, House Committee on Appropriations," 25 March 2015, 4.

²¹³ Sanford J. Grossman and Oliver D. Hart, "An Analysis of the Principal-Agent Problem," *Econometrica* 51.1 (1983): 7-46.

organization will use its information advantage to conduct more (rather than less) nuclear weapons activity/produce more nuclear weapons than the government would otherwise prefer.²¹⁴

A nuclear weapon program that is nested inside another organization – such as a nuclear program in an armed forces research institute – may still have bureaucratic champions, but that organization’s *raison d’être* and overall status and resources does not rely on the continuation of the nuclear weapon program to the same extent as a specialized nuclear weapon organization would.²¹⁵ Army chiefs, for example, with other priorities, such as conventional weapon programs, may not lobby as vigorously for more resources or to extend a program’s duration as the management of a specialized nuclear research organization when faced with opposition from other corners of government.²¹⁶ While building nuclear arms and integrating them into a country’s armed forces might constitute a substantial marginal increase in funding and status for a state’s armed forces, even in the world’s most heavily nuclear-armed states delivering nuclear arms is not the core mission of their armed forces.²¹⁷

²¹⁴ Using an information advantage to execute a foreign policy that may not be in accordance with the wishes of the principal is analyzed in George W. Downs and David M. Rocke, “Conflict, Agency, and Gambling for Resurrection: The Principal-Agent Problem Goes to War,” *American Journal of Political Science* 38.2 (1994): 362-380.

²¹⁵ In the French case, the French armed forces opposed a nuclear weapon program in the early 1950s allegedly out of concern that it would lend additional military decision-making power to the CEA, thus harming the army; see Hymans (2006), 96.

²¹⁶ In the summer of 1942 the US’ Manhattan Project did not face opposition within the government, but it did face considerable procedural barriers. Specifically, efforts to begin construction on several pilot facilities was hampered by Colonel James Marshall’s insistence that plans to acquire land for the project be subjected to a lengthy review process and by the fact that the project had difficulty getting the Army and Navy Munitions Board to grant the project’s various requests high priority ratings (which would give contracts associated with the Manhattan Project priority over other war-related work). After all, while “the bomb might win the war someday, but the Army had to be sure that the war was not lost in the meantime.” Richard G. Hewlett and Oscar E. Anderson, Jr, *The New World: A History of the United States Atomic Energy Commission, Volume 1, 1939-1946* (US Atomic Energy Commission, 1972), 79.

²¹⁷ Of course it is possible that some organizations, at some times will simply fight for all the resources they can get and regard any budgetary cuts as a setback. Organizations are not necessarily strictly rational in setting their priorities. However, it is reasonable to assume that on average when faced with choices between cutting core programs and secondary, non-core programs from their operations, many organizations will prioritize preserving their core programs.

Table 3 Degrees of Nuclear Weapon Organization Specialization

General organization (Least specialized and weakest organizational imperative to maintain activities)	Mixed organization	Specialized organization (Most specialized and strongest organizational imperative to maintain activities)
<ul style="list-style-type: none"> • Researching, designing, and building nuclear arms is not the organization's principal task and the organization has a broad mandate that may be incongruent with managing nuclear weapon activities • Examples: Blue House (Republic of Korea); French-Italian-German nuclear arrangement 	<ul style="list-style-type: none"> • Researching, designing, and building nuclear arms is not the organization's principal task, but it is congruent with the organization's overall mandate • Examples: Armscor; Ministry of Supply (United Kingdom); programs housed in armed forces (e.g., Brazil, Sweden, Switzerland, Taiwan) 	<ul style="list-style-type: none"> • Researching, designing, and building nuclear arms is the organization's only task, or it is a disproportionately large part of the organization's mandate • Examples: MMMB; PAEC; Atomic Energy Board (South Africa)

The difference between specialized nuclear weapon-oriented organization and a relatively less specialized organization can be illustrated by comparing the Pakistani and Brazilian nuclear programs. Pakistan's nuclear weapon program was launched at the behest of PM Ali Bhutto in 1972, and he charged the Pakistan Atomic Energy Commission (PAEC) with the task. While the PAEC does conduct research and development work for peaceful nuclear applications, it also researches, designs, and manufactures Pakistan's nuclear warheads. So, while it has multiple mandates and priorities, all of those goals and mandates are in nuclear research, design, and engineering.

PAEC's history helps clarify the relative magnitude of its various mandates. In 1972, when Pakistani President Z.A. Bhutto ordered PAEC to begin developing nuclear arms, PAEC's

science and engineering infrastructure was modest. The Pakistan Institute of Nuclear Science and Technology, PAEC's premiere research laboratory, had a single 5 MW swimming pool-type research reactor, the Pakistan Atomic Research Reactor.²¹⁸ Pakistan had one other reactor, the Karachi Nuclear Power Plant, a 137 MW, natural uranium fuelled, deuterium oxide moderated design, which went critical in 1971. PAEC boasted little in the way of fuel cycle facilities at this time. The Atomic Energy Mineral Centre in Lahore was able to mill mined uranium and convert it to yellowcake (a form of refined uranium oxide), but did not have the facilities or personnel to produce natural fuel elements, convert the yellowcake to uranium metal, or produce uranium hexafluoride, let alone conduct enrichment or reprocessing of spent fuel.²¹⁹ PAEC also had a number of agricultural research labs around the country. Since the Pakistani government's aim was to acquire nuclear weapons, it ruled out signing and ratifying the NPT, and PAEC determined that they would have to develop a complete fuel cycle (i.e. the front end activities of mining, milling, processing, and enriching uranium and manufacturing fuel, and the back end activities of separating plutonium from irradiated fuel) that PAEC could operate with a minimum of foreign support. This meant PAEC had to embark on a considerable effort to develop, design, and build a complete fuel cycle infrastructure inside Pakistan.²²⁰ This meant that the majority of PAEC's activity – including the development of potentially dual-use facilities such as uranium mills or enrichment plants – was tied directly to PAEC's nuclear weapon mission. If the Pakistani government did not want to acquire a nuclear weapon, signing and ratifying the NPT would be an option, which would allow the country freer access to much needed foreign technology, freeing PAEC to concentrate on its relative strengths, rather than reinventing technology it could import from overseas. However, given the Pakistani government's nuclear

²¹⁸ Khan, 57

²¹⁹ Khan, 104

²²⁰ Khan, 105-110, 112-117, 122-123.

weapons policy, PAEC not only had to design and build nuclear weapons, but also design and build the means to make nuclear weapons. Thus, even its efforts that could be applied to civilian needs (such as Pakistan's uranium enrichment program) only existed because of the government's nuclear weapons policy. PAEC, therefore, from 1972 onwards, was a nuclear weapons organization first, and a provider of civilian nuclear technology second.

On the other hand, the Brazilian nuclear weapon program was operated by Brazil's airforce (alongside navy and army nuclear programs that did not appear to be aimed at producing weapons). While the Brazilian airforce pursued a nuclear weapon with some vigour (and may have begun preparations to test a weapon), their nuclear weapon activity was simply one priority that had to contend with others.²²¹ A military might conduct research and develop weapon systems, but if it faces political pressure to terminate a program, it is not being asked to terminate a one of its core missions. Of course, specialized and autonomous programs can be abandoned – for example, Yugoslavia's first nuclear weapon program was nested in its atomic energy establishment – and programs that are run by armed forces or other organizations – such as the Manhattan Project, which was run by the United States Army – can succeed in their bomb-building mission. The relationship between organizational imperatives and nuclear abandonment is, after all, probabilistic, and not deterministic.

²²¹ Alongside the Brazilian air force's nuclear weapon program, the Brazilian navy and army also operated nuclear research and development efforts. Each branch of the Brazilian armed services concentrated on different fissile material production technologies: the army worked on reactors for plutonium production and on some experimental enrichment technologies, the navy focussed its efforts on uranium ultracentrifuges, and the air force researched and develop laser enrichment technology. While there is some evidence that the three efforts were partly coordinated by Brazil's National Security Council, it appears that it was only the air force that conducted nuclear weapon activities. These activities included weapon design and preparations for explosive tests (Barletta 1997; Cirincione et al. 2005, Sara Z. Kutchesfahani, *Politics and the Bomb: The Role of Experts in the Creation of Cooperative Nuclear Non-Proliferation Agreements* (New York: Routledge, 2013); Togzhan Kassenova, *Brazil's Nuclear Kaleidoscope: An Evolving Identity* (Washington, D.C.: Carnegie Endowment for International Peace, 2014)). The navy's projects in particular do not appear to have been aimed at a weapons program (though they certainly could have been used in one), but instead were intended to develop reactors and fuel to power submarines. The ultimate goal of the Brazilian army's nuclear research and development efforts remains unknown, but there is little-to-no evidence positively pointing to a plan or effort by the Brazilian army to develop nuclear weapons.

Nuclear weapon programs that are the least specialized are those that are attached to an organization that has many other tasks, or whose tasks are generally unrelated to nuclear science or military affairs. Most real-world examples involve situations where a government's executive branch or cabinet (or a direct off-shoot) engages in extensive nuclear planning activities.²²² An illustrative example is South Korea's nuclear weapon activities in the 1970s. President Park Chung Hee set up the nuclear program as a secret unit that reported directly to his office. According to American intelligence estimates from the time, Park personally administered the nuclear weapon program budget, and oversaw it as its chief manager.²²³ South Korea's nuclear weapon activities literally were an outgrowth of the president's office, instead of a separate organization with legal standing that simply reported directly to the president's office. Thus, there was no specialized organization that conducted South Korea's nuclear weapon activities, and shutting down the program did not mean cutting the presidency's power, budget, or influence.

These differences in specialization and mandate between various *de facto* nuclear weapon organizations are ordinal differences. As operationalized, there is no way to measure whether an organization is a "specialized" nuclear weapon organization or a "mixed" organization without comparing two or more organizations (see Table 3). So while this study does classify organizations as specialized, mixed, and generalist organizations, these differences in organizational focus (and therefore the degree to which abandoning nuclear weapon activities threatens their existence) are relative.

²²² Simply because an organization must eventually report to the executive branch does not make that organization an example of a non-specialized organization. For example, the old French commissariat à l'énergie atomique (CEA) ultimately reported to the French prime minister. However, the CEA had its own budget, which it did not need to justify to the ministry of finance; it had considerable latitude in setting its own research agenda, and it was given a broad mandate to conduct research in all aspects of applied and theoretical nuclear physics. While the CEA was ultimately accountable to the prime minister (in theory), it has more-or-less unfettered control over its research agenda and finances. See Scheinman for details.

²²³ Central Intelligence Agency, "East Asia Biweekly Review," 10 January 1978.

3.3.2 The Role of the Executive Branch

An obvious second government actor of major theoretical importance is the executive branch. As noted in section 3.1.1, in many countries the executive branch of government seems to play a significant role in determining the final content of a nation's nuclear policy. Allison and Halperin also argue that generally, if the executive is legally competent to set policy in a given area, and their policy preferences are unambiguous, we can expect them to carry the day. However, they also admit that in democratic states relatively more actors are probably involved in any given policy decision, particularly compared to autocracies. We know, for example, that the American president is relatively constrained by congress, the size of the American foreign policy bureaucracy, and by the need to delegate responsibilities to that bureaucracy. Heads of government in other countries may not face those same constraints. Heads of government in autocratic states still face information asymmetries and must delegate important aspects of policy formation and execution to their bureaucracies, they are not bound by the same legal constraints that executives in strong democratic systems must obey. It is therefore prudent to entertain the possibility that formal and informal constraints on the executive branch's power could affect the likelihood of abandonment. To be clear: this is a small possibility, since the history of nuclear weapon programs around the world suggests that the number of government departments that are involved in nuclear weapon policy making are often small. Furthermore, legislatures and judiciaries - which are often designed to act as checks on executive power – appear to have rarely played significant roles in nuclear weapon policy making. Nevertheless, states with highly legally constrained executives may be less likely to abandon their nuclear weapon activities. This is because the executive may not be able to unilaterally end the activities.

Thus, during the testing that I report in chapter four, I did develop a number of alternative specifications that include a measure (drawn from the Polity IV dataset) of how legally and/or informally constrained a country's executive branch is when attempting to unilaterally set government policy. The hypothesis is that all things being equal, nuclear abandonment should be more likely when the executive branch is relatively unrestrained, since an unrestrained executive branch would be able to swiftly react to changes in the international or domestic political environment that make abandoning nuclear weapon activities attractive. The more constrained the executive branch is, the more likely it will encounter effective resistance from other parts of the government that wish to keep the state's nuclear weapon activities. While an intuitive and appealing hypothesis, the hypothesis routinely fails various empirical tests. The sole exception is that when the effect of executive constraints – conditioned on the degree of organizational specialization of the nuclear weapon program – is estimated. Using that specification (i.e. an interaction term of executive constraint and organizational specialization) offers evidence that when an executive branch is highly constrained at the same time that a nuclear weapon organization is highly specialized, nuclear abandonment is less likely than when the executive branch is unconstrained and the nuclear activities are housed in a general organization. These results are briefly discussed and analyzed in chapter four. However, given the narrow nature of this finding, this chapter does not emphasize the potential theoretical role of the executive branch in determining nuclear abandonment, though there does appear to be potential for future research along that avenue.

3.3.3 The Role of Other Organizations

This study's hypothesis and informal model of policy making are deliberately simplified versions of reality, designed to focus attention on an understudied and potentially important

aspect of nuclear abandonment. Of course, reality is far more complex. Organizations that conduct nuclear weapon activities are not the only government organizations that will have an interest in the state's nuclear weapon policy. Armed forces – the end users of nuclear weapons – can also safely be assumed to have an interest in whether a state continues or terminates its nuclear weapon activities. Likewise, any organizations that are acting as subcontractors to a state's nuclear weapon organization will have an interest in the state's nuclear weapon policy. Therefore the possibility that nuclear weapon organizations may engage in a form of 'logrolling'²²⁴ with the armed forces or other groups in government in order to extend the life of a nuclear weapon program should not be ignored. This study therefore acknowledges the possibility that government organizations will ally with one another in an effort to sustain a nuclear weapon program, but is agnostic about how that process might work, and about its historical prevalence. Investigating a logrolling hypothesis to explain nuclear weapon program duration may be a fruitful direction for additional research.

3.3.4 Organizational Imperatives and Culture

It should also be noted that organizational imperatives and organizational essence are used interchangeably in this study as they refer to the functional reason that a government organization exists. That is to say, a government organization, as discussed, exists to achieve certain policy goals, whether that goal is to manage public finances, maintain armed forces that can go to war, or, conduct nuclear weapon activities. If a government determines that it no longer needs to achieve or pursue a given policy, then government no longer needs the organization that

²²⁴ The term logrolling – as generally used in political contexts – comes from the practice of legislators exchanging favours, such as agreeing to vote for one another's legislation, so that both parties achieve their interests. In this context it is meant to convey that two organizations, perceiving themselves as having similar (or compatible) interests, will support and promote each other's interests. In this case, it would be to forestall or prevent the termination of nuclear weapon activities. For a formal treatment of the logrolling concept, see Dennis C. Mueller, *Public Choice III* (Cambridge, UK: Cambridge University Press, 2003).

exists to achieve that policy goal, and the organization is essentially obsolete. Organizational imperatives/essence should not be confused with organizational culture, which is typically defined as the rules and beliefs that an organization has discovered or developed, which help the organization adapt to and overcome internal and external challenges, and which existing members of the organization transmit to new members of the organization.²²⁵ It is plausible, however, that that organizational imperatives and organizational cultures are correlated and that the organizational culture of a nuclear weapon organization may play a role in effecting the likelihood that a state abandons its nuclear weapon activities by determining (in part) how organizations pursue their interests and fulfil their imperatives. Evidence from India and from the two cases presented in chapter five of this thesis supports this claim.

3.3.4a India's Atomic Energy Commission: The Freedom to Pursue Science

In January 1966, Homi Bhabha, the charismatic chairman of India's Atomic Energy Commission, died when the plane that was carrying him crashed into a mountainside. Bhabha had played significant role in formulating India's nuclear policy, particularly by personally working to convince the late Prime Minister Lal Bahadur Shastri (who publicly opposed India acquiring nuclear weapons) in autumn 1964 to allow the InAEC to work towards building a nuclear explosive, ostensibly, in Bhabha's words, for mining or clearing passes through mountains.²²⁶

When Bhabha died, India's new Prime Minister, Indira Gandhi had to replace him. She chose Vikram Sarabhai. While trained as a physicist and a member of the InAEC, Sarabhai was at the time in charge of the Indian National Committee for Space Research, and was well known

²²⁵ Edgar Schein, "Coming to a New Awareness of Organizational Culture," *Sloan Management Review* 25.2 (1984): 3-16.

²²⁶ Chengappa, 94-95, 98-99; Perkovich, 82-85.

for his scientific contributions to the study of cosmic radiation.²²⁷ While there was no question about Sarabhai's competence, at least one analyst of India's nuclear history suggested that Ghandi appointed Sarabhai because he hailed from a wealthy Gujarati family, something that she hoped would help blunt the appeal of her political rival Moraji Desai (himself from Gujarat).

When Sarabhai formally took over the InAEC in 1966 he ordered a stop to the organization's peaceful nuclear explosive program. Apparently InAEC employees ignored him. According to Raja Ramanna (who would later chair the InAEC himself) who was leading the group working on the nuclear explosive at the time, his team ignored "Sarabhai could not keep scientists from doing their work. He couldn't look over our shoulders."²²⁸ Ultimately, in Ramanna's eyes, he and his employees did not need Sarabhai's permission to act. Instead "BARC [Bhabha Atomic Research Centre, the campus where Ramanna was managing the explosive research effort] itself has the freedom to initiate such things."²²⁹

Homi Sethna (who would also go on to chair the InAEC), who was then the top official at the BARC campus also directly clashed with Sarabhai. According to Raj Chengappa, Sethna openly questioned Sarabhai's wisdom at meetings, sought ways to limit Sarabhai's direct control over BARC's finances, and reportedly told him "you are a rocket and cosmic rays man. You know nothing of nuclear hardware."²³⁰

Sethna's willingness to defy and challenge Sarabhai probably stemmed from Sethna's belief that he was Bhabha's natural successor. However, Sarabhai's order to stop the nuclear

²²⁷ Perkovich, 114; B.S. Kademani, V.L. Kalyane, and Vijai Kumar, "Scientometric Portrait of Vikram Ambalal Sarabhai: A Citation Analysis," *SRELS Journal of Information Management* 37.2 (2000): 107-132.

²²⁸ Quoted in Perkovich, 123.

²²⁹ Chengappa, 112. Ramanna's decision to disobey Sarabhai may have helped preserve India's nuclear weapon program. Raj Chengappa claims that Parmeshwar Narain Haksar, who was Prime Minister Indira Ghandi's secretary (and trusted political confidante and advisor) from 1967 to 1973, met with Ramanna regularly in 1967. Chengappa suggests that Haksar in turn helped convince Ghandi to formally reauthorize India's nuclear weapon activities, which she did in the autumn of 1967. See Chengappa, 108-113.

²³⁰ Chengappa, 106.

explosive program also clashed with the culture and ethos of India's nuclear science bureaucracy. Homi Bhabha played a significant role in establishing India's publicly-funded nuclear science organizations in the 1940s. For example, in 1948 he authored a note to Prime Minister Nehru where he argued that India's existing Board of Research on Atomic Energy be replaced with a three-person executive board, responsible to the prime minister alone, with its own independent secretariat. This suggestion ended up forming the basis for the InAEC, and Bhabha was at its helm, with a broad mandate to develop and nurture nuclear science and research in the country.²³¹ The 1958 InAEC constitution also allowed the chair to unilaterally overrule the other members of the commission.²³² This meant Bhabha had tremendous latitude in setting the InAEC's agenda.

When it came to managing the BARC (India's principle nuclear science research facility in the 1950s and through the 1960s), Bhabha reportedly excelled at securing funding, streamlining procedure, and leaving his scientists alone to conduct research.²³³ Bhabha also reportedly subscribed to a "trickle-down" theory of science and development, arguing that in India, science for its own sake was worth spending money on, since yesterday's great discoveries, given time, would find their way into tomorrow's radios, penicillin, or some common household item.²³⁴

This suggests that the InAEC and its subordinate institutes was - from the 1950s until Bhabha's death - an environment that was insulated from national politics where nuclear physicists were free to experiment, research, and do science for the sake of science. Ramanna

²³¹ Spenta R. Wadia, "Homi Jehangir Bhabha and the Tata Institute of Fundamental Research," *Current Science* 96.5 (2009): 725-733.

²³² Abraham, 97.

²³³ George Greenstein, "A Gentleman of the Old School: Homi Bhabha and the development of science in India," *Current Science* 64.2 (1993): 121-128.

²³⁴ Greenstein, 124-5.

and Sethna may have internalized this ethos: one account of the Indian nuclear program claims the two saw limited downside to testing a nuclear explosive. Even if doing so engendered hostile responses from the rest of the world, testing an explosive was an exciting prospect for the two physicists, worth doing for the sake of discovery and learning, and as a way of sending a message about India's scientific prowess.²³⁵

Sarabhai, who seemed more passionate about getting India into space than mastering nuclear fission, collided with a culture that valued autonomy and found intrinsic worth in research. So when the chair of the InAEC declared that work on the nuclear explosive program should stop, he was trying to impose his will on an organization that had developed its own way of doing things for more than a decade.

3.3.4b: Switzerland and South Africa: Military Discipline and By-the-Book Operations

The Indian example contrasts rather sharply with both of the case studies in chapter five. In both Switzerland's Federal Military Department (EMD) and South Africa's Armscor, a conservative, deliberate, and even at times dispassionate organizational culture seemed to be at work. In Switzerland, when the cabinet told the military to restrict its research efforts, the military made little effort to reverse that decision, and there is no evidence that military researchers ignored their orders and expanded their efforts. Similarly, in South Africa, former Armscor employee Andre Buys recalls that the nuclear weapon program was treated much like any other program inside the company (with the exception of the veil of secrecy that covered the project), to the point where the engineers working on the bombs persisted in attempting to get the South African military to provide an end-user specification for the weapons. When the military did not offer any specifications, Buys then reached out to South Africa's political leadership for

²³⁵ Abraham, 148-9.

guidance.²³⁶ Similarly, Richardt van der Walt (formerly of South Africa's AEC), Hannes Steyn (formerly of Armscor), and Jan van Loggerenberg (the former chief of South Africa's air force) claimed that "South Africa was forced to choose the nuclear route at a time when it was cut off from its traditional suppliers of weapons in the West...Once the political decision had been made, it was the Defence Family's [sic] responsibility to ensure that the development of the nuclear weapons systems and the concomitant nuclear strategy be executed in the most responsible way possible."²³⁷ Van der Walt, Steyn, and van Loggerenberg's characterization of the program is corroborated by the Armscor-commissioned history, *Armscor: A Will to Win*. The authors of *A Will to Win* claim that "security measures were so tight that only the most essential information was supplied to a person who inevitably had to be informed, and a register was kept accordingly...only a little more than 300 names were entered in this register."²³⁸

While India's nuclear weapon scientists worked in an organizational culture characterized by personal independence and a spirit of discovery, South Africa's nuclear bomb makers appear to have worked in a culture marked by achieving goals through a structured system, where employees worked according to strict protocols. The Swiss EMD's decision to (without reservation) accept the Swiss cabinet's order to move Switzerland's nuclear weapon activities to an interdepartmental committee and then eventually abandon those activities is also consistent with a hierarchical, structured organizational culture (as one would expect in the professional military officer corps) where decisions are made according to well-established rules and patterns, rather than on the basis of individual preferences.

²³⁶ Chandré Gould, "The Nuclear Weapons History Project," in Kate Allen, ed., *Paper Wars: Access to Information in South Africa* (Johannesburg: Wits University Press, 2009), 117.

²³⁷ Van der Walt et al., 15.

²³⁸ L.J. van der Westhuizen and J.H. Le Roux, *Armscor: A Will to Win* (Bloemfontein, South Africa: University of the Free State, 1997), 175.

3.4 Nuclear Weapon Organization Specialization and Abandonment

We can therefore hypothesize that when a government attempts to terminate a nuclear weapon program, if that program is housed in a relatively specialized organization, termination will be less likely than if the program is housed in an organization with a relatively broader mandate. Nuclear weapon organization chiefs could contest the decision by appealing directly to the chief executive, to cabinet members, to other senior bureaucrats, or theoretically, to parliament if possible. However, nuclear weapon organizations could also have relatively little at stake if their nuclear weapon activities are a relatively minor part of their mandate and overall activities. In those cases, not only might the organization conducting nuclear weapon activities not contest the decision to eliminate the nuclear weapon activities, but they might favour the decision if faced with an even worse option.

This discussion yields a crucial, testable hypothesis: States – all other things being equal - should be less likely to abandon their nuclear weapon activities when a relatively specialized nuclear weapon organization conducts those activities, than when an organization with a broader mandate conducts those activities. This formulation of the bureaucratic politics argument is testable. It is also generalizable, while remaining falsifiable. It is also probabilistic: it is entirely possible that in any one historical instance that a specialized nuclear organization has relinquished their nuclear weapon activities, and in other cases, general organizations have resisted efforts to change nuclear policies. This thesis cannot account for every variation of history, nor does it claim to. Furthermore, it is highly likely that many of the factors that analysts believe influence nuclear policy making do in fact influence policy. However, it is likely that the effects of such factors are additive, not mutually exclusive, and their effects may be probabilistic

as well. This hypothesis' assumptions are also consistent with the bureaucratic politics theories discussed earlier in the chapter: namely, it assumes that different organizations within a government have different policy preferences and that that the policy-making process is competitive. Chapter four presents several large-sample tests of this general hypothesis.

4 Testing the Organizational Nuclear Abandonment Hypothesis

4.1 Rationale

To assess the general validity of the hypothesis developed in chapter three, this chapter will present the results of several large sample empirical tests. These tests use multiple regressions to assess the likelihood that a country that has an active nuclear weapon program will abandon that program in a given year. This is modelled as both a standard probit model, and as a probit model with sample selection. The purpose of these tests is to determine whether there is – on average – a significant, observable relationship between the degree of specialization of the organization that is conducting a state’s nuclear weapon activities, and the probability that a state abandons those activities.

A multivariate statistical method, as this chapter uses, is particularly well suited for identifying general (or average) patterns and tendencies, rather than explaining the outcome in a specific case or a single data point. Again, appealing to Goertz and Mahoney, “implicit in statistical models...are thousands, if not millions, of potential paths to a particular outcome. The right-hand side of the statistical equation essentially represents a weighted sum, and as long as that weighted sum is greater than the specified threshold—say in a logit setting—then the outcome should (on average) occur. Within this framework, there will be countless ways that the weighted sum could exceed the threshold. One has equifinality in spades.”²³⁹ To elaborate: two states may both have nuclear weapon activities and share a broad range of other similarities, including facing military threats from other states, relying on international trade to fuel their economies, and may have democratic governments. These two states may have these attributes in

²³⁹ James Mahoney and Gary Goertz, “A Tale of Two Cultures: Contrasting Quantitative and Qualitative Research.,” *Political Analysis* 14.3 (2006): 237.

different proportions though (e.g. the same variables in two countries may have different values), and in one country the added effect of all those factors may be sufficient to cause nuclear abandonment, and in another, the added effect may be “smaller” and therefore insufficient. This method allows researchers to remain agnostic about the effects of various factors, while controlling them sufficiently to be confident about the ultimate effect of any single factor on average. As previously stated, this study’s core hypothesis was explicitly formulated to be a complementary - rather than exclusive – explanation for nuclear abandonment. It is therefore possible that organizational imperatives may drive a state towards abandonment while other factors are also pushing it towards (or against) abandonment.

The rest of the chapter will proceed in the following fashion. First, it will describe the data, starting with the dependent variable. Next is the description of the chief independent variable of interest – the state’s nuclear weapon organization – including how it was measured, operationalized, collected, and coded. It will also describe a second important independent variable: the degree to which a state has obtained the means to produce fissile materials (i.e. to enrich uranium or separate plutonium from used reactor fuel).

4.2 The Dependent Variable

The dependent variable (DV), *Abandon* is binary variable coded on a country-year basis. *Abandon* has a value of 0 when a state has a nuclear weapon program, and a value of 1 in a year where it appears the state has abandoned that program. It is therefore the event, rather than the status of the program, that the data are meant to capture. Observations where a state does not have a nuclear weapon program are coded as missing. Thus, the estimates reported in this

chapter are for samples that only include annual observations where nuclear weapon activities are believed to have occurred.

4.3 Independent Variables

4.3.1 Organizational Specialization

Organizational specialization, as I have defined it, is a somewhat abstract construct. There is no objective and fully transparent way to quantify an abstract concept such as the degree of specialization of a nuclear weapons organization. Any effort, including this one, is a matter of professional judgement, though some steps can be taken to make the coding as transparent and as internally valid as possible.

Organizational specialization is operationalized on a country-year basis for 29 states, as a variable named *Organization*. With some exceptions, there is one observation for every year that a state in the sample conducts nuclear weapon activities.²⁴⁰ Each country-year is coded according to the relationship between nuclear weapon activities and the core mission of the organization that is undertaking the activities. This relationship is coded according to three categories: low (1), medium (2), and high (3). An observation coded as a 3 means that a state's nuclear weapon activities are conducted by an organization that solely conducts nuclear weapon activities or that conducts nuclear weapon activities alongside other nuclear science and engineering activities. An observation coded as a 2 means that nuclear weapon activities are important to the organization, but it has other missions to fulfil as well (which may not be directly related to nuclear science and engineering). If an observation is coded as a 1, that is an indication that the nuclear weapon activities are a relatively insignificant part of the organization's mandate. That is not to say that it

²⁴⁰ Libya and North Korea have some missing observations due to a lack of available data.

is unimportant, but that from an organizational point of view, budgets, careers, and prestige do not rely on the organization continuing its nuclear weapon activities.

As a general rule, observations were coded in the following manner. If a nuclear weapons program was directly attached to a state's cabinet or executive branch, it was coded as a 1. An example of nuclear weapon activity that is coded as a 1 is the German and Italian plan to build nuclear weapons in conjunction with France. This coding reflects the fact that the activities were confined to the German and Italian cabinets. In other words, the cabinet was the parent agency for the nuclear weapons activity. However, unlike, say, an atomic energy agency, a country's cabinet has multiple missions and tasks. Nuclear weapon activities might be one of those tasks, but it is hardly a core mission. When Charles de Gaulle moved to cancel the tri-partite nuclear weapon agreement, the West German and Italian cabinets did not cease to exist or lose their organizational impetus because they were no longer in the nuclear weapon business. This coding scheme does not mean that organizations that *report* directly to the cabinet or executive are coded as 1 however. For example, the Israeli Atomic Energy Commission (IAEC) reports directly to the Israeli Prime Minister's Office (PMO). However, the IAEC has legal standing as an independent organization. It just happens to bypass cabinet and is responsible only to the PMO. The PMO is not involved in the daily activities of the IAEC, and the PMO is not the parent organization of the IAEC. The IAEC exists independently of the PMO, and has its own budget, management, and mission.

The Soviet Union provides another clear example of how this coding scheme works. In 1942, Soviet intelligence suspected that Germany and the United States were both coming close to building nuclear weapons. Soviet scientists, understanding the basic physics of nuclear bombs, along with officials in the armed forces, and the head of the People's Ministry of Internal

Affairs, Lavrentiy Beria, began to lobby in favour of a nuclear weapon program. Accordingly, in early 1943, the State Defence Committee (GKO) – an interdepartmental, ministry-level body designed to mobilize the Soviet economy to win the war – established a nuclear weapon research program.²⁴¹ This program was housed in the Academy of Sciences, which in turn reported to S.V. Kaftanov, the GKO's science chief who was charged with setting the overall direction of the USSR's scientific effort.²⁴² The nuclear program remained in the GKO for the next two years, until the United States dropped two atomic bombs on Japan in August 1945. I code the Soviet nuclear weapon program as a 2 for the years of 1943-1945, since while the team working on the nuclear project had no other duties, they were simply one department in a much larger organization. The GKO's core mission during the war was to put the Soviet economy on a war footing. While building a nuclear weapon might be part of that mission, it was not the GKO's core mission, but was instead just one among a long list of military projects. While the nuclear weapon project may have been important, it was not the Academy or the GKO's *raison d'être*.

In August 1945, the Soviet nuclear program was restructured. Following the bombings of Hiroshima and Nagasaki, Joseph Stalin demanded that his commissar of munitions, Boris Vannukov, “provide us with atomic weapons in the shortest possible time!”²⁴³ In turn, the GKO handed over the bomb project to the newly formed First Main Directorate (PGU), an interdepartmental, ministry-level organization, and was headed by Beria. The PGU had powers comparable to the Ministry of Defense for requisitioning materials and aid from other departments. The PGU remained in charge of the USSR's nuclear weapon activities until

²⁴¹ Thomas B. Cochran, Robert S. Norris, and Oleg A. Bukharin, *Making the Russian Bomb From Stalin to Yeltsin* (Boulder, CO: Westview Press, 1995), 20-22.

²⁴² Holloway.

²⁴³ Cochran et al., 23.

1953.²⁴⁴ For the years 1945-1953, the USSR's nuclear weapon activities are coded as a 3. The PGU was literally created to research and build nuclear weapons. It was also not subordinated to any other ministry or organization: it was practically a ministry of nuclear weapons. Thus, nuclear weapon activities were not only its core mission, but its sole mission. This means that cancelling the USSR's nuclear weapons program would mean the PGU would be redundant. This structure meant that Beria and the PGU's employees had strong incentives to lobby for the continuation of the program.

Nuclear weapon activities that were housed in a larger parent organization are typically coded as a 2. An example is the Manhattan Project. While it had its own dedicated staff and budget, it was housed inside the United States Army. Building a nuclear weapon was the core mission of the Manhattan Project, and it was certainly important to the US Army, but it was not a core mission of the Army. The South African nuclear weapon program after 1979 is another such example. In 1979, Armscor, the state-owned South African armament corporation took over Pretoria's nuclear weapon activities. Building nuclear weapons closely fit Armscor's overall purview of researching, developing, and producing arms for South Africa's armed forces, but nuclear weapons, as will be shown later, were just one of many products Armscor made. Thus, nuclear weapon activities, while important to Armscor, were not the core of their mandate and mission.

Finally, organizations for which nuclear weapon activities were part of their core mission and duties were coded a 3. An example is the British nuclear weapon program between 1952 and 1972. In 1952, the British government transferred its nuclear weapon program from the Ministry of Supply (which was responsible for arms and munitions for the three armed services) to a dedicated nuclear science and weapons bureaucracy, the Atomic Energy Organization

²⁴⁴ Ibid.

(UKAEO). The UKAEO was responsible for developing peaceful nuclear technologies alongside its weapon activities, but nuclear weapons were among its core missions. In this study's sample time period, the United States Department of Energy (DoE) is another example of a specialized nuclear weapon organization. Though in the past the DoE has had missions besides developing and building nuclear weapons, in 1985, nuclear weapon activities took up 63% of its budget, and even in the 2010s, nuclear activities have been the DoE's single largest budget item.²⁴⁵ Eliminating the American nuclear program would mean gutting the DoE. Generally, atomic energy agencies that conducted nuclear weapon activities, and dedicated nuclear weapon/nuclear energy ministries are coded as a 3.

Table 4.1 summarizes the rules used to code the nuclear weapon programs of 29 states.

Table 4.1 Coding Rules for *Organization*

Program is managed by the cabinet or executive office, or is housed in an organization with no/minimal military or nuclear science mandate. Examples: Blue House (Republic of Korea); French-Italian-German nuclear arrangement.	1 , or low level of specialization: nuclear weapon activities are not part of the organization's core mission.
Program is nested in a ministry-level organization, such as a public works agency, or housed in a unit of a military organization or general science organization. Examples: Armscor; Ministry of Supply (United Kingdom); programs housed in armed forces (e.g., Brazil, Sweden, Switzerland, Taiwan).	2 , or medium level of specialization: nuclear weapon activities are an important part of the organization's core mission, but exist alongside other missions that are unrelated to nuclear science and engineering.

²⁴⁵ Patrick Burke, ed. *The Nuclear Weapons World: Who, How & Where* (Westport, CT: Greenwood Press, 1988), 25; the DoE's FY 2012 budget request asks for approximately \$11.5b for the National Nuclear Security Administration (NNSA). The NNSA budget constitutes about 40% of the DoE's total budget request, and the weapon activities budget alone is the largest single DoE budget request – larger than either the Department's civilian nuclear energy or environmental programs and activities. Department of Energy, *FY 2012 Congressional Budget Request* (Office of the Chief Financial Officer, Department of Energy, 2012), 15.

Program is housed in an atomic science/energy commission, or in a dedicated nuclear energy/weapons ministry/organization. Examples: MMMB; PAEC; Atomic Energy Board (South Africa).	3, or high level of specialization: nuclear weapon activities are the organization's core mission. Terminating nuclear weapon activities would involve disbanding the organization or severely reducing its size and budget.
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Observations were coded using a combination of primary and secondary sources. A full list of sources can be found in Appendix III.

The operationalization that I use is an ordinal scale: it only speaks to the relative apparent specialization of the organization that handles a state's nuclear weapon activities. The three categories described in Table 4.1 should not be understood as having any cardinality.

Given the somewhat subjective nature of quantifying qualitative data, I have used eight different versions of the variable, changing the values on certain cases. The empirical results are consistent across versions. Some countries and time periods (such as North Korea and Libya in the 1980s) in particular were difficult to code due to contradictory and sparse data. In situations where there were not enough data to assign even tentative values, the observations have been coded as missing. In Table 4.2 the summary statistics of the most commonly used version of *Organization* is reported.

For a sense of the distribution of *Organization*, please refer to Figure 4.1. Table 4.2 offers a representative summary of the coding outcomes for 29 states.²⁴⁶

²⁴⁶ The data in the table is representative since around a dozen versions of *Organization* were coded. The values or *Organization* vary for some country-years, depending on the version of the variable in question.

Figure 4.1: Distribution of Nuclear Weapon Organization Country-Years
1942-2000

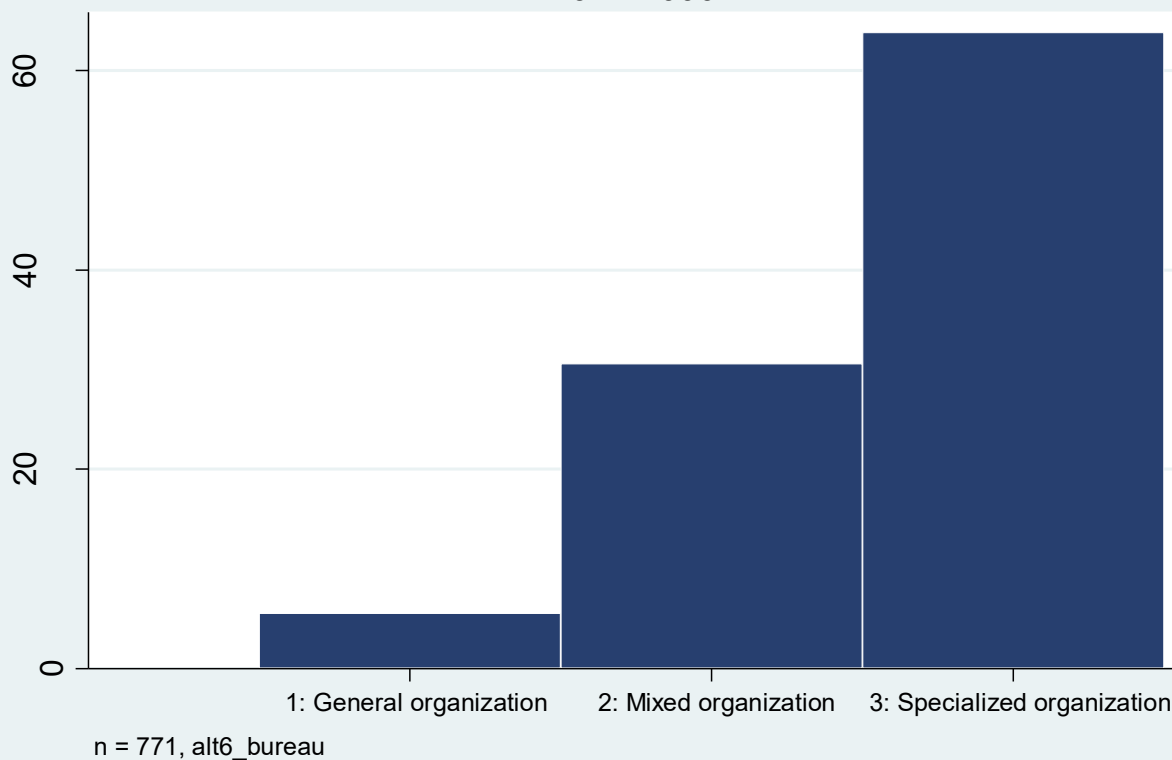


Table 4.2 Coding Outcomes for *Organization*

Country	Years of Activity and <i>Organization Value</i>	Approximate Year of Abandonment
Algeria	1983 – 1985: 1 1986 – 1991: 2	1991
Argentina	1968 – 1990: 3	1990
Australia	1956 – 1962: 2 1963 – 1973: 1	1973
Brazil	1978 – 1990: 2	1990
China	1955: 1 1956 – 2000: 3	<i>N/A</i>
Egypt	1955 – 1972: 3	1972
France	1954: 1 1955 – 2000: 3	<i>N/A</i>
West Germany	1957 – 1958: 1	1958
India	1965 – 2000: 3	<i>N/A</i>
Indonesia	1965 – 1966: 2	1966
Iran	1974 – 1978: 3 1989 – 2000: 2	1978, 2009
Iraq	1972 -1973: 2 1974 – 1986: 3	1991

	1987 – 1991: 2	
Israel	1955 – 1963: 1 1964 – 1965: 2 1966: 1 1967 – 2000: 3	<i>N/A</i>
Italy	1955 – 1957: 2 1958: 1	1958
Japan	1967 – 1970: 1	1970
North Korea	1965 – 1985: missing 1986 – 2000: 2	<i>N/A</i>
South Korea	1970 – 1978: 1	1978
Libya	1970 – 1994: missing 1995 – 2000: 2	2003
Norway	1946 – 1951: 2	1951
Pakistan	1972 – 2000: 3	<i>N/A</i>
Romania	1981 – 1989: 2	1989
South Africa	1969 – 1979: 3 1980 – 1990: 2	1990
Sweden	1946 – 1969: 2	1969
Switzerland	1946 – 1956: 3 1957 – 1978: 2 1979 – 1988: 1	1988
Taiwan	1967 – 1977: 2 1987 – 1988: 2	1977, 1988
Union of Soviet Socialist Republics/Russia	1943 – 1944: 2 1945 – 2000: 3	<i>N/A</i>
United Kingdom	1945 – 1951: 2 1952 – 1972: 3 1973 – 2000: 2	<i>N/A</i>
United States of America	1942 – 1946: 2 1947 – 2000: 3	<i>N/A</i>
Yugoslavia	1955 – 1963: 3 1974 – 1987: 2	1963, 1987

4.3.2 Control Variables

The control variables all come from either the qualitative nuclear abandonment literature, or the quantitative nuclear proliferation/nuclear weapon program onset literature. Where possible, this study uses existing data, and versions of variables that other analysts have used, so as to facilitate comparisons between this study and the existing literature.

4.3.2a Security Variables

MIDs: *MIDS* is the 5-year simple moving average (SMA) of the intensity of the militarized interstate disputes (MIDs) that a state is involved in. The data are from the Correlates of War (CoW) Militarized Interstate Dispute dataset (v. 3).²⁴⁷ The CoW MID dataset treats the intensity of a dispute using an ordinal scale, ranging from 1 (no militarized action) to 5 (war).²⁴⁸ Since MID intensity is an ordinal variable, using a SMA is not a perfect or ideal solution, but it should capture the intuition that national security policies are not made simply on the basis of a single year of experience, but instead, on the basis of what policy makers believe to be longer-term trends. I also conducted robustness tests with 3-, 7-, and 10-year SMAs. While the coefficients and standard errors of these other versions of *MIDs* were rarely significant, generally, the different SMA lengths have similar effects, and do not affect the overall results.

Allies: *Allies* is a binary variable that indicates whether a country has a mutual defence pact with at least one nuclear-armed country in a given year. *Allies* is drawn from the CoW Formal Alliances dataset (v. 3).²⁴⁹

I include *Allies* since Paul (and Solingen) identifies diplomatic pressure from a nuclear armed and allied state as a potential influence on a state's nuclear weapon policy. It also stands to reason that a state with a nuclear armed ally might be tempted to free-ride off of that ally's capabilities.

²⁴⁷ Glenn Palmer, Vito D'Orazio, Michael Kenwick, and Matthew Lane, "The MID4 Data Set: Procedures, Coding Rules, and Description," *Conflict Management and Peace Science* 32.2 (2015): 222-242.

²⁴⁸ Faten Ghosn, Glenn Palmer, and Stuart Bremer, "The MID3 Data Set, 1993–2001: Procedures, Coding Rules, and Description," *Conflict Management and Peace Science* 21.2 (2004):133-154.

²⁴⁹ Douglas M. Gibler, *International Military Alliances, 1648-2008* (Washington, D.C.: CQ Press, 2009).

Rivals: this variable was built using Diehl and Goertz's (2001) definition, operationalization, and coding of "enduring rivalries".²⁵⁰ Generally speaking, in the IR literature, an enduring rivalry is defined as a relationship between two states where those states engage in a certain number of threats of force, shows of force, or uses of force (i.e. MIDs) against each other in a certain time period. Analysts differ over how many MIDs must happen, the temporal spacing of those MIDs, and whether the disputes are focussed on the same issue. However, all definitions of enduring rivalries focus on repeated threats or use of force in a dyad.

The list of states and years involved in rivalries comes from Diehl and Goertz.²⁵¹ Since Diehl and Goertz's data only extends to 1992, rivalry duration was extended for dyads that experienced at least one MID after 1992 and before 2002, in order to remain consistent with their operationalization, which ends a rivalry after a 10 year period with no disputes.²⁵² Otherwise, *Rivals* uses Diehl and Goertz's data, which means that a dyad must engage in at least six militarized disputes within a 20-year period.²⁵³ So, while *Rivals* draws from the same data pool as *MIDs*, it is sufficiently different to merit inclusion, and captures a unique aspect of a state's security environment that a simple count or moving average cannot, namely whether a state is engaged in frequent and numerous militarized disputes with one other state.

This particular operationalization also borrows from Jo and Gartzke by using the ratio of the sum of the CoW National Material Capabilities (NMC) of all a state's rivals in a year and that state's NMC. This introduces variation caused both by the size and wealth of a country's rivals (and the number of rivalries the country is involved in), and its own size and wealth.

²⁵⁰ Paul F. Diehl and Gary Goertz, *War and Peace in International Rivalry* (University of Michigan Press, 2001).

²⁵¹ Ibid., 145-146.

²⁵² Ibid., 46.

²⁵³ Ibid., 43-45.

I have included a logarithmic transformation of the variable as well, to model decreasing returns to scale (results are comparable to the untransformed version). Binary versions of the variable, using both Diehl and Goertz's coding and Bennett's 1998 coding, provide similar results.²⁵⁴

Rivals is included in the estimates given Paul's claim that states acquire nuclear arms because they are in enduring rivalries, and abandon their nuclear activities when they are not embroiled in rivalries. Since *Rivals* is operationalized and coded using the rules from the rivalry literature – which means that rivalries exist when two states engage in several MIDs within a set time period – it therefore indicates whether a state's MIDs are concentrated among one (or a few) countries. However, the correlation between *MIDs* and *Rivals* is low, at 0.028.

4.3.2b Government Characteristics

Polity: *Polity* is simply the Polity IV project's 21-point ordinal scale characterizing governments' relative degree of autocracy or democracy. While the Polity IV data are imperfect (for example, the Polity scale collapses several distinct dimensions of government behaviour into a single index), it is widely used by analysts to approximate how relatively competitive and open a country's politics are, and using Polity IV makes it easier to compare this study to other research in the field.²⁵⁵

4.3.2c Economic Variables

GDP: Drawn from Singh and Way, who use per capita Purchasing Power Parity Gross Domestic Product (GDP) data from Penn World Tables (6.1), Angus Maddison's historical GDP dataset,

²⁵⁴ D. Scott Bennett, "Integrating and Testing Models of Rivalry Termination," *American Journal of Political Science* 42.4 (1998): 1200-1232 .

²⁵⁵ Monty G. Marshall, Ted Robert Gurr, and Keith Jagers, *Polity IV Project: Political Regime Characteristics and Transitions, 1800-2013* (Center for Systemic Peace, 2014).

and Gleditsch's (2002) expansion of IMF data. *GDP* is expressed in thousands of dollars per capita.

*GDP*²: *GDP*² is a squared transformation of *GDP*, and it is included in the regressions to control for possible non-linear relationships between national wealth and nuclear abandonment.

I include *GDP* to account for the possibility that financial constraints may help push policymakers towards nuclear abandonment. While there is no well-developed hypothesis in the literature that claims that unforeseen economic challenges are a major determinant of nuclear abandonment, the logic that economic constraints may lead to policy changes is simple and sound. Furthermore, both Reiss and Liberman cite economic difficulties as helping cause nuclear abandonment in some specific cases. I also include *GDP*² to test and control for the possibility that economic wealth has a non-linear effect on the decision to abandon or retain a nuclear weapon program.

Trade: *Trade* is the ratio of the nominal value of a country's imports plus exports to nominal GDP. *Trade* is drawn from Singh and Way, who retrieved the data from the Penn World Tables. Used as test for Solingen's claim that economic liberalizing governments will refrain from nuclearization because of fear of economic sanctions harming their supporters, who in turn might oust the government from office. While Solingen's construct of a "liberalizing coalition" is probably multi-dimensional, she gives little guidance as to how to measure or operationalize it, and cites Singh and Way approvingly as evidence in support of her hypothesis. All things being equal, we should anticipate that countries ruled by governments with an outward-looking economic policy should have higher trade: GDP ratios than autarkical states.

4.3.2d Social Expectation Variables

NPT: *NPT* is a continuous variable that measures the proportion of states in the world that have ratified/acceded to the NPT as a Non-Nuclear Weapon State.²⁵⁶ I am using this to model the effect of an anti-nuclear norm that analysts such as Rublee, Müller and Schmidt, and Long and Grillot claim pushes states to not acquire nuclear weapons. This is a more reasonable operationalization than using a dummy for years after 1956 (when Ireland introduced its anti-nuclear resolution in the United Nations General Assembly) or a dummy for years after 1968 (when the NPT was opened for signature), since, as Rublee argues, the anti-nuclear norm works on the basis of what states believe other states expect of them. All things being equal, the more states that have ratified the NPT, the more likely that any state considering acquiring nuclear weapons will be dissuaded from proceeding with such acquisition. If a norm is established by the expectations of a social group (in this case, the countries of the world), then the more the members of the community value the norm (in this case by ratifying the treaty), the stronger its effect should be.

Whether a country itself has ratified the NPT is not included in any specifications, since doing so would introduce endogeneity and potentially confound the results. This is because we should expect states – on average – to ratify the NPT once they have already decided to not acquire nuclear weapons. Doing so may send a powerful signal to other countries that a state does not intend to acquire nuclear weapons in the future, thereby reducing fears of nuclear proliferation.²⁵⁷ Ratifying the NPT is, on balance, likely to be a result of the conditions and causes that lead a country to abandon its nuclear weapon activities in the first place. There is

²⁵⁶ Jo and Gartzke use a nearly identical operationalization.

²⁵⁷ For the potential role of treaties as signalling devices in the US context, see Lisa L. Martin, "The president and international commitments: Treaties as signaling devices," *Presidential Studies Quarterly* 35.3 (2005): 440-465.

little in the way of theoretical or empirical reasons that we should expect that being a party to the NPT should have an independent effect on a state's decision to abandon its nuclear weapons.²⁵⁸

Polity X NPT: *Polity X NPT* is an interaction term of *Polity* and *NPT*. This draws from Müller and Schmidt's claim that democratic countries are more sensitive to anti-nuclear norms than autocracies.

I therefore include *Polity* in the equation (since it is a lower-order term of *Polity X NPT*). Other than in order to satisfy the requirements for the interaction term, there is little reason to include *Polity* in the equation. As discussed in chapter two, the literature – other than Müller and Schmidt – makes few claims about the relationship between a government's democratic or autocratic character and the likelihood of abandonment (Long and Grillot even argue that democratization in South Africa and Ukraine had no effect on the decision to abandon their nuclear weapons).

4.3.2e Technology Variables

Fissile materials: *Fissile materials* is a four-point ordinal scale that characterizes the relative ability of a state to produce fissile materials (i.e. enriched uranium and/or separated plutonium). This is an original data series, which was coded using an array of primary and secondary sources, the full list of which is available in the Appendix.

Fissile materials ranges from 0 to 3. If a state does not produce any sort of fissile material in its borders, it is coded as a 0. If there is evidence of laboratory-scale production, it is coded 1; evidence of pilot-scale production, 2, and; multiple pilot-scale or commercial/industrial-scale, 3. The cutoffs between categories are crude: 1 ~several grams of plutonium and/or several

²⁵⁸ For a general version of this argument see Jana Von Stein, "Do treaties constrain or screen? Selection bias and treaty compliance," *American Political Science Review* 99.04 (2005): 611-622.

separative work units (SWU) of uranium enrichment per annum; 2 ~dozens of grams but less than one Significant Quantity (SQ) of plutonium and/or dozens to a couple hundred SWU per annum; 3 ~one SQ of plutonium (or more) and/or several hundred SWU (or more) per annum.

The coding was done by identifying, to the greatest extent possible, the universe of uranium enrichment and plutonium reprocessing facilities built between 1945 and 2010. States were coded as having some ability to produce fissile materials in any year that it had at least one operational laboratory-, pilot-, or commercial-scale facility on its soil. Situations where a state had a fissile material production facility on its soil, but the facility was not operational (e.g. not yet able to produce enriched uranium or separate plutonium from spent fuel) are treated as if the state has no fissile material facilities available (i.e. that observation is coded as 0).

I include *Fissile Materials* as a crude measure of a state's proficiency in nuclear science, technology and engineering. Including a measure of scientific and engineering ability is crucial for avoiding a false positive finding. Technological achievements are one critical dimension of a nuclear weapons program, but are independent of the organizational dimension. We should expect nuclear weapons programs that are nearing success to have a source of fissile materials available to them, but we do not want to confuse organizational specialization with how close a program is to producing a weapon, or how successful the state has been in mastering some of the technical aspects of building a nuclear bomb. Including *Fissile Materials* in the equation effectively separates the program's organizational and technological dimensions into two independent terms (the correlation between *Organization* and *Fissile Materials* is 0.47). *Fissile Materials* also provides a nuclear science-specific measure of material capability that is only weakly correlated with real per capita GDP (the two measures have a correlation of 0.288), thus helping distinguish between a state's inability to afford continued nuclear weapon activities, and

its inability to achieve critical technical benchmarks in a program. Including *Fissile Materials* in the equation also provides a reasonable instrument for assessing whether nuclear program retention is partly a function of sunk costs, as the ability to produce fissile materials should be, *ceteris paribus*, evidence of a relatively large and/or successful investment in the state's nuclear weapon activities.

It should also be noted that I also used alternative measures of a state's nuclear science and engineering capacity in some auxiliary regressions.²⁵⁹

4.3.2f Other controls

I have included three time variables, following the advice of Signorino and Carter, in order to control for time dependence.²⁶⁰ The three variables are T , T^2 , and T^3 . T is simply the count of the number of years since a country enters the sample, while T^2 and T^3 are the square and cubic transformations of T , respectively.

Observations in all models are clustered by country, to control for country-level heterogeneity.

4.3.2g Summary Statistics and IV Correlations

Table 4.3 contains the summary statistics for study sample (29 states with nuclear weapon activities) between 1950 and 2000.²⁶¹ Table 4.4 shows the correlation matrix for *Organization* and the control variables (less the time controls and *Polity X NPT*). The correlation coefficients shown in Table 4.4 suggest very little multicollinearity among the independent

²⁵⁹ These alternative measures come from Kroenig and Singh and Way. I do not report the results of these regressions since the alternative measures were always statistically insignificant and did not change the coefficients or standard errors of *Organization* in any substantive way.

²⁶⁰ David B. Carter and Curtis S. Signorino, "Back to the Future: Modeling Time Dependence in Binary Data," *Political Analysis* 18.3 (2010): 271-292.

²⁶¹ I have also collected data on a larger sample (173 states and other international entities inside the Correlates of War universe) in order to use Heckman's selection method. Since formal tests routinely rejected the need to use a selection method, the results of the selection method are only reported in the Appendix. The summary statistics for the larger sample are also reported in the Appendix.

variables, save for *GDP* and *GDP*², which are unsurprisingly have a correlation coefficient of 0.945.²⁶²

Table 4.3 Summary Statistics: Study Sample

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>Abandon</i>	770	.0311688	.1738868	0	1
<i>Organization</i>	677	2.539143	.6132327	1	3
<i>MIDs</i>	766	7.233159	7.678943	0	61.4
<i>Allies</i>	774	.4031008	.4908379	0	1
<i>Rivals</i>	779	3.116755	5.771029	0	43.21541
<i>Fissile Materials</i>	779	1.403081	1.356425	0	3
<i>Trade</i>	767	34.05811	22.95318	2.52	125.58
<i>NPT</i>	779	47.49724	36.84287	0	97.89
<i>Polity</i>	779	1.675225	8.078728	-10	10
<i>PolityXNPT</i>	779	36.16535	467.4213	-881.01	978.9
<i>GDP</i>	771	8.11463	6.31667	.630	33.309
<i>GDP</i> ²	771	106.6769	157.3986	.3969	1109.489

Table 4.4 Correlation Matrix

	<i>Organization</i>	<i>MIDs</i>	<i>Allies</i>	<i>Rivals</i>	<i>Fissile Materials</i>	<i>Trade</i>	<i>NPT</i>	<i>Polity</i>	<i>GDP</i>
<i>Organization</i>	1	-	-	-	-	-	-	-	-
<i>MIDs</i>	0.1593	1	-	-	-	-	-	-	-
<i>Allies</i>	-0.091	-0.044	1	-	-	-	-	-	-
<i>Rivals</i>	-0.083	0.271	-0.034	1	-	-	-	-	-
<i>Fissile Materials</i>	0.384	0.294	0.23	0.019	1	-	-	-	-
<i>Trade</i>	-0.19	-0.228	-0.157	0.111	-0.258	1		-	-
<i>NPT</i>	0.019	-0.074	-0.006	0.166	0.259	0.158	1	-	-
<i>Polity</i>	-0.145	-0.061	0.28	-0.195	0.207	0.213	-0.14	1	-
<i>GDP</i>	-0.147	0.001	0.45	-0.167	0.209	0.221	0.122	0.61	1
<i>GDP</i> ²	-0.086	0.073	0.392	-0.158	0.219	0.152	0.192	0.513	0.945

4.4 Specifying the Equations

As discussed in chapter two, the literature provides a large number of potential general causes of nuclear abandonment. To mitigate the risk of getting false-positive results when testing

²⁶² Since *GDP* and *GDP*² are the only pair of independent variables that are strongly correlated, I have not shown the results of dropping *GDP*² from the estimates in this chapter. However, when re-estimating Model 1.3 without *GDP*², most of the coefficients and errors remain largely unaffected, except for the coefficient of *GDP*, which becomes strongly statistically significant ($p < 0.001$) while remaining negative. This strongly suggests that as a country becomes richer, the likelihood of it abandoning its nuclear weapon activities declines. The substantive effect of increasing *GDP* from \$3,350 (which is approximately the 25th percentile of the sample) to the sample mean of \$5,773 changes the likelihood of abandonment in a given year from 2.95% to 0.7% (while all other variables are held at their means).

the study's core hypothesis, these potential causes are included, in some form, in the empirical estimates. As discussed in this study's introduction, the hypothesis that this study is investigating is not meant to be understood as an exclusive or dominant explanation for nuclear abandonment. Instead, I believe that this study's organizational hypothesis is complementary to existing explanations. The empirical tests are therefore designed to assess the generalizability and validity of the organizational hypothesis, rather than to test it "against" other explanations. Accordingly, when this chapter discusses the results of the tests, the focus is on the findings as they pertain to the organizational hypothesis.

4.5 Tests and Results

This section provides the results of a number of tests. All results were obtained using probit estimators, unless otherwise specified. In all models reported in this section, countries were eliminated from the sample after nuclear abandonment occurred. All estimates use robust errors clustered on country.

4.5.1 Main Results

Table 4.5 shows the results of several probit estimates. Model 1 simply regresses *Organization* against the dependent variable; Model 1.1 includes time controls. Model 1.3 is a fully specified equation, while Model 1.2 was specified by starting with Model 1.3 and stepwise deleting the variable with the largest p -value until all remaining regressors (except the time controls) have p -values < 0.05 .²⁶³

²⁶³ Model 1.3 attempts to control, to the greatest practical extent, for the factors that the literature claims are important causes of nuclear abandonment. Readers should note that additional estimates were made including terms measuring five-year changes in trade openness and polity. However, since these terms were routinely insignificant and there are already measures of trade openness and polity in Model 1.3, these results are not reported in this chapter.

Table 4.5 Main Estimates

Probit	Model 1	Model 1.1	Model 1.2	Model 1.3	Model 1.4
Organization	-.639*** (.129)	-.603*** (.136)	-.596** (.181)	-.763*** (.181)	-.784** (.242)
MIDs				-.05 (.03)	-.115* (.056)
Ally				-.0726 (.152)	.104 (.275)
Rival			-.048* (.023)	-.001 (.025)	-.003 (.034)
Fissile materials			-.189* (.086)	-.241* (.086)	-.347* (.152)
Trade				.008 (.005)	.019** (.007)
NPT Norm				-.006 (.006)	-.01 (.008)
Polity				-.022 (.032)	-.028 (.046)
Polity X NPT				.0007 (.0005)	.001 (.0008)
GDP			-.05** (.02)	-.06 (.07)	-.06 (.1)
GDP ²				-.002 (.003)	-.003 (.004)
T		-.0289 (.078)	.03 (.146)	.022 (.174)	-.171 (.135)
T ²		.001 (.002)	-.0007 (.004)	.0004 (.005)	.006 (.004)
T ³		-9.93 x 10 ⁻⁶ (.00002)	8.69 x 10 ⁻⁶ (.00003)	-4.46 x 10 ⁻⁶ (.00004)	-.00005 (.00004)
Constant	-.4 (.267)	-.35 (.82)	-.289 (1.766)	-.127 (1.96)	2.468 (1.345)
N	677	677	667	667	162
Clusters	29	29	28	28	29
Pseudo R ²	0.091	0.094	0.169	0.194	0.315

Robust standard errors are clustered by country and are in parentheses below coefficients. Statistically significant coefficient estimates are in bold and are denoted by *($p < 0.05$), **($p < 0.01$), ***($p < 0.001$).

4.5.2 Estimates with Five-Year Data

Given that we may not expect significant year-over-year variation in the data, and that it is reasonable to assume that governments make major national security policy decisions with reference to medium-term (e.g. several years) trends, events, and expectations, Model 1.4 was

produced using five-year – rather than annual – data. The results are comparable to the models using annual data.²⁶⁴

4.6 Interpretation of Results

Overall, *Organization* is negatively correlated with nuclear abandonment, and as models 1-1.4 show, that relationship is statistically significant (often at the 99.99% level or higher, meaning that the likelihood that the observed negative relationship is a product of random chance is quite small). These findings are consistent with chapter three's hypothesis: states are relatively less likely to abandon their nuclear weapon activities when a relatively specialized organization is responsible for conducting those nuclear weapon activities.

While the sign and significance of the coefficients in models 1-1.3 strongly support this study's core claims, does a state's organizational choices substantively affect the likelihood of nuclear abandonment? In other words, while the empirical tests suggest that there is a real, measurable effect, is that effect large enough that it might make an observable, "real world" difference?

To estimate the substantive effect of organizational type on the likelihood of nuclear abandonment in a given year, I used a Monte Carlo method to produce simulations of the model parameters and estimates of the predicted probability of nuclear abandonment under certain scenarios.²⁶⁵ Table 4.6 (using Model 1.3) shows the predicted probability of abandonment for the

²⁶⁴ Model 1.4 uses a version of *Allies* drawn from Kroenig's 2009 dataset (which is drawn from Singh and Way's 2004 data), as it allowed the estimate to converge more easily. The correlation between my version of *Allies* and Kroenig's is 0.85.

²⁶⁵ Michael Tomz, Jason Wittenberg, and Gary King (2001). CLARIFY: Software for Interpreting and Presenting Statistical Results. Version 2.0 Cambridge, MA: Harvard University, June 1. <http://gking.harvard.edu>; Gary King, Michael Tomz, and Jason Wittenberg, "Making the Most of Statistical Analyses: Improving Interpretation and Presentation," *American Journal of Political Science* 44.2 (2000): 347-61.

three different values of *Organization*, while all other independent variables are held at their mean, and *Allies* = 1, and *Fissile Materials* = 2.

Table 4.6 Substantive Effect of *Organization*

	Probability of abandonment (95% confidence interval in parentheses)
<i>Organization</i> = 1	0.094 (0.028 – 0.204)
<i>Organization</i> = 2	0.021 (0.006 – 0.05)
<i>Organization</i> = 3	0.003 (0.0003 – 0.014)

Using Model 1.3. *Allies* = 1; *Fissile Materials* = 2; all other regressors set to their mean.

These results suggest that organizational choices are associated with a substantial change in the likelihood of abandonment. If we observe a country where a non-specialized organization is responsible for conducting and managing nuclear weapon activities, we can predict a roughly 9.4% chance that the country will abandon its nuclear weapon activities in that year (given the values on the other variables). Holding all other variables constant, if a country's nuclear weapon activities are housed in a mixed organization, the likelihood of abandonment is ~2.1%. Finally, if a specialized or dedicated organization conducts a state's nuclear weapon activities, the predicted probability of abandonment is ~0.3% in a given year. Comparing these static estimates helps clarify the size of *Organization*'s effect. When a state houses its nuclear weapon activities in a mixed-purpose organization (i.e. *Organization* = 2), the likelihood of abandonment is seven times greater, than compared to a scenario where the same state houses the activities in a specialized organization (i.e. *Organization* = 3). The difference in likelihood is even greater when comparing a state that houses its nuclear weapon activities in a generalized organization (*Organization* = 1) to a state that uses a specialized organization. In this second case, the state using the generalized organization is thirty-one times more likely to abandon its nuclear weapon activities in a given year than the state using the specialized organization.

These observed effects are also worth comparing to the unconditional probability of observing abandonment in any given year that a country has a nuclear weapon program. For the study sample, the unconditional probability of abandonment is approximately 3.12%. The effect of a highly specialized nuclear weapon organization can therefore be understood as being associated with a 90% reduction in the probability of abandonment, compared with an unconditional baseline. On the other hand, a generalized organization is associated with a roughly 300% increase in abandonment compared to that same baseline.

Table 4.7 Effect of *Organization*: First Difference

	Change in predicted probability of abandonment (95% CI in parentheses)
3 → 1	0.094 (0.023 – 0.225)
2 → 1	0.08 (0.019 – 0.194)
3 → 2	0.014 (0.003 – 0.04)

Dynamic changes (i.e. a first-difference change) in *Organization* also have a significant effect on the probability of abandonment. As Table 4.7 shows, moving a state’s nuclear weapon activities from a specialized organization (i.e. a value of 3) to a generalized organization (i.e. a value of 1) is associated with a 9.4% increased probability of abandonment, all other things being equal. Moving the activities from a mixed organization to a general organization increases the probability of abandonment by nearly 8%. Even moving activities from a specialized organization to a mixed organization (e.g. from a stand-alone atomic science and weapons organization to the armed forces) increases the probability of abandonment by around 1.4%.

To provide a fuller assessment of the degree to which organizational imperatives are associated with abandonment compared to other factors, I repeated the analysis in Tables 4.6 and

4.7 for several other independent variables. Table 4.8 shows the predicted probability of abandonment for the range of values of *Fissile Materials*.

Table 4.8 Substantive Effect of *Fissile Materials*

	Probability of abandonment (95% CI in parentheses)	Δ probability of abandonment
<i>Fissile Materials</i> = 0 (No operational uranium enrichment or plutonium separation facilities.)	0.04 (0.011 – 0.088)	0.0144
<i>Fissile Materials</i> = 1 (Laboratory-scale enrichment or separation facilities/ < 1 SQ per annum.)	0.0256 (0.006 – 0.061)	0.0086
<i>Fissile Materials</i> = 2 (Pilot-scale enrichment or separation facilities/ ~ 1 SQ per annum.)	0.017 (0.003 – 0.048)	0.006
<i>Fissile Materials</i> = 3 (Commercial-scale/multiple pilot-scale enrichment and/or separation facilities/ > 1 SQ per annum.)	0.011 (0.001 – 0.037)	-

Using Model 1.3. Allies = 1; Organization = 2; all other regressors set to their mean.

As Table 4.8 shows, the probability of abandonment, given the specification in Model 1.3, with *Organization* = 2, *Allies* = 1, and all other variables set to their means, ranges from 1.1 to 4%, depending on the value of *Fissile Materials*. This means that the predicted probability of abandonment when *Fissile Material* has a value of 0 (no ability to produce enriched uranium or separated plutonium) is ~ 3.6 times greater than when *Fissile Material* has value of 3 (the ability to produce several thousand SWU of enriched uranium or several kilograms of separated plutonium in a year). While this is not an insignificant difference, it is much smaller than *Organization*'s effect: the likelihood of abandonment, when *Organization* is at its minimum value, is 31 times larger than when *Organization* is at its maximum.

Table 4.9 Effects of *Fissile Materials*: First Difference

	Change in predicted probability of abandonment (95% CI in parentheses)
0→1	-0.014 (-0.039 – -0.002)
0→2	-0.023 (-0.061 – -0.003)
0→3	-0.029 (-0.074 – -0.005)

Simulating the effect of a dynamic change in a state's ability to produce fissile materials leads to similar conclusions (see Table 4.9). While acquiring the ability to produce fissile materials appears to reduce the likelihood of abandonment (by 1.4 to 2.9%, depending on the final value of *Fissile Materials*), these effects are smaller than any of the first difference effects of *Organization* (except when *Organization* moves from a value of 3 to 2). These results suggest that in terms of the change in the likelihood that a state will abandon its nuclear weapon activities, moving a state's nuclear weapon activities from a specialized organization to a general organization is has a three-fold larger effect than a state with no ability to produce enriched uranium or separated plutonium acquiring a functional commercial-scale enrichment or reprocessing facility.

Tables 4.10 – 4.13 display the predicted probability of abandonment in Model 1.3 given various values of *MIDs* and *Polity X NPT*. While neither of these terms are significant in Model 1.3 (and are only sometimes significant in other specifications), they represent theoretically important concepts (namely, tangible threats to a state's security, and the normative influence of widespread adoption of the NPT).

Table 4.10 Substantive Effect of *MIDs*

	Probability of abandonment (95% CI in parentheses)
<i>MIDs</i> = 25 th percentile (0)	0.034 (0.011 – 0.076)
<i>MIDs</i> = 50 th percentile (0.8)	0.02 (0.005 – 0.049)
<i>MIDs</i> = 75 th percentile (2.8)	0.012 (0.001 – 0.047)
<i>MIDs</i> = 99 th percentile (20.2)	0.008 (2.14×10^{-8} – 0.063)

Table 4.11 Effects of *MIDs*: First Difference

	Change in predicted probability of abandonment (95% CI in parentheses)
1 st percentile → 25 th percentile	-0.009 (-0.027 – 0.001)
25 th percentile → 50 th percentile	-0.014 (-0.042 – 0.003)
50 th percentile → 75 th percentile	-0.009 (-0.022 – 0.005)
75 th percentile → 99 th percentile	-0.004 (-0.022 – 0.02)

Table 4.12 Substantive Effect of *Polity X NPT*

	Probability of abandonment (95% CI in parentheses)
<i>Polity X NPT</i> = 25 th percentile	0.01 (0.001 – 0.047)
<i>Polity X NPT</i> = 50 th percentile	0.014 (0.002 – 0.045)
<i>Polity X NPT</i> = 75 th percentile	0.038 (0.001 – 0.095)
<i>Polity X NPT</i> = 99 th percentile	0.096 (0.011 – 0.303)

Table 4.13 Effects of *Polity X NPT*: First Difference

	Change in predicted probability of abandonment (95% CI in parentheses)
1 st percentile → 25 th percentile	0.002 (-0.013 – 0.011)
25 th percentile → 50 th percentile	0.004 (-0.007 – 0.014)
50 th percentile → 75 th percentile	0.024 (-0.009 – 0.075)
75 th percentile → 99 th percentile	0.058 (-0.006 – 0.223)

The effects of *MIDs* and *Polity X NPT* do not appear to be as large as the effects of *Organization*. While Table 4.10 suggests that there is a noticeable difference in the likelihood of abandonment when comparing low-conflict countries (those in the 25th percentile of *MIDs*) and high-conflict countries (those in the 99th percentile), the difference is still small: the high-conflict scenario has a 0.8% chance of abandonment, while the low-conflict scenario is associated with a 3.4% chance of abandonment. The first differences reported in Table 4.10 are even smaller (typically <1%), and statistically insignificant.

Interpreting *Polity X NPT*'s coefficient is more difficult than interpreting the coefficients for *Organization*, *Fissile Materials*, and *MIDs*, since it is an interaction term. However, Table 4.12 does suggest that when a state is both strongly democratic and states have broadly ratified and/or acceded to the NPT, the likelihood of abandonment is relatively high (~9.6%). This finding is similar to the scenario in Table 4.7 where *Organization* = 1. *Polity X NPT*'s first-difference effects are not as notable though. Moving from the 1st to 25th and 25th to 50th percentiles of *Polity X NPT* has much smaller effects than similar shifts in *Organization*, and the effects of *Polity X NPT* are not statistically significant. While the effect of moving to higher

percentiles of *Polity X NPT* is substantive (an increase in the probability of abandonment of 2.4 to 5.8%), again these effects are statistically insignificant.

This analysis suggests that not only is *Organization* a consistently statistically significant predictor of nuclear abandonment, but that its effects are substantive as well. Generally, states that have housed their nuclear weapon activities in generalized organizations are ~9.1% more likely to abandon them in a given year than states which house their nuclear weapon activities in specialized organizations. While this may seem to be a small difference in probability, in relative terms it is not: a state using a general organization is around 30 times more likely to abandon its nuclear weapon activities than a state with a specialized nuclear weapons organization.

Importantly, *Organization*'s effects are often comparable or greater than the effect of other theoretically important factors. Dramatic changes in a state's security environment (as measured by MID intensity) and the global normative environment (as measured by the spread of the NPT and a state's sensitivity to social expectations) often have smaller effects on the likelihood of abandonment than organizational changes. Even if states have mastered the elements of the nuclear fuel cycle that allow them to make enriched uranium or separate plutonium from irradiated reactor fuel, this mastery appears to have a smaller effect on the probability of abandonment than organizational type. This evidence is not grounds to reject hypotheses that claim that security, normative, or technological factors and events influence a government's decision to abandon their nuclear weapon activities. Instead, this evidence is strongly suggestive that organizational decisions, even when other important factors are accounted for, also exert a substantive influence on nuclear abandonment decisions, and may, in fact, exert a larger measurable effect than these other factors.²⁶⁶

²⁶⁶ It is also possible that in some cases a government's executive branch may move a nuclear weapons program to a general organization from a specialized one as a consequence (rather than a cause) of a decision to deprioritize the

4.6 Interaction Terms – Executive Constraint and Polity

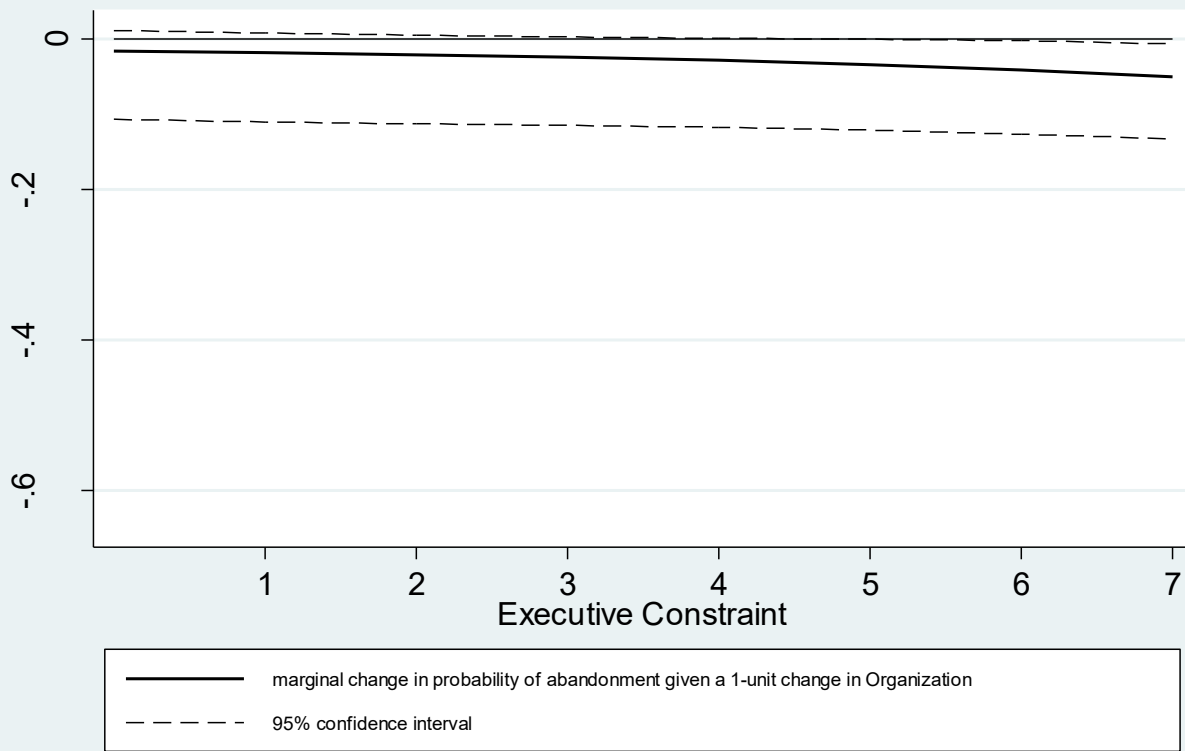
As noted in chapter three, section 3.3.2, the organizational nuclear abandonment hypothesis has at least one obvious extension: namely, executive branches that are relatively constrained in their decision-making powers either due to a formal constitutional separation of powers, or by informal checks, such as the ruling party in a one-party state or politically active militaries, will find it relatively difficult to unilaterally order an end to nuclear weapon activities.²⁶⁷ While a measure of legal and informal executive constraints (the variable *exconst* from the Polity IV dataset) is insignificant in all specifications, an interaction term of *Organization* and *Executive Constraint* yields interesting results. Interacting these two terms tests a slightly different hypothesis: that governments are less likely to abandon their nuclear weapon activities when the executive branch is both constrained (either by legal or informal means, as Polity IV includes both), and the nuclear weapon organization is specialized (e.g. executive constraints alone do not affect the likelihood of abandonment, but these constraints do matter at high levels of specialization).

Including the terms *Executive Constraint* and *Organization X Executive Constraint* in a variation of Model 1.3 provides some evidence in support of this hypothesis. Figure 4.2 shows the marginal change in the likelihood of abandonment given a one-unit change in *Organization*, conditional on the level of *Executive Constraint*.

country's nuclear weapon activities. Once policy makers place a nuclear weapons program in a general organization it may be easier for them to neglect the program and allow it to atrophy.

²⁶⁷ Monty G. Marshall, Ted Robert Gurr, and Keith Jagers, *Polity IV Project: Dataset Users' Manual* (Center for Systemic Peace, 2013), 24-25, 62-66.

Figure 4.2: Effects of Organization
Conditioned on level of Executive Constraint



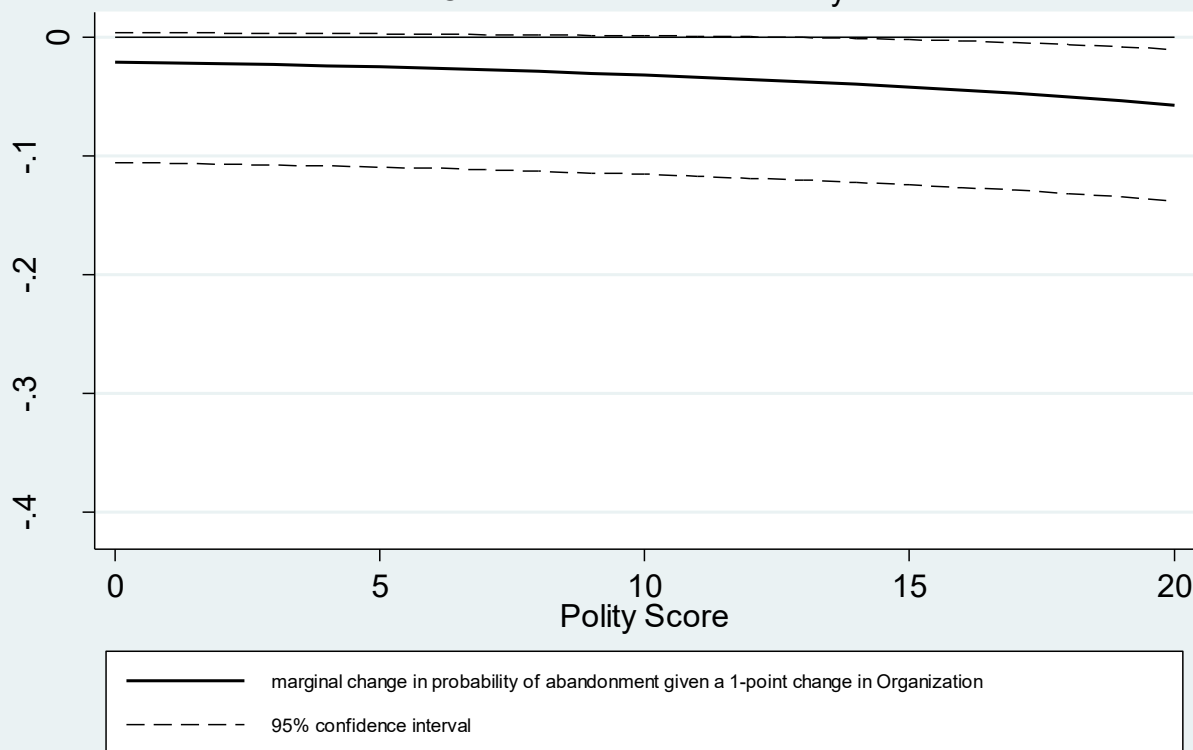
As Figure 4.2 shows, at high levels of *Executive Constraint*, an increase in *Organization* is associated with a marginal decrease in the likelihood of abandonment. While this decrease is not particularly large (roughly 4 to 5%), it is statistically significant.

Conducting a similar analysis using an interaction of *Organization* and *Polity* yields similar results.²⁶⁸ As Figure 4.3 demonstrates, an increase in *Organization* - at high levels of democracy - decreases the likelihood of abandonment. As in the case of *Organization X Executive Constraint*, this change in probability is modest (around 5%) and statistically significant.

²⁶⁸ In the equation used to generate Figure 4.3, *Polity X NPT* was dropped from Model 1.3 due to the complications involved in interpreting the effect of a single lower-order term that is included in two interaction terms.

Together, these results do suggest that in addition to the unconditional effects of organizational imperatives on nuclear abandonment, there may also be a substantive interaction between other aspects of a government and organizational imperatives. The result obtained by interacting *Executive Constraint* and *Organization* can be interpreted as a simple case of specialized organizations being shielded by legal or informal constraints on the executive's ability to unilaterally set policy. In other words, the executive may need the support or acquiescence of other parts of the government to terminate nuclear weapon activities under the twin conditions of limited executive powers and nuclear weapon organization specialization. The second result – where democracy combined with organizational specialization is associated with a decreased chance of abandonment – is difficult to reconcile with the literature. After all, Müller and Schmidt argue that democracy is a force for nuclear abandonment. Whether the apparent conditional effect of democracy is a spurious result (given the strong correlation between *Polity* and *Executive Constraint*) or the product of a different relationship remains to be seen.

Figure 4.3: Effects of Organization
Conditioned on level of Polity



4.7 Comparisons to Other Studies

These findings are not directly comparable to other studies due to a lack of published research on nuclear abandonment that uses similar methods. Nevertheless, a simple comparison with the findings of the qualitative nuclear abandonment literature is warranted.

First of all, some of the estimates do offer some support to a few of the literature's explanations for nuclear abandonment. Model 1.2, which only includes statistically significant terms (other than time controls) finds that states that are involved in enduring rivalries are less likely to abandon their nuclear weapon activities. Broadly speaking, this is compatible with Paul's explanation for abandonment. Likewise, Model 1.4, which uses 5-year (rather than annual) data, finds that involvement in militarized interstate disputes is negatively correlated

with abandonment. Again, this is compatible with Paul's claims, as well as other authors (such as Bergner, Braut-Hegghammer, and Tagma) who attribute abandonment decisions largely to changes in a state's security environment. The coefficient of *Trade openness* is also statistically significant in Model 1.4, lending additional support to Solingen's contention that governments that rely on robust economic relationships with the outside world to stay in power are more likely to stop their efforts to acquire nuclear weapons. Finally, *NPT Norm* and *Polity X NPT* are statistically significant in some specifications (which are not reported in this chapter), and *Polity X NPT* generally has the theoretically correct positive sign.

That being said, overall this chapter's results do not strongly support many of the existing literature's claims. *Trade openness*' coefficient is not consistently statistically significant across specifications. Further examination of the *Polity X NPT* variable (using the same methods as in Figures 4.2 and 4.3 to evaluate the effects of interaction terms) suggests that the effect of the spread of the NPT is not statistically significant by standard measures. Müller and Schmidt's claim that democratic countries in particular are more likely to abandon their nuclear weapon activities also needs to be reconciled with the findings presented in Figure 4.3 (and to a lesser extent Figure 4.2), which suggest that high degrees of democracy (or executive constraint) and high degrees of organizational specialization are jointly associated with a lower likelihood of abandonment.²⁶⁹

Why this chapter's results are only weakly supportive of the existing literature is unclear. However, one possibility has already been alluded to. This study's literature review did argue that many of the existing explanations of nuclear abandonment, on close examination, are probably better explanations of why states do not initiate nuclear weapons activities than explanations for why they terminate ongoing activities. The results of a two-stage estimate,

²⁶⁹ The correlation between *Executive Constraint* and *Polity* for the study sample is 0.94.

using Heckman's selection method (see 4.9.5 for a description of the method) on a larger sample yields results that are consistent with this line of argument.²⁷⁰ Using a Heckman selection equation yields several statistically significant predictors of nuclear weapon activities which also appear in the qualitative abandonment literature. Namely, the coefficients of *MIDs*, *Ally*, *Rival*, *NPT Norm*, *Polity* and *Polity X NPT* are all statistically significant (with the theoretically correct signs) in at least some specifications. The results of the outcome (e.g. abandonment) equations are consistent with the findings of the rest of this chapter, i.e. high values of *Organization* are strongly negatively associated with abandonment. The Heckman estimates suggest that many of the factors which the qualitative abandonment literature identifies are important determinants of overall nuclear behaviour, and are compatible with explanations of nuclear abandonment, but only as determinants of whether a state begins nuclear weapon activities in the first place, and not as determinants of whether it terminates those activities.

4.8 Robustness Tests

To help determine how robust the results of Models 1-1.4 are, I performed a number of robustness tests, varying the sample, the coding of the dependent variable, and testing categorical versions of the independent variable.

4.8.1 Nuclear Weapon States

As a robustness check, I coded two other versions of the dependent variable which do not include observations of any of the five Nuclear Weapon States (NWS) from 1950 and 1968 onwards. As Paul argues, the five "great powers" (China, France, Russia, the United Kingdom, and the United States) face a unique set of geopolitical incentives that cause them to retain their

²⁷⁰ The full results of using the Heckman methods can be found in Appendix I. They are not reported in this chapter since formal tests did not reject the null hypothesis that the selection and outcome equations were independent.

nuclear weapons. Likewise, these five states enjoy a privileged status under the NPT, which entitles them to possess nuclear arms and conduct certain nuclear weapon activities.

Furthermore, throughout this study's time period, the five NWS have often had fairly specialized, stand-alone nuclear weapon organizations. It is therefore reasonable to suspect that the patterns reported in Models 1-1.3 could be a spurious result of the five NWS developing specialized nuclear weapon organizations and then retaining their nuclear weapon activities due to the combination of their global interests and NPT status. Dropping the five NWS from 1968 (when the NPT was opened for signature) and from 1950 (the first year of the study period) lets us assess whether these states are driving the results.

Dropping the five NWS from the analysis gives comparable results. *Organization* remains significant at the 99.99% level and the coefficient remains comparable. These results help discount the possibility that the overall findings are driven by the NWS, all of which had specialized, stand-alone nuclear weapon organizations for long periods of time.

A similar test is to use a censored sample that excludes all observations where a state has a nuclear weapon.²⁷¹ Using the specification from Model 1.3 on such a sample yields consistent results. *Organization* remains significant at the 99.5% level, though the size of the effect is somewhat different (a coefficient of -.57, rather than the more typical range of ~-.68 to -.75). The full results of these robustness tests can be found in Table 4.14.

4.8.2 Lags and Leads of the Dependent Variable

In case of coding errors, I have also tested a version of the DV that includes a one-year lag and lead. In other words, if I have coded a country as terminating its activities in 1990, this version of the variable, 1989 and 1991 would also be abandonment years. This should help address the inherent imprecision involved in assigning a discrete date to the abandonment event

²⁷¹ India is assumed to have acquired a nuclear weapon in 1974 and Pakistan in 1983.

(and since governments make many of these decisions in relative secrecy, there probably are some errors in the data). Again, equations using this form of the DV produce comparable results to the aforementioned approaches. The full results of this test are in Table 4.14.

4.8.3 Dropping Countries from the Sample

Another simple robustness test was to re-run the regressions with one country randomly eliminated from the sample. This was done using both Heckman probit estimators and panel probit estimators, and was repeated for every country with a nuclear weapon program in the sample. The size of the key IV's effect and its significance level were consistent throughout. I can provide a stata log of the results, rather than reproducing them here.

4.8.4 Random Samples

To further determine how dependent the results are on the sample, two random subsamples of ~470 observations were drawn from observations where a state has a nuclear weapon program. This was done by generating a pseudorandom variable from a uniform distribution. Each subsample was assigned a specific seed. Probit estimators were used to estimate Model 1.3 on each subsample. In both random subsamples, *Organization* remains significant at the 99% level, and the coefficients are comparable with other specifications (~-.69 to -.72).

Table 4.14: Robustness Tests

All models use probit estimator	No NWS after 1950	No NWS after 1968	No country- years with nuclear weapons	One year lags and leads of DV
Organization	-.787*** (.191)	-.797*** (.177)	-.572** (.195)	-.8929*** (.178)
Ally	-.03 (.184)	-.05 (.177)	.104 (.27)	.043 (.242)
Rival	.017 (.032)	.018 (.033)	-.003 (.028)	.003 (.031)
MIDs	-.054 (.038)	-.059 (.041)	-.032 (.024)	-.065 (.034)
Fissile materials	-.059 (.143)	-.088 (.104)	-.008 (.164)	-.352** (.101)
Trade	.006 (.007)	.007 (.006)	.01 (.006)	.01 (.005)
NPT Norm	-.007 (.006)	-.007 (.006)	-.002 (.006)	-.007 (.007)
Polity	-.044 (.038)	-.039 (.036)	-.011 (.037)	-.037 (.035)
Polity X NPT	.001 (.0006)	.0009 (.0007)	.0008 (.0006)	.001 (.0006)
GDP	.006 (.07)	-.003 (.1)	-.09 (.1)	-.04 (.09)
GDP ²	-.003 (.004)	-.003 (.004)	-.0002 (.004)	-.003 (.003)
T	-.032 (.202)	-.023 (.196)	-.0002 (.192)	-.088 (.152)
T ²	.001 (.006)	.001 (.006)	.001 (.006)	.003 (.005)
T ³	-3.65 x 10 ⁻⁶ (.00005)	-4.11 x 10 ⁻⁶ (.00005)	-.00002 (.00005)	-.00003 (.00004)
Constant	.577 (2.168)	.389 (2.122)	-.576 (2.105)	1.945 (1.698)
N	406	506	349	688
Pseudo R ²	0.13	0.168	0.10	0.27
Clusters	23	28	27	29

Robust standard errors are clustered by country and are in parentheses below coefficients. Statistically significant coefficient estimates are in bold and are denoted by *($p < 0.05$), **($p < 0.01$), ***($p < 0.001$).

4.8.5 Heckman Selection Equations

Estimating the correlates of nuclear abandonment poses an obvious methodological challenge due to the fact that we only observe nuclear abandonment among states that have nuclear weapon activities. In other words, the dependent variable is only observed for a restricted, non-random sample. Only estimating the relationship between variables of interest and nuclear abandonment in a sample of states with nuclear weapon activities introduced the risk of producing biased coefficients (and coming to erroneous conclusions). This is in part because a limited dependent variable, like the one used in this study, is an approximation of reality. It may be more appropriate to think of all nuclear weapon activities existing on a continuous scale, ranging from absolutely no interest or intent at one end, to a large, institutionalized nuclear weapons production program at the other end. Unfortunately, we cannot observe the historical record with enough precision to quantify this variation in a continuous manner. Instead, we categorize behaviour once it reaches a certain threshold. In this case, once we can observe nuclear weapon activities in a country's historical record, we record that activity. Otherwise, the state is treated as having no nuclear weapon activities.

To overcome the methodological challenge, I estimated several models **using** Heckman's selection method, adapted for limited dependent variables. These estimates included a near-universal panel of states from 1950 to 2000, including states that did not initiate nuclear weapon activities during that period.

The likelihood ratio (LR) test for the selection models routinely failed to reject the null hypothesis that $\rho = 0$. In other words, the LR could not reject the possibility that the selection and outcome equations (e.g. the equation that predicts whether a state has a nuclear weapon program and the equation that predicts if a state that has a nuclear weapon program abandons

that program) are independent. This strongly suggests that there is no need to use a selection equation. Thus, I have not reported the results of the two-stage estimates in this chapter, and instead reported them in Appendix I. The results of the selection models are on the whole similar to the results reported in Tables 4.4 and 4.14.

4.8.6 Rare Events Logit

Given the large ratio of 0:1 (746:24, or ~31:1) in the dependent variable (e.g. the ratio of the number of years with no abandonment to the number of years where abandonment occurs), I re-estimated the models with a rare events logit estimator.²⁷² King and Zheng document that logit coefficients are biased not just when used with small samples, but also in sample sizes reach in to the thousands, and these biases tend to lead to underestimating the probability of an event occurring.²⁷³ Overall, rare events logistic and probit regressions yielded similar coefficients and standard errors.

4.8.7 Panel Probit Estimators

Most of the estimates presented in this chapter use a standard probit estimator because of its flexibility and compatibility with software used to perform the Monte Carlo simulations used to estimate the substantive effects in tables 4.6-4.13. Estimating Model 1.3 using a random effects panel probit estimator gives signs, coefficients, and errors that are highly consistent with the results reported in this chapter. A regression table for several random effects panel models can be found in the Appendix.

²⁷² Gary King and Langche Zeng, "Logistic Regression in Rare Event Data," *Political Analysis* 9.2 (2001): 137-163.

²⁷³ Gary King and Langche Zeng, "Explaining Rare Events in International Relations," *International Organization* 55.3 (2001): 693-694.

4.9 Conclusions

This chapter has presented large-sample evidence that is consistent with the claim that the sort of organization that conducts a state's nuclear weapon activities has a substantive effect on the likelihood that a state will abandon those nuclear weapon activities. Not only are these differences in the likelihood of abandonment significant according to classical statistical tests, but the observed effects are also substantive: in one estimate a change in organizational specialization from the most to least specialized is associated with nearly a 10% increase in the likelihood of abandonment. These results are also robust to a number of specifications, and while the Heckman selection technique does not appear to be necessary (according to the results of the Wald test), estimates using a Heckman selection estimator also produced consistent, statistically significant results.

These results are also consistent with the claim that the effects of organizational imperatives on the likelihood of abandonment are unconditional and that we can reasonably claim that they matter on average.

It should also be noted that these results should not be interpreted as a repudiation or rejection of other hypotheses about why states abandon their nuclear weapon activities. The other variables included in this chapter's estimates are there to reduce the likelihood of identifying a spurious correlation between organizational specialization and nuclear abandonment. The estimates presented in this chapter's tables are not designed or intended to be tests of any alternative hypotheses, but instead are simply meant to assess whether there is a *prima facie* case to claim that organizational imperatives have a substantive average effect on the likelihood of nuclear abandonment.

That being said, the coefficients of many of the variables that should capture other important factors in the nuclear decision-making process are routinely insignificant across many different specifications. This chapter's findings offer substantial support to the organizational hypothesis of nuclear abandonment, but little to explanations that emphasize the effects of interstate conflict or the effect of the NPT. Furthermore, this chapter's results apply to a large sample of countries, and are relatively unaffected by selection bias. This is particularly important given that the literature has relied on small samples to come to broad conclusions about nuclear abandonment. While by no means definitive, the weak statistical performance of the alternative explanations of nuclear abandonment does offer grounds for thoroughly reassessing those theories.

It should also be kept in mind that this chapter does not offer an explanation for how states choose which sort of organization will conduct its nuclear weapon activities. It is possible that nuclear weapon organization type is in and of itself a function of a latent variable such as the level of desire or demand a state has for nuclear weapons. This possibility has at least two important theoretical and empirical implications. First, theoretically a severe security threat could "cause" states to select specialized organizations to conduct nuclear weapon activities since those states might both be highly motivated to acquire nuclear weapons and believe that specialized organizations are more likely to produce nuclear arms quickly.²⁷⁴ Empirically, such a relationship could help explain why some (i.e. threat environment and security) variables do not have statistically significant coefficients in the estimates presented in this chapter, despite the literature's claims that they should. This would be because *Organization* is acting as an

²⁷⁴ Similar logic could be applied to an environment where norms against acquiring nuclear weapons are weak, such as during the years before the NPT came into force. In an environment with a weak anti-nuclear norm, states may believe the political consequences of acquiring nuclear weapons are relatively minor, and thus assign a presumably more efficient specialized organization to the task of building nuclear arms.

intervening variable: a security threat causes a state to begin nuclear weapon activities and to select an organization to conduct those activities. *Organization* then ultimately determines whether the activities continue or end. If this logic is correct, it would not mean that organizational type is an unimportant factor in nuclear abandonment, but that its effect needs to be carefully separated from (and understood in) the context of the state's security environment. Looking for that possible relationship (and the potential latent nuclear weapon desire/demand variable) is one potential avenue for further analysis and research.

Finally, the tests and results in this chapter are not meant to test any specific instance of nuclear abandonment. As stated, these estimates report average effects for the whole population of states with nuclear weapon activities. How organizational imperatives might lead to nuclear abandonment in any specific place and time is beyond the scope of this chapter. Thus, chapter five will present two narrative case studies, and explore the history of Switzerland and South Africa's nuclear weapon policies. These two cases act as an additional plausibility probe: they both bolster our confidence in the general hypothesis that organizational imperatives can have an important effect on whether a state abandons its nuclear weapon activities, and they provide additional nuance to the story, hinting at some possible specific causal mechanisms.

5 Case Studies – Organizational Imperatives and Nuclear Weapon Activity in Switzerland and South Africa

5.1 Rationale

This chapter will offer some additional nuance to the story that this study has told so far. While states are less likely to abandon their nuclear weapon activities when a specialized organization is in charge of those nuclear weapon activities, if other types of organizations are responsible for a state's nuclear weapon activities, then abandonment is in fact more likely. Specifically, a state is more likely to abandon its nuclear weapon activities when the organization that is in charge of a state's nuclear weapon activities has significant priorities and responsibilities beyond the nuclear weapon task.

So far, this study has deliberately avoided identifying specific causal chains to explain how organizational choices lead to nuclear abandonment. This is because, as stated earlier, one of this study's goals is to propose and test a generalizable explanation for nuclear abandonment. I have therefore made an effort to identify a pattern that fits the entire universe of cases. That being said, while there may be a broad correlation between organizational specialization and nuclear abandonment that does not mean that there are not differences in the way that organizational imperatives act to help cause abandonment in different cases.

This chapter therefore has two goals. First, it aims to provide further evidence that is consistent with the overall, general hypothesis that states which entrust their nuclear weapon activities to government organizations with significant mandates and activities beyond their nuclear weapons activities are relatively likely to abandon their nuclear weapon activities. It aims to provide this evidence by demonstrating that organizational imperatives and mandates in two countries – Switzerland and South Africa – appeared to play a role in debates about the future of

both countries' nuclear weapon programs. The second goal is to inductively offer some potential causal explanations. Since these two cases have largely been selected on the basis that they feature reasonably accessible records detailing cabinet deliberations (in the case of Switzerland) and decent data about the mandate and activities of the organization in charge of the country's nuclear weapon activities (in the case of South Africa), this chapter will make no claims about the generalizability of the precise chain of events that appear in these two cases.

The rest of the chapter will proceed with two brief case studies: a study of the history of Switzerland's nuclear weapon activities from the immediate aftermath of the Second World War to the 1980s, when the Swiss government appears to have definitively terminated all of its nuclear weapon activities, and of a study of South Africa's nuclear weapon activities, with a particular focus on the 1980s, when the military equipment company Armscor was in charge of the country's nuclear weapons program.

5.2 Switzerland

The most thorough English-language accounts of why Switzerland terminated its nuclear weapons activities are by T.V. Paul and Ursula Jasper.²⁷⁵ Paul concludes that Switzerland decided to not acquire nuclear weapons because the Swiss government feared that if they had nuclear weapons, they would become a target for pre-emptive nuclear strikes. Paul identifies the USSR in particular as a state that might pre-emptively attack a nuclear-armed Switzerland.²⁷⁶ Switzerland, given its small population, relatively small armed forces, and small territorial footprint would have been particularly ill-suited to withstand a surprise nuclear attack. Jasper, on the other hand argues that the supposed threat posed by the USSR is a poor explanation for Switzerland's decision to not acquire nuclear weapons. She likewise argues that there is "little

²⁷⁵ Paul, 91-98; Jasper, 55-115.

²⁷⁶ Paul, 95-96.

evidence for the centrality of...bureaucratic interests,” and instead claims that changing beliefs about Swiss national identity best explain Switzerland’s decision to not acquire nuclear weapons.²⁷⁷

I argue below that these interpretations are incomplete. Switzerland’s efforts to acquire nuclear weapons peaked in the late 1950s and early 1960s, and were largely driven by the Swiss military. While Swiss archival documents do suggest that the Swiss government was sensitive to international opinion, it does not appear that other states’ reactions to Switzerland’s nuclear weapon policy were a decisive influence on Swiss policy. Instead, two factors appear to have decisively shaped Swiss nuclear weapon policy. The first was the fact that Swiss policy makers’ interest in nuclear weapons was founded in their concerns about unforeseen future military conflicts, rather than in any current, tangible threat. The second factor was the role of the armed forces. The Swiss military took over the nuclear weapons portfolio in the 1950s. While the military certainly wanted to keep the nuclear option open, in the short-run, acquiring nuclear bombs was not a pressing priority, especially when the armed forces had other tasks – such as developing and new defence doctrine and reorganizing the armed services – to contend with. In turn, the Swiss nuclear weapons program stagnated, and was eventually moved to a high-level interdepartmental committee that attempted to maintain a modest latent nuclear capability (by directing occasional studies attempting to keep the DIORIT reactor running) until the late 1980s.

5.2.1 The Defence Policy-Making Context in Switzerland, 1939-1964

Before delving into the history of Switzerland’s nuclear weapon activities, two aspects of the federal policy-making process in Switzerland in the 1939-1964 period merit explanation.

The first is the LVK (Landesverteidigungs Kommission/National Defence Commission). Originally established in 1891, the LVK was composed of several high-ranking military officers

²⁷⁷ Jasper, 101-103.

and the minister of defence. The LVK's role was to directly offer the minister of defence (who also chaired the committee) direct access to professional advice on a broad range of aspects of Switzerland's military policy.²⁷⁸ After the Second World War, the LVK consisted of twelve people, eleven of which were from the armed forces, and the minister being the sole civilian. While the Federal Council (the Swiss cabinet) appointed the military members of the LVK, typically the LVK would propose nominees to the Council, who in turn typically accepted the LVK's advice.²⁷⁹

The LVK became particularly influential in defence policy making during the Second World War when the Swiss federal legislature granted the Federal Council emergency (or "full") powers in 1939.²⁸⁰ The Council's emergency powers authorized it to "enact all legislation necessary to protect Switzerland and its citizens," which allowed it to pass laws without the consent of the legislature.²⁸¹ The Council's emergency powers also allowed it to appropriate funds for the military's budget without the legislature's approval. These powers were renewed in 1941 and 1946, and expired in 1954.²⁸² It was during the Second World War and the first post-war decade - while the Federal Council still exercised full powers - when the military's role in policymaking grew substantially, including shaping the Swiss government's final defence doctrines and procurement policies in the years after the war.²⁸³ While the Council of course retained the ultimate decision-making power on these matters, the Swiss military had direct

²⁷⁸ Stefanie Frey, *Switzerland's Defence and Security Policy During the Cold War (1945-1973)* (Lenzburg, CH: Verlag Merker im Effingherof, 2002), 57-58.; Karl W. Haltiner and Tibor S. Tresch, "Democratic control of the Swiss militia in times of war and peace," in Hans Born, Marina Caparini, Karl W. Haltiner, and Jürgen Kuhlmann, eds., *Civil-Military Relations in Europe: Learning from crisis and institutional change* (London: Routledge, 2006): 191-201.

²⁷⁹ Haltiner and Tresch, 191-196.

²⁸⁰ Wolf Linder, *Swiss Democracy: Possible Solutions to Conflict in Multicultural Societies*, 2nd ed., (New York: Palgrave Macmillan, 1998), 121.

²⁸¹ Thomas Fleiner, "Swiss Confederation," in Akhtar Majeed, Ronald L. Watts and Douglas M. Brown, eds., *Distribution of Powers and Responsibilities in Federal Countries*, Vol. 2 (McGill-Queen's University Press, 2006): 271.

²⁸² Frey, 136-7.

²⁸³ Haltiner and Tresch, 195-198.

access to the minister of defence while the legislature was essentially excluded from defence policymaking.

This state of affairs only ended in 1964 as a consequence of the Mirage scandal. Members of the legislature accused the LVK of misleading the government about the potential cost of 100 Dassault Mirage III combat aircraft. Legislators were successful in reforming the LVK to include more civilian members, and to reaffirm the parliament's defence committee's right to access relevant information.²⁸⁴

5.3 Switzerland's Nuclear Weapon Activities Under the Federal Military Department

Switzerland's nuclear weapon activities began almost immediately after the bombings of Hiroshima and Nagasaki. In August 1945, Corps Commander Hans Frick contacted Switzerland's defence minister, Karl Kobelt, inquiring into the possibility of beginning research on protecting Swiss troops against nuclear weapons on the battlefield, and whether Switzerland would acquire its own nuclear weapons.²⁸⁵

In 1945, at the urging of the Swiss military, Switzerland established the Studienkommission für Atomenergie (Study Commission for Atomic Energy, or SKA).²⁸⁶ Its mandate included military research, including research into developing defensive measures against nuclear weapons, and potential weapon applications.²⁸⁷ While the SKA attempted to secure uranium from the United States, and Switzerland acquired a research reactor from the United States in 1953, the SKA's military activities do not appear to have yielded any

²⁸⁴ Ibid.

²⁸⁵ Christian Bühlmann, "Le développement de l'arme atomique en Suisse: Bref tour d'horizon," Working Paper (Université de Lausanne, 2007), 6.

²⁸⁶ Peter Hug, "La genèse de la technologie nucléaire en Suisse," *Relations Internationales* 68 (1991): 324-344.

²⁸⁷ Jurg Stüssi-Lauterburg, *Historical Outline on the Question of Swiss Nuclear Armament*, translated by U.S. Department of State (Bern: Federal Administration, 1995), 3-4; Federal Military Department (Switzerland), "Richtlinien für die Arbeiten der S.K.A. auf militärischen Gebiet," 5 February 1946, Dodis-335 (translated from German).

substantive results.²⁸⁸ By 1955, the Swiss military claimed that the proliferation of nuclear weapons meant that Swiss defence policy had to adapt to be ready to fight a nuclear-armed adversary. This entailed spending considerable sums on new arms, equipment, and nuclear bomb shelters, but this new defence policy did not call for Swiss nuclear weapons.²⁸⁹ Meanwhile, the Swiss Federal Council was considering creating a cabinet-level office that would oversee all Swiss civilian nuclear activity.²⁹⁰

The Federal Council ended up establishing the position of Delegate of the Federal Council for Atomic Matters. The Delegate was not a Federal Councillor but advised the Council while reporting directly to the Minister of the Department of Transport, Communications and Energy (EVED).²⁹¹ Dr. Urs Hochstrasser (the Delegate through most of the 1960s) was not only involved in debates with the Council and Swiss Federal Military Department about Switzerland's nuclear weapon policy, but also served as Switzerland's delegate to the IAEA from 1962 to 1970, and as the Chair of the Steering Committee for Nuclear Energy in the OECD's Nuclear Energy Agency from 1964 to 1966.²⁹²

The armed forces – via the LVK - soon became one of the loudest voices in favour of a Swiss nuclear weapon program. While in 1955 the Swiss military seemed more concerned with how to mount a defence against nuclear weapons, in 1956 the armed forces began to argue that Switzerland might need nuclear weapons. In August of that year, the Minister of Defence, Paul

²⁸⁸ For early efforts to acquire uranium from the United States, see Federal Political Department (Switzerland), "Abschrift: An die Direktion der Militärverwaltung des Eidgenössischen Militärdepartements," 29 May 1946, Dodis-1662 (translated from German).

²⁸⁹ Federal Military Department (Switzerland), "La défense nationale dans l'avenir," 23 September 1955, Dodis-10166.

²⁹⁰ Federal Political Department (Switzerland), "Nomination d'un Délégué du Conseil fédéral aux questions atomiques," 6 January 1956, Dodis-10978.

²⁹¹ L.J. Anthony, *Sources of Information on Atomic Energy* (London: Pergamon Press, 1966), 85.

²⁹² International Atomic Energy Agency, "Delegations," GC(VI)/INF/56/Rev. 2 (Vienna: IAEA, 1962); "Delegations," GC(VIII)/INF/75/Rev. 2 (Vienna: IAEA, 1964); "Delegations," GC(XIV)/INF/125/Rev. 2 (Vienna: IAEA, 1970); Organisation for Economic Co-operation and Development, "History of the OECD Nuclear Energy Agency," 2010, <<https://www.oecd-neo.org/general/history/work.html>>

Chaudet wrote to the Foreign Minister, Max Petitpierre about Switzerland's plans to enter into a nuclear cooperation deal with the United States. Chaudet relayed the military's hope that entering into civilian nuclear accords with other countries would not involve Switzerland closing off the option to use nuclear technology – including acquiring nuclear bombs – for military purposes. Chaudet claimed that the attitude in the armed forces was that nuclear weapons would give Switzerland an incontestable defensive advantage. The military also wanted to be consulted about the siting of any nuclear installations in Switzerland, so that nearby troops could plan for the potential release of radioactive materials in the event of an accident, but also for the possibility that the armed forces might acquire any fissile materials produced in Switzerland for use in bombs or as battlefield contaminants. The military's chief fear, though, was that the Foreign Ministry might foreclose on these options by signing an agreement with the US that would safeguard any spent fuel that the US supplied to Switzerland. The military believed that if Switzerland signed such a deal, other countries might insist on similar terms.²⁹³ Chaudet's letter emphasized the need to maximize future policy flexibility, rather than the need to immediately acquire a nuclear weapon. This policy stance was repeated in a memorandum from the military to the federal council later that year.²⁹⁴

Two years later, the Swiss armed forces argued to the Federal Council that Switzerland needed nuclear weapons. This conclusion rested on the key assumption that in the event of war, any nuclear-armed states will likely use its nuclear weapons.²⁹⁵ Without its own nuclear bombs, hostile states would be able to mass troops at Switzerland's borders, and soften Swiss defences with their own nuclear arms. The Swiss military argued that nuclear arms were a good fit for

²⁹³ Paul Chaudet, "Personnel – Monsieur Max Petitpierre," letter, 7 August 1956, Dodis-13275.

²⁹⁴ Federal Military Department (Switzerland), "Utilisation pacifique de l'énergie atomique," 20 October 1956, Dodis-13245.

²⁹⁵ Federal Military Department (Switzerland), "Rapport succinct du Département militaire fédéral au Conseil fédéral concernant l'acquisition d'armes atomiques pour notre armée, du 30.6.58," 6 June 1958, Dodis-16066.

Switzerland's deterrence policy, and that not acquiring them would leave Switzerland open to attack. In turn, in July 1958, the federal council gave the nuclear acquisition mission to the armed forces, with the order to "study the possibility of acquiring nuclear arms."²⁹⁶ The federal council's announcement shared much of the logic of the military's assessment: more states would probably acquire nuclear weapons in the near future, and the possibility that they would be used could not be ruled out.²⁹⁷

Soon after the Swiss government publicly announced it was exploring the nuclear option, Switzerland's ambassador to the USSR, Alfred Zehnder, reported to Bern that First Deputy Premier Anastas Mikoyan "violently" critiqued the announcement. Mikoyan told Zehnder that Swiss nuclear arms could only be aimed at the USSR, and that he suspected the Swiss had adopted this policy at the behest of the United States.²⁹⁸ Later that year, other Soviet officials again expressed their displeasure with Switzerland's nuclear weapons policy to the Swiss embassy in Moscow, however, there is little evidence that the Soviet government made any other efforts to discuss the issue with their Swiss counterparts.

By March 1960 the military had made little progress on the nuclear weapons file. In a letter to Foreign Minister and President of the Council Max Petitpierre, Chaudet explained that progress had been slow because the reorganization of the army had taken precedence. Chaudet argued that they needed to get a better sense of potential foreign and domestic reaction before proceeding with efforts to purchase nuclear weapons abroad.²⁹⁹ Despite the Soviet Union's unfavourable reaction to Bern's nuclear weapon announcement of July 1958, Chaudet claimed

²⁹⁶ Paul Chaudet, "Au Chef du Département politique fédéral – Acquisition d'armes nucléaires," letter, 21 March 1960, Dodis-16060.

²⁹⁷ "Déclaration relative à l'acquisition d'armes atomiques pour notre armée," 11 July 1958, Dodis-16065.

²⁹⁸ Alfred Zehnder, "L'Ambassadeur de Suisse à l'URSS au Max Petitpierre," letter, 7 July 1958, Dodis-14421.

²⁹⁹ Chaudet, 1960, Dodis-16060. The Swiss military preferred to either buy nuclear weapons from another state, or develop them jointly with another state, rather than producing them domestically because they believed this would be a faster and easier route. See Federal Military Department (Switzerland), 1958, Dodis-16066.

that procurement/acquisition plans remained unchanged. He then offered three policy options for acquiring nuclear weapons. The first was to approach the US, the UK, and the USSR (despite the aforementioned Soviet displeasure) and ask to purchase nuclear arms on a commercial basis. When each state would be approached, they would be informed that the Swiss had made the same inquiry to the other two. The second option involved making a similar commercial offer to France, along with an offer to help pay for the costs of additional French nuclear tests, in return for test data. The third option was to approach Sweden, and offer to financially contribute to Swedish research and/or production efforts. All three of these options were to be reconsidered in the event that an international nuclear weapons accord was concluded.³⁰⁰

5.3.1 Why Reorganize Switzerland's Armed Forces?

When defence minister Pierre Chaudet told President Petitpierre in 1960 that reorganizing the armed forces had taken precedence over the military's nuclear weapons mission, what precisely did he mean? Why could the military not handle both policies at the same time? While it is difficult to definitively answer the second question, understanding the magnitude of the shift in Swiss military policy between the Second World War and the early 1960s give us some insight into Chaudet's explanation for the slow progress in the military's nuclear weapon activities.

During the Second World War, the Swiss government adopted a defence doctrine known as the Redoubt. Under the Redoubt doctrine, if Switzerland were to be invaded by Germany and/or Italy, the Swiss army would retreat to the country's Alpine mountains, where they believed they would be able to fight a guerrilla war, resist the occupation, and deny Italy and Germany the mountain passes that connected the two countries. The Swiss armed forces would

³⁰⁰ Chaudet, 1960, Dodis-16060.

have to leave Switzerland's central plateau without any permanent defences for the duration of hostilities.

The Swiss government chose the Redoubt doctrine out of necessity. The Swiss armed forces did not have adequate mechanized forces to defend the easily traversed central plateau. Concentrating Switzerland's forces in the mountains would also remove a good deal of Germany's advantage in armour and mechanized forces should they have made any attempt to pry the Swiss from their defences.³⁰¹

By the late 1940s, the Swiss General Staff began to plan for a possible Soviet invasion, which they deemed the most likely threat to Switzerland's territory. A joint Italian-German invasion would have come from the south and north of the country, so an Alpine redoubt that could hold the major north-south passes had the potential to deny the aggressors the ability to traverse the country and use those passes to their advantage. If taking Switzerland's north-south passes would cost an enormous sum in men and materiel, then the incentives to invade for the Axis powers would be substantially weakened. On the other hand, Swiss planners thought that a Soviet invasion would come from the east or north-east (likely in the Schaffhausen region) and proceed westward, in an effort to turn NATO's flank in south-west Germany and eastern France. Given the advances in airpower and mechanized warfare that occurred in the Second World War, the Redoubt strategy appeared as if it might be useless against a Soviet invasion.³⁰²

This conclusion triggered a broader debate inside the Swiss armed forces about what sort of doctrine they should adopt. Positions ranged from plans for fairly static defences, to proposals for a fully mobile and active defence doctrine that envisioned mechanized Swiss forces spread out through the country, only concentrating themselves just before launching a major attack,

³⁰¹ Frey, 51-55.

³⁰² Frey, 92-98.

while being supported by a modern air force. In 1951 the government settled on a compromise doctrine that while relying on static defensive positions, allowed for the armed forces to engage in mobile warfare at the tactical level. This compromise held until 1955.³⁰³

By 1955, the Swiss General Staff had become increasingly concerned with tactical nuclear weapons and how they might be used against Switzerland's armed forces during wartime. Stephanie Frey claims that the 1951 military doctrine fared poorly in 1954's annual military exercise when tactical nuclear weapons were included in the scenario.³⁰⁴ So, in 1955, the LVK launched a thorough review of Switzerland's defence policy, which produced four studies that year, three of which endorsed mobile warfare as the best way for Switzerland to deal with the threat of tactical nuclear arms (the fourth argued in favour of a relatively static doctrine).³⁰⁵ Two years later, in 1957, the LVK settled on a proposal which called for a mobile doctrine. Finally, in 1961, after the Federal Council considered the issue, Switzerland adopted its 1961 defence doctrine, which with a few amendments, generally resembled the LVK's 1957 proposal.³⁰⁶

Thus, when Chaudet reported to Petitpierre in March 1960, he was doing so while Switzerland's armed forces were reimagining how they would fight the next war, how they would need to be organized to do so, and identifying the equipment they would need. Nuclear weapons certainly seemed to play a role in the future of Switzerland's military, but they were only one piece in a much bigger puzzle.

³⁰³ Frey, 104-111.

³⁰⁴ Frey, 111.

³⁰⁵ Frey, 112-115.

³⁰⁶ Frey, 116-117.

5.3.2 Stagnation and Debating Moving the Program

When the Swiss cabinet met in April 1960 to discuss the nuclear weapon issue, they decided to sit back and wait. Noting the fact that the military had made little progress on the file, Petitpierre asked his colleagues for advice, while also pointing out that talks were underway for both a limited test ban treaty, and a nuclear non-proliferation treaty. There was therefore some logic in not acting too hastily, and waiting to see how these efforts developed. Thus, the cabinet unanimously agreed to stick to the 1958 policy, and have the military keep investigating the nuclear option, but that any efforts to purchase nuclear arms from another country should only happen with cabinet approval.

This state of affairs continued for the next several years. The EMD continued to work on developing procurement plans (e.g. estimating the financial and human resources they would need to build nuclear weapons in Switzerland), including determining what new equipment the military would need in order to integrate nuclear weapons into its force structure. Probably the most notable requirement the EMD identified was for a new aircraft (which would end up being licenced variants of the French Dassault Mirage III) to carry Switzerland's nuclear bombs. At least one account of the program's history suggests that the EMD had assigned some scientists to conduct basic research on weapon physics, but the number of scientists and scale of this part of the EMD's activities is difficult to pinpoint.³⁰⁷

As noted earlier, the Swiss military began a thorough reorganization and procurement process in the 1950s. This effort was ongoing in 1961 when the Swiss parliament authorized the military to spend 870 million Swiss francs (CHF) to acquire 100 French Dassault Mirage III combat aircraft. Over the next several years, the costs of the Mirage project climbed by an

³⁰⁷ Stüssi-Lauterburg, 9-18.

additional CHF 350 million, while only 57 aircraft were actually delivered.³⁰⁸ One result was that the legislature launched an inquiry into the matter, and in the late summer of 1964 concluded that the military had withheld important details about the procurement plan (such as avionics upgrades and airframe modifications that were necessary for the Mirage to meet the military's specifications) from the legislature.³⁰⁹ The inquiry committee in turn successfully demanded a number of changes be made to the Swiss defence policy making process, including placing more civilians on the LVK, separating the research and acquisition of new arms, and enhancing parliamentary oversight of government contacts.³¹⁰

As the parliamentary inquiry did its work (and before they issued their conclusions and recommendations), the Federal Council, in June 1964, ordered the Federal Military Department to reduce its scientific research staff working on nuclear weapons to a single scientist.³¹¹ The military's response to the Council took nearly a year to draft and deliver. In a memo sent to the Council in June 1965, the EMD suggested three ways to reorganize the theoretical research component of their efforts. The first option would be to allow the military to form a working group that would hire scientists from Switzerland's universities on a contract basis. The second option would be to establish a specialized, more permanent research unit inside the armed forces. The third option was to create a group of experts recruited from various government departments, universities, and the private sector. The memo proposed that this group be housed in EVED (which was embarking on a nuclear reactor research and design program). If the

³⁰⁸ Fiona Lombardi, *The Swiss Airpower: Wherefrom? Whereto?* (vdf Hochschulverlag AG, 2007), 51, n. 81.

³⁰⁹ Frey, 134-135.

³¹⁰ Stüssi-Lauterburg, 11.

³¹¹ Stüssi-Lauterburg, 12.

Council did not accept any of these proposals, then “it seems logical and consistent to eliminate the weapons portion of the research right off the bat.”³¹²

At least one physicist in the military’s research Technology Department wrote a memorandum endorsing the idea that the nuclear weapon project be housed in EVED. Walter Heilpern argued that mastering the science and technology (e.g. fissile material production and ignition mechanisms) of nuclear weapons was necessary simply to give Switzerland the option of building nuclear arms should the military need arise. However, he continued, “in the field of fissile material enrichment and production, the most important contributions will be made by specialists and institutes specializing in reactor construction (EIR [Federal Institute for Reactor Research], Würenlingen [a private firm that operated a research reactor and was taken over by the government in 1962], Reaktor Lucens etc.”³¹³ In at least Heilpern’s opinion, Switzerland’s nuclear weapon efforts would be better served by moving at least some of the work into EVED’s institutes.³¹⁴

It does not appear that concerns about parliamentary oversight motivated the Federal Council to tell the military to reduce the number of personnel doing direct weapon research (as opposed to force planning and researching ways to procure nuclear arms), though concerns about what the parliamentary inquiry might conclude were probably on the mind of at least defence minister Chaudet. Regardless of why the Council ordered the military to reduce its activities, the EMD did not appear to fight the decision, and there is no clear evidence of the military attempting to promote a bigger role for itself via the LVK. Instead, the EMD offered the Council several options which would allow Switzerland to continue its nuclear weapon activities. At least

³¹² Stüssi-Lauterburg, 15.

³¹³ Stüssi-Lauterburg, 18; Anthony, 85.

³¹⁴ As of 1966 the EIR was under the administrative control of the Delegate for Atomic Energy, Dr. Urs Hochstrasser, who was ultimately responsible to EVED. See Anthony, 84.

one of the options the EMD offered the Council would remove Switzerland's nuclear weapon activities from the responsibility of the military, and the EMD went so far as to suggest terminating the program if none of the three options were acceptable to the Council. Rather than actively promote the idea of Switzerland acquiring nuclear weapons, as the military did in the late 1940s and early 1950s, by the mid-1960s, when confronted with orders to reduce their activities, the EMD suggested transferring the program to another department or cancelling it.

While Switzerland's nuclear weapon activities stalled, the Treaty on the Non-proliferation of Nuclear Weapons began to take shape. In late 1965 the Federal Council considered the nuclear issue again. Defence minister Chaudet asked his colleagues if the Swiss military should continue its nuclear weapon activities, and for their position on the evolving non-proliferation treaty. The cabinet's enthusiasm for nuclear weapons had waned at this point, but not sufficiently to terminate the country's nuclear program. However, the Council decided to accept the third option in the EMD's June 1965 paper: developing a nuclear weapon working group recruited from government, academia, and the private sector, and housed in EVED.³¹⁵ (The next week, Chaudet gave the EMD orders to develop a plan that would detail the composition and responsibilities of the new working group.³¹⁶) The Council also debated whether Switzerland should sign a future non-proliferation treaty, and concluded that without a draft treaty to examine, Switzerland should not pre-commit to joining.³¹⁷

While the cabinet had certainly softened on the nuclear issue, they kept the door open to acquire nuclear weapons. This hedging policy continued through 1967, when in response to a question from a Swiss parliamentarian, the cabinet replied that Switzerland would only sign a

³¹⁵ Federal Council (Switzerland), "Séance extraordinaire du 26 octobre 1965, à 15 heures, maison de Watteville: notes de séance," 26 October 1965, Dodis 32007.

³¹⁶ Stüssi-Lauterburg, 22-23.

³¹⁷ Federal Council (Switzerland), 26 October 1965, Dodis 32007.

non-proliferation treaty if its membership was universal, and if it only had a limited duration. If Switzerland signed treaty of unlimited duration that had few other signatories, it would be leaving itself open to intimidation and blackmail.³¹⁸ Meanwhile, the military continued to develop plans to build or acquire nuclear weapons, and estimated that on a budget of 175 million francs per year, they could produce 400 warheads within 15 years.³¹⁹ This planning activity occurred alongside the EMD's efforts to negotiate the size, composition, and mandate of the proposed EVED-housed nuclear working group.

5.3.3 The AAA and the End of Switzerland's Weapon Activities

Despite the military's ongoing activities, Switzerland signed the NPT in 1969 (but did not ratify it until 1977). However, Switzerland did not entirely abandon its nuclear weapon activities. In April of that same year, the Federal Council settled on the structure of the working group which the EMD had first proposed in June 1965. What the EMD originally had proposed as an office of the EVED became an interdepartmental committee called the Working Committee for Nuclear Issues (AAA). The federal military convened the AAA, but the board included members of the Federal Department of the Interior, the foreign ministry, and the Federal Department of Transportation and Energy. Until 1976 the AAA also had a small cadre of scientists – recruited on a part-time basis from industry and academic institutions – to provide technical advice.³²⁰ However, there were no personnel permanently assigned to the AAA. Instead, employees of the aforementioned departments met on a regular basis to identify work that their respective departments could perform to support the AAA's mandate, which was to maintain and develop the technical infrastructure necessary to give Switzerland a small breakout capacity. Two

³¹⁸ Nicolas Michel, *La Prolifération Nucléaire: La Régime International de Non-prolifération des Armes Nucléaires et la Suisse* (Fribourg, CH: Éditions Universitaires Fribourg Suisse, 1990), 53-54.

³¹⁹ Stüssi-Lauterburg, 44-45.

³²⁰ Stüssi-Lauterburg, 49, 76, 91.

illustrative examples are research in the early 1970s on estimating the critical mass and modelling of spherical bomb cores, and an effort to identify means to finance the continued operation of the DIORIT research reactor at EIR Würenlingen (which could provide a crash attempt to build a nuclear weapon with plutonium).³²¹ The AAA was essentially a preparatory measure in case the NPT and its associated regime failed.

After Switzerland ratified the NPT in 1977 the AAA continued its work, arguing that it was prudent for Switzerland to take all steps allowed by the NPT that are necessary to make it a nuclear “emerging power.”³²² As part of this “emerging power” policy, Switzerland held a stockpile of 5.5 tons of raw uranium and uranium oxide (UO₃) in secret until 1981, when it was placed under IAEA safeguards, four years after ratifying the NPT.³²³ The AAA continued its work sporadically until 1988 when it was finally shut down, officially ending Switzerland’s nuclear weapon activities.

From 1958 to 1969, the Swiss nuclear weapon program was contained within and run by the federal military. After 1969, it was essentially reduced to an inter-departmental committee, albeit one with a large military presence. However, claiming that Switzerland conducted nuclear weapon activities after 1969 is fully justified. Here is why: the AAA was a logical extension of Swiss nuclear weapons policy from 1958 to 1969. This period was the most active phase of Swiss nuclear weapon activity, but even then, Switzerland’s policy was largely hedging against the possibility that nuclear weapons would further spread around the globe and that they would be used as a matter of course during war time. As noted earlier, in communiques between the military and the foreign ministry, the armed forces emphasized the need to ensure that as Switzerland signed peaceful nuclear cooperation agreements with foreign governments that all

³²¹ Stüssi-Lauterburg, 58, 63-64.

³²² Stüssi-Lauterburg, 69.

³²³ Stüssi-Lauterburg, 71-73.

measures be taken to ensure Switzerland was not closing off military options for the future. The Swiss program was a serious effort in as much as it was intended to give Switzerland the tools to acquire nuclear arms if certain international conditions prevailed. That meant that it was a conditional policy that prepared for a worst-case scenario where nuclear weapons continued to spread horizontally at the approximate rate seen in the 1950s and 1960s (that is, a new nuclear weapon state every 3 to 5 years). The defence ministry's policy was also clear on another point: if an international nuclear weapons regime was created, this would be reason to revisit Switzerland's nuclear weapons policy.

The post-1969 AAA policy was a logical continuation of Switzerland's pre-NPT policy. If the regime should be stillborn, or were it to suddenly collapse (due to a loss of confidence caused by a nuclear breakout, for example), Switzerland would have at least have primed the pump. It would not be bereft of nuclear knowledge, and in theory, would have a basic scientific and technical foundation from which to launch a weapon program. Thus it was only in the late 1980s that all of Switzerland's nuclear weapon activity was finally by the Federal Council in 1988, when it terminated the AAA's mandate.³²⁴ At least one author explained this decision as a function of the Swiss government being satisfied that the NPT looked as if it would hold, and more importantly, that West Germany would not make any attempt to nuclearize.³²⁵ Another Swiss researcher cites the minutes from what may have been the last meeting of the AAA (in October 1988) which stated "undoubtedly, there has been a change in the foreign policy of the USSR."³²⁶

Organizational incentives helped shape this outcome. When the Swiss cabinet gave the nuclear weapon mission to the Swiss armed forces in 1958, the armed forces did not prioritize

³²⁴ Stüssi-Lauterburg, 88.

³²⁵ Bühlmann, 16-17.

³²⁶ Stüssi-Lauterburg, 88.

building or acquiring nuclear arms. While the military appeared to be enthusiastic about acquiring nuclear arms, when it came to committing its human and financial resources, the Swiss military prioritized implementing a new defence doctrine and was busy reorganizing itself. This pushed the task of identifying ways for Switzerland to acquire nuclear weapons down the priority list. After all, while the Swiss armed forces certainly thought that nuclear weapons may have been useful in certain scenarios, they did not see any immediate threats that needed to be countered with atomic arms. Additionally, through the early 1960s, the Swiss military was relatively well resourced, with Switzerland spending between 2.7% and 2.5% of GDP on the armed forces. This compares to Finland (which one would expect to have large military expenditures because of its border and history with the USSR) at 2.37%, Sweden (also near the USSR) at 4.11% and Denmark and Norway (both NATO members) at 2.26% and 3.53% respectively.³²⁷ Thus, if we assume that government organizations lobby and push for the nuclear weapons option in order to acquire more financial resources, it is difficult to argue that the Swiss military was starved for funding, and thus must have seen the nuclear option as a way to fill their coffers. At least compared to other small European states, Switzerland's defence establishment does not appear to have been underfunded at the time. The Swiss armed forces also had other expensive priorities: the aforementioned reorganization of the armed forces, which involved developing not only a new defence doctrine, but also acquiring the conventional arms it needed to put that doctrine into action. The point, however, is that far from being under-resourced, it appears that the Swiss military was well funded from the late 1950s through the mid-1960s. Any proposals to terminate Switzerland's nuclear weapon activities simply would not pose a

³²⁷ Hanspeter Kriesi, "Military Service and Social change in Switzerland," *Armed Forces & Society* 2.2 (1976): 218-226; James C. Murdoch and Todd Sandler, "The Political Economy of Scandinavian Neutrality," *Scandinavian Journal of Economics* 88.4 (1986): 583-603.

significant threat to the Swiss military's funding and core operations. Its principal mission after all was national defence, and not nuclear bomb making.

Once Switzerland's nuclear weapon activities were transferred to the AAA, the organizational environment became even more amenable to nuclear abandonment. Since the AAA was largely an interdepartmental committee, there were few (if any) jobs, funding, or prestige attached to its existence. It was not a dedicated nuclear weapons organization, but instead a small organ of the federal government that coordinated nuclear-related activities among several departments. After 1977 the AAA's scientific advisory committee was disbanded, effectively reducing the AAA to an occasional planning exercise.

These organizational factors also interacted with the way that Swiss policymakers forecast their future security environment. Time and again the Swiss armed forces stressed their concern that nuclear weapons would become more - rather than less - common. The Swiss government expected that the spread of nuclear weapons would be accompanied by their use. As this did not happen, Swiss policymakers updated their perceptions. They found themselves in a world of only a few nuclear weapon states, and one where nuclear weapons may have been brandished as threats, but were never used save for once. At the same time that nuclear weapons were not spreading at a rapid pace, a nascent non-proliferation regime was coming into being. While states such as Iran, Iraq, Libya, North Korea and Romania have ratified the NPT and then proceeded to conduct illegal nuclear weapon activities (in non-compliance with the treaty), generally becoming a party to the treaty should be a credible legal signal of one's intent to not build nuclear weapons. The treaty requires also safeguards, including inspections, which increase the risk of being caught cheating (though safeguards and inspections were rudimentary in the 1960s). With the spread of nuclear weapons slowing, and the creation of a treaty that was quickly

signed and then ratified by a large number of states, Swiss policymakers found the worst-case scenario they had envisioned was not coming into being. Of course they did not wholly trust the NPT, or at least not at first. Switzerland, after all, took eight years to ratify the treaty after signing it. This gap is consistent with their pre-NPT policy, which was to keep the door to nuclear weapons open, and to wait-and-see if the changing international context worsened.

Does the organizational imperative hypothesis of nuclear abandonment fit the Swiss case better than competing theories of nuclear abandonment? In one sense, no, since the hypothesis of organizational imperatives claims that organizational politics can affect the likelihood that a state abandons its nuclear weapon activities, but it posits that how a state's nuclear weapon activities are organized either pose a barrier to abandonment, or create conditions that make abandonment more likely. Which organization conducts a state's nuclear weapon activities does not constitute a proximate trigger for the decision to abandon activities. The hypothesis that abandonment is more common when a non-specialized organization conducts a state's nuclear weapon activities is therefore fully compatible with Paul's theory that states abandon nuclear weapon activities for fear of a security dilemma, or Solingen's theory that leaders that rely on liberalizing coalitions forego nuclear arms. That being said, the evidence presented in this case study does not strongly support the predominant claim that the Swiss government ultimately terminated its nuclear weapon activities because they feared this would lead others to target them with nuclear weapons. Recall that the principle motive for the Swiss nuclear weapon program in the 1950s was a fear of a more nuclearized future: specifically, the possibility that nuclear weapons would spread and be used like conventional arms. This concern persisted well into the 1960s, even after the Cuban Missile Crisis highlighted the possibility that using nuclear weapons could result in uncontrolled escalation of a crisis potentially leading to mass destruction. The 1966 military

doctrine that the Federal Council presented to the Swiss parliament specifically noted that the very existence of nuclear arms meant that limited-scale conventional conflicts could become full-fledged “general” nuclear wars.³²⁸ The 1966 doctrine also suggested that if a nuclear-armed adversary wanted to wipe out Switzerland’s armed forces in a pre-emptive strike, there was little the country could do.³²⁹ Some Swiss defence analysts seemed to have come to the same conclusion a few years earlier, arguing that simply because Switzerland did not have nuclear weapons did not mean that a nuclear-armed adversary would hesitate to use nuclear arms against Switzerland. However, like the government, analysts concluded that nuclear blackmail was more likely than one-sided use.³³⁰

Thus, the government’s 1966 doctrine left the door open for acquiring nuclear weapons, arguing that so long as nuclear weapons existed and could be used, the Swiss government had an obligation to carefully study the benefits and disadvantages of acquiring them, not only for deterrence purposes, but also for use on the battlefield. Unilaterally renouncing them, argued the doctrine, would mean Switzerland was abandoning its freedom of action.³³¹

Since a specific conventional or nuclear threat did not materialize, the incentive to keep investing in a nuclear weapon capability faded over time. In other words, Switzerland had few (if any) good reasons to acquire nuclear arms. Without a motive to build nuclear weapons, any reason for abandoning nuclear weapon activities will be more potent.

³²⁸ Federal Assembly (Switzerland), “Rapport du Conseil fédéral à l’Assemblée fédérale concernant la conception de la défense nationale militaire,” *Feuille Fédérale* 1.24 (1966): 877.

³²⁹ *Ibid.*, 878.

³³⁰ Société d’études militaires, “La Suisse et son équipement en armes atomiques,” *Evolution de l’armée suisse* 11 (1962): 1156.

³³¹ Federal Assembly (Switzerland), 892. The 1966 doctrine also claimed that Swiss nuclear weapon policy needed to determine if there was a horizontal proliferation threshold - that if breached - would be grounds for acquiring nuclear weapons. (“Il s’agirait en outre de déterminer le degré de dissémination des armes nucléaires qui pourrait forcer notre pays à en acquérir.”)

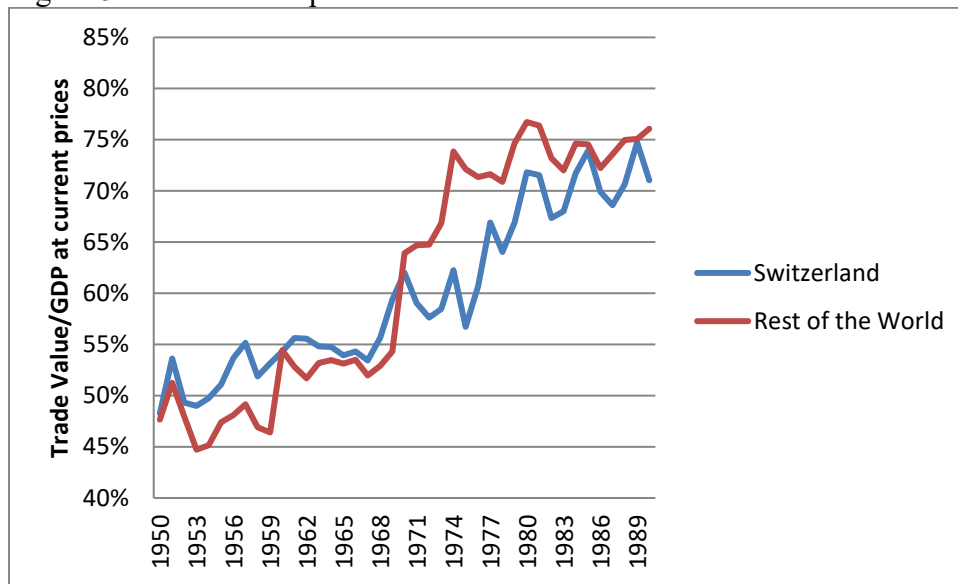
Other hypotheses on nuclear abandonment do not explain Swiss nuclear weapon policy all that well. While the USSR levied some vague threats after Switzerland announced its nuclear policy, these threats did not appear to weigh too heavily in cabinet deliberations.³³²

Second, Switzerland is a democracy, and a good portion of its nuclear weapon activity happened after the NPT was created in 1968. According to Müller and Schmidt, this means that Switzerland should have been particularly sensitive to anti-nuclear norms. The correlation is there (Switzerland was a democracy and had ratified the NPT when it finally terminated all its nuclear weapon activities), but the correlation is crude, and the final decision to terminate all activities came approximately a decade after Bern ratified the treaty. While Switzerland was not aggressively pursuing a nuclear weapon for this decade, the notion that it finally stopped all nuclear weapon activities because of normative pressure is unsatisfying. If an anti-nuclear norm was at work, why did not all nuclear activity end when Switzerland signed or later ratified the NPT? The Swiss case is not completely incompatible with the democracy/norm hypothesis, but it does not strongly support it either.

The Swiss case is also only somewhat consistent with the liberalizing elite hypothesis. Switzerland was a relatively closed economy, compared to the rest of the world, after 1968. Before 1968, Switzerland traded with the rest of the world somewhat more than the global average. By 1968 (the year the NPT was created), Switzerland's trade-to-GDP ratio was lower than the global average (see Figure 5.1).

³³² Swiss ministers did mention Soviet concerns about Switzerland's nuclear policy from time to time, but Moscow's stance did not seem to unduly influence cabinet deliberations. See Federal Council (Switzerland), "Procès-verbal interne de la 24e séance du 5 avril 1960," 5 April 1960, Dodis-16077, 3.

Figure 5.1 Economic Openness: Switzerland and the Rest of the World



Data drawn from Penn World Tables 7.1.

On the other hand, the Swiss banking sector relied heavily on foreign customers throughout the 20th century, with the aim of becoming a global financial centre that could compete with New York or London.³³³ Overall, whether Switzerland was an open economy that was particularly sensitive to threats of sanctions or being denied access to global capital markets from 1946 to 1988 is an open question. Furthermore, concerns about economic reprisals do not appear in the archival record. Whether Switzerland's ruling elite would even need a nuclear weapons program to gain the support of inward looking elites and atavistic industrialists is unclear. While Switzerland had to import all of its heavy weapon platforms (i.e. aircraft and heavy armoured vehicles) from the UK between 1945 and 1958, Switzerland otherwise had a growing and moderately large defence industry (particularly given the size of the country).³³⁴ Oerlikon had been exporting anti-aircraft guns since at least the 1930s, and by 1968, a Swiss state-owned firm

³³³ Sébastien Guex, "The Origins of the Swiss Banking Secrecy Law and Its Repercussions for Swiss Federal Policy," *The Business History Review* 74.2 (2000): 237-266.

³³⁴ Marco Wyss, "Neutrality in the Early Cold War: Swiss Arms Imports and Neutrality," *Cold War History* 12.1 (2012): 25-49.

was building the Swiss army's main battle tanks.³³⁵ From 1960 to 1988, Switzerland exported an average of \$304 million USD worth of arms and ammunition to the rest of the world.³³⁶ In short, Switzerland had a thriving arms industry. If Switzerland's nuclear weapon activities were an effort to shore up political support for the federal government among Swiss industrialists and the armed forces, there were plenty of simpler options (such as increasing conventional arms expenditures) that could have been pursued.

That being said, this study's organizational imperative hypothesis does shed some new light on why Switzerland never built a nuclear weapon. First, recall that the standard formulation of the relationship between organizational incentives and nuclear weapons is that a nuclear weapon program is a way for government organizations to promote their own interests. Building nuclear weapons means that a state needs to build a nuclear infrastructure, and delivering nuclear weapons means that the armed forces needs aircraft, missiles, or submarines. A nuclear weapon program should be a professional boon to any organization charged with running it, and lead to budget windfalls for armed forces. In Switzerland, organizational imperatives did not push the country towards building a nuclear weapon. Instead, organizational prerogatives slowed down Switzerland's nuclear weapon activities. The Swiss military had other priorities that it placed ahead of its nuclear weapon activities, causing the nuclear program to stagnate. That stagnation allowed Switzerland's nuclear policy to become irrelevant. While the nuclear program was not progressing, nuclear weapons were spreading slowly throughout the rest of the world. The Swiss military's concern that nuclear weapons would become standard fare in armed combat also failed to materialize. This state of affairs further de-prioritized acquiring nuclear weapons.

³³⁵ Kenneth P. Werrell, *Charlie, Flak, AAA, and SAM: A Short Operational History of Ground-Based Air Defense* (Maxwell AFB: AL, 1988), 51; Hervé de Weck, "Troupes mécanisées et légères," *Dictionnaire Historique du la Suisse* (2012): <http://www.hls-dhs-dss.ch/textes/f/F24633.php>

³³⁶ Statistic derived from Stockholm International Peace Research Institute, *SIPRI Arms Transfers Database*, 2016. Value is in 1990 USD.

5.4 South Africa

Organizational imperatives also played a role when South Africa abandoned its nuclear weapons program. At first glance, South Africa does not appear to be an ideal case to assess the hypothesis that organizational imperatives can help cause nuclear abandonment. After all, South Africa is the only state to have indigenously built, and then abandoned, a nuclear arsenal. South Africa is thus different from the vast majority of states that have terminated their nuclear weapon activities in the fact that South Africa had a full-fledged nuclear bomb production program when the government reversed its nuclear weapon policies. If we subscribe to the conventional wisdom about organizational behaviour in governments that is sketched out in chapter three (that government organizations over-produce goods and services since they generally seek to maximize their budgets), then in South Africa organizational imperatives should have been a major impediment to terminating South Africa's nuclear weapon activities. As one account of the South African nuclear weapons program puts it, "Armcor [the organization in charge of the nuclear weapon program in the 1980s] transformed the South African program from a fledgling exploratory effort into a full-scale weaponization and production effort."³³⁷ On the other hand, Liberman's account of the development and dissolution of the South African nuclear weapon program suggests that organizational preferences can help explain why South Africa built nuclear bombs, but do a poor job of explaining why South Africa abandoned its nuclear weapons.³³⁸ Perhaps the important question about organizational politics and the demise of the South African nuclear weapon program is why does the standard organizational behaviour hypothesis fit with the South African case so poorly?

³³⁷ Roy E. Horton, *Out of (South) Africa: Pretoria's Nuclear Weapons Experience* (USAF Academy, CO: USAF Institute for National Security Studies, 2000), 25.

³³⁸ Liberman (2001), 82.

This brief case study will show that the way that South Africa's nuclear weapons program was organized in the 1980s actually made the program a good candidate for termination. It also offers a slightly different explanation for how organizational imperatives can directly lead to abandonment. While in Switzerland the Swiss armed forces simply appeared to deprioritize their nuclear weapon activities in favour of achieving other goals, in South Africa, it appears that nuclear weapons simply played no obviously useful role in Armscor's business portfolio. Both organizations deprioritized their nuclear weapon activities in favour of other tasks. While in Switzerland, the armed forces were in charge of the country's effort to acquire nuclear weapons, the South African nuclear weapons program was first under the auspices of the country's publicly-owned nuclear science laboratories, and then, in the late 1970s, transferred to Armscor, a state-owned arms conglomerate. In the case of Switzerland's nuclear weapon activities, the push to acquire nuclear weapons lost momentum due to the armed forces' other priorities taking precedence. In South Africa, the dynamic was different, but still comparable. It was Armscor, after all, that successfully turned the South African Atomic Energy Commission's crude nuclear explosive into a full-fledged deployable nuclear bomb. Thus, by that feat alone, the South African nuclear weapons program was far more successful than the Swiss program. However, Armscor, while competent and motivated to execute the nuclear weapon file ultimately had little riding on the program's success. As the following analysis will show, Armscor was a sprawling, sophisticated enterprise. Building nuclear weapons had little to do with Armscor's *raison d'être*, and thus, when the South African government decided to terminate its nuclear weapons activities, Armscor had little to lose by acquiescing. By making Armscor responsible for South Africa's nuclear arms project, Pretoria's policymakers may have inadvertently created

a situation where the nuclear weapons program lacked a strong, institutional champion to lobby to keep the program alive.

This case study draws heavily from the secondary scholarly literature, and when possible, uses accounts written by individuals who worked in the South African bomb program. It also draws upon a small number of archival documents. However, the South African nuclear weapons program was a secretive affair, and when the program was cancelled, as a matter of policy the South African government deliberately destroyed the vast majority of the program's records.³³⁹ So while the Swiss archives offer a relative wealth of original documents to analyze, the written history of South Africa's nuclear weapon program has been largely lost, and may never be recoverable.³⁴⁰ This makes analyzing South Africa's nuclear weapons program a challenging task. This short case study therefore aims to sketch the contours of the South African nuclear weapon program, and place it in the larger context of the South African defence industry, where the program ultimately met its fate.

The rest of this case study will proceed as follows: first, it will offer a brief description of the history of South Africa's nuclear science activities and how South Africa's peaceful nuclear explosive, and then, nuclear bomb project came into being. This is followed by a description of Armscor – the state-owned arms firm – that took over the nuclear weapon project in 1979. Finally, the case will conclude with an assessment of how Armscor operated the project, and how Armscor's organization and corporate goals helped create the conditions for F.W. de Klerk's decision to terminate the South African nuclear bomb program in the late 1980s and early 1990s.

³³⁹ L.J. van der Westhuizen and J.H. Le Roux, *Armscor: A Will to Win* (Bloemfontein, South Africa: University of the Free State, 1997), 184.

³⁴⁰ André Buys describes the document destruction process in Gould, 119.

5.4.1 A Brief History of South Africa's Nuclear Explosives and Weapon Activities

The first dedicated program to design nuclear explosives in South Africa began in the early 1970s. South Africa's Atomic Energy Board (AEB; later renamed the Atomic Energy Corporation of South Africa, Ltd. (AEC)) began a peaceful nuclear explosive (PNE) research and design program in 1971. The PNE program was housed in the AEB's pre-existing Reactor Development (RD) division. From approximately 1960 to 1969, the RD worked on the PELINDUNA (**P**elindaba **D**euterium **U**ranium **S**odium (**Na**)) - also known as Safari-2) reactor concept.³⁴¹ PELINDUNA was a molten salt cooled design that produced a large amount of thermal power (per unit of fuel), which meant that the smallest effective reactor of the type would be around 1,000 MWe, which engineers estimated was far too large for the South African power grid in the foreseeable future.³⁴² South Africa's helicon enrichment technology had also matured by the late 1960s, making natural uranium fueled reactors less important, and thus the PELINDUNA project was abandoned.

Sometime in the late 1960s – while the AEB's uranium enrichment efforts were slowly succeeding – the AEB began studying the feasibility of using nuclear explosives in the mining industry. This initial foray into PNE research was limited to studies of the existing literature on the subject.³⁴³ While the initial findings were positive, it was not until the uranium enrichment project looked like it would be successful (and could therefore provide a PNE program with fissile material), that the Minister of Mines approved, in 1971, an AEB work group to study the possibility of building nuclear explosives in South Africa.³⁴⁴ The AEB reorganized the RD for

³⁴¹ J.D.L. Moore, *South Africa and Nuclear Proliferation* (London: Macmillan, 1987), 83.

³⁴² Central Intelligence Agency, "South Africa's Turn to Heavy Water Technology: History and Implications," 9 April 1984, 3.

³⁴³ Waldo Stumpf, "South Africa's Nuclear Weapons Program: From Deterrence to Dismantlement," *Arms Control Today* 25.10 (1995-6): 4.

³⁴⁴ *Ibid.*

this purpose.³⁴⁵ By 1974, the AEB concluded that building nuclear explosives was feasible, and the government subsequently authorized a program to design and build nuclear explosives.³⁴⁶ The RD consisted of nine groups. Some of these were highly specialized. For example, the Reactor Engineering Group was responsible for the design, manufacture, and assembly of nuclear explosives, and the Theoretical Reactor Physics Group was charged with writing computer software to aid in nuclear explosive design. Other groups had more generic tasks. The Electronic Engineering Group concentrated solely on design, manufacture, and procurement of any electronic equipment the rest of the division needed, while the Physical Metallurgy Group manufactured the project's metallic components.³⁴⁷ It appears that many of the RD's tasks probably used basic engineering and manufacturing skills that the program's employees had already acquired working on other projects, and there does not appear to have been any effort to train or recruit large numbers of individuals specifically for the PNE project.

When Prime Minister P.W. Botha formally decided that South Africa should have nuclear weapons in 1978, the government quickly established a tripartite management board that involved the AEB, Armscor, and the South African Defence Force (SADF).³⁴⁸ The board's job was largely policy formulation and planning. It was quickly supplemented by a second body modeled on the typical South African arms procurement process. This included a project officer who represented the end user (the South African Air Force), a program manager who represented the procurement body (the procurement half of Armscor) and a project manager from the subcontractor (the AEC).³⁴⁹ It was at this point that it appears the government decided to hand

³⁴⁵ André J. Buys, *Proliferation Risk Assessment of Former Nuclear Explosives/Weapons Program Personnel: The South African Case Study* (Pretoria: University of Pretoria, 2007), 8.

³⁴⁶ Stumpf, 4.

³⁴⁷ Buys, 9.

³⁴⁸ Van der Walt et al., 42.

³⁴⁹ Van der Walt et al., 73.

over the entirety of the weapons program (less fissile material production and a few other tasks) to Armscor. As three former employees of Armscor, the AEC, and the SADF describe it, the AEC's civilian nature simply made it a poor choice to turn an ostensibly peaceful project into one with clear military aims. The AEC's nuclear explosive had to be turned into a robust, safe, and reliable weapon that in turn could be mated to an array of existing delivery systems.³⁵⁰ The AEC did not have this expertise, but Armscor obviously did.

In 1979, following the government's adoption of the "demonstrate/deter" nuclear policy, the AEB assembled a nuclear explosive. André Buys, who worked in the bomb program from 1981 until 1987 describes the AEB explosive as "a 'rapid-deployment' nuclear explosive for an underground capability-demonstration test."³⁵¹ (Presumably this would be used in phase three of P.W. Botha's nuclear doctrine.) South African officials did not, however, consider it to be a weapon that could be delivered and used during military operations.

In that same year the South African government gave Armscor, the state-owned armaments enterprise, responsibility for turning what the AEC had accomplished into safe, secure, deliverable weapons. Armscor took over all responsibility for the design, manufacture, and assembly of deliverable nuclear weapons. These weapons would be designed to be delivered by a H2/Raptor glide bomb or ballistic missile.³⁵² The AEC continued to be involved in the nuclear weapon program as a subcontractor: it supplied Armscor with fissile material, provided environmental and health monitoring, and continued theoretical work on future designs, including work on producing lithium-6, tritium, plutonium, and implosion designs.³⁵³

³⁵⁰ Van der Walt et al., 73-74.

³⁵¹ Buys, 7.

³⁵² Both Buys and Liberman (2001) describe the glide bomb delivery system, and General Magnus Malan describes a mobile ballistic missile system, see Hilton Hamann, *Days of the Generals* (Cape Town: Zebra Press, 2001), 164.

³⁵³ Buys, 7; G. Dillon and D. Perricos, "Verification of Completeness and Correctness of Inventory: Experience Gained in the Verification of the Completeness of the Inventory of South Africa's Nuclear Installations and

In 1982, Armscor assembled its first deliverable nuclear weapon. This prototype was designed to be safe, secure, and robust, and could be “kicked out the back of a plane.”³⁵⁴ It was not until 1988 that Armscor completed its first production model bomb (the front element of the weapon was built in 1987, but the rear element of the device was not completed until 1988). Overall, South Africa built seven nuclear explosives: the AEB/C built one, and Armscor six. The last weapon was completed in March 1989.³⁵⁵

Given the small number of deployable weapons Armscor produced, it is unsurprising that the program remained rather small. In 1980, one year after Armscor took over the nuclear weapons project, Armscor built the Kentron Circle facility to house the program. Kentron Circle (KC) was itself physically located inside the Gerotek vehicle test range.³⁵⁶ The KC personnel were a combination of RD personnel (most RD personnel were redeployed to civilian reactor projects in the AEC) and Armscor personnel drawn from other divisions. According to one manager at KC, in the early 1980s, approximately 70 people worked for Kentron.³⁵⁷ By the time the nuclear weapon program ended in 1989-90, between 230 and 300 people were involved, and around half of those were directly involved in developing, designing, and building the bombs.³⁵⁸ This represented around 1% of Armscor’s workforce in 1989.³⁵⁹

Armscor also seems to have made an effort to minimize the quantity of resources that were exclusively dedicated to the nuclear weapons program. For example, Kentron (Armscor’s aerospace and missile subsidiary) had a facility near Pretoria for developing, manufacturing, and integrating inertial guidance systems, originally for South Africa’s space launch vehicle and

Material,” in *International Nuclear Safeguards 1994: Vision for the Future*, Vol. 1 (Vienna: International Atomic Energy Agency, 1994): 238-9.

³⁵⁴ Hamann, 167.

³⁵⁵ Gould, 106.

³⁵⁶ David Albright, “South Africa and the Affordable Bomb,” *The Bulletin of the Atomic Scientists* 50.4 (1994): 43.

³⁵⁷ Buys, 8.

³⁵⁸ Buys, 8; van der Westhuizen and Le Roux, 178.

³⁵⁹ Buys, 10.

satellite program. This facility was also useful for developing the guidance systems for missiles, bombs, and aircraft that would be used in any effort to deploy or use the nuclear bombs produced at KC.³⁶⁰ Likewise, the Overberg Test Range, which began construction in 1984 (during the midst of Armscor's nuclear years), was intended to replace the St. Lucia range.³⁶¹ While Overberg could have eventually been the test site for a nuclear-capable ballistic missile, Armscor also indicated in the late 1980s that they had long-term plans to develop conventionally-armed ballistic missiles to replace the SADF's aging tactical bomber fleet.³⁶² Whether the July 1989 test of a three-stage rocket test at Overberg was for a future nuclear-tipped missile or a space launch vehicle is still unclear, since South Africa also demonstrated a considerable interest in expanding its space program and developing its own reconnaissance satellites in the 1980s.³⁶³ Even resources within Kentron Circle were reused: the highly enriched uranium from Armscor's 1982 pre-production weapon (named HOBOT/CABOT) was removed from HOBOT and reused in 1988-89 when it was installed in weapon 503.³⁶⁴

5.4.2 *What was Armscor?*

Armscor still exists today, but the contemporary Armscor is different from the organization that existed from the 1960s until the mid-1990s.

Armscor's foundation was laid during the Second World War. During the war, a small South African arms industry developed, largely to produce ammunition and some light armoured vehicles for South African armed forces deployed throughout North and East Africa.³⁶⁵ During

³⁶⁰ Van der Walt et al., 77, 79.

³⁶¹ United Nations Department for Disarmament Affairs, *South Africa's Nuclear Tipped Ballistic Missile Capability* (New York: United Nations, 1991), 20.

³⁶² United Nations Department for Disarmament Affairs, 24.

³⁶³ United Nations Department for Disarmament Affairs, 25-6; van der Walt et al., 74-5; Purkitt and Burgess, 62, 73-4.

³⁶⁴ Gould, 106.

³⁶⁵ Ron Matthews, "The Development of the South African Military Industrial Complex," *Defense Analysis* 4.1 (1988): 7-24.

the war, around 12,000 workers at six factories manufactured around 50 million rounds of ammunition. Once hostilities were over, the industry rapidly downsized, and arms factories either closed or were re-tooled for civilian purposes.³⁶⁶ The rapid decline of the South African arms industry caused the military some anxiety, so in 1948 the government established the Advisory Committee on Union Defence Requirements to assess South Africa's potential for an ongoing domestic arms industry. One year later the Committee became the Defence Resources Board, which offered the Minister of Defence advice on the nation's arms industry potential.³⁶⁷ Two years later, the South African government got directly involved in the arms industry by establishing the Munitions Production Board/Office, which was followed with the construction of a Defence Department-owned rifle factory in 1953.³⁶⁸ Otherwise, the 1950s saw little other government involvement in arms and military hardware production. Much of the South African Defence Force's needs in the 1950s were met by imports. This ranged from British-made hardware, including a range of light arms and small weapons, Centurion Main Battle Tanks, de Havilland DH.100 Vampires, and some of the Royal Navy's surplus minesweepers and large patrol craft, to CL-13 Sabres from Canada and helicopters from the United States.³⁶⁹ Belgium, France, Israel, Italy, and West Germany also sold notable amounts of arms and equipment to South Africa through the 1950s and 1960s.³⁷⁰

This began to change in earnest in the 1960s, when three related trends began. The 1960 Sharpeville massacre drew international attention to apartheid, and marked the beginning of a

³⁶⁶ Graeme Simpson, "The politics and economics of the armaments industry in South Africa," in Jacklyn Cock and Laurie Nathan, eds., *War and Society: The Militarisation of South Africa* (Cape Town and Johannesburg: David Philip, 1989): 217-231.

³⁶⁷ Simpson, 220; Matthews (1988), 7.

³⁶⁸ Simpson, 221.

³⁶⁹ Signe Landgren, *Embargo Disimpelemented: South Africa's Military Industry* (New York: Oxford University Press, 1989), 24, 39-40.

³⁷⁰ W. Andrew Terrill, "South African Arms Sales and the Strengthening of Apartheid," *Africa Today*, 31.2 (1984): 3-13; Landgren, 24.

broad, coherent anti-apartheid movement outside of South Africa. Pretoria was subsequently forced to leave the British Commonwealth in 1961. Also in 1961, the Baixa de Cassanje revolt marked the beginning of Portugal's decolonialization wars in Africa. South African defence policymakers responded by offering military and political support to the region's colonial governments and anti-revolutionary forces, so as to maintain a "*cordon sanitaire*" of apartheid-friendly regimes along South Africa's borders.³⁷¹ Finally, in 1963, the non-mandatory United Nations arms embargo against South Africa came into effect, which punctuated the possibility that South Africa would be able to continue to rely on its long-time military suppliers in the near future. In response to the violence on its borders, the growing anti-apartheid movement at home, and the spectre of a more energetic international anti-apartheid movement, Pretoria began to modernize and arm itself earnestly. The early 1960s saw a surge in South African firms producing weapons and equipment under licence, and around 120 licences were negotiated between 1961 and 1965.³⁷²

The surge in the number of domestic firms producing weapons and military equipment was not just a case of the South African Defence Force substituting domestically-made equipment for imports. It was also a reflection of the growth of South Africa's defence establishment. From 1961 to 1970, South Africa's annual military spending grew around 260% in real terms (this meant a compound annual growth rate of around 11.3%).³⁷³ To manage the South African Defence Force's growing procurement needs, the government established the Armaments Production Board (later Armaments Board) in 1964, and gave it the mandate "to control the manufacture, procurement and supply of all armaments and equipment for the

³⁷¹ Robert M. Price, "Pretoria's Southern African Strategy," *African Affairs* 83.330 (1984): 14.

³⁷² Landgren, 41; Simpson, 221.

³⁷³ Figures estimated from Peter Batchelor and Susan Willett, *Disarmament and Defence Industrial Adjustment in South Africa* (New York: Oxford University Press, 1998), p. 25.

SADF.”³⁷⁴ By this time, the South African defence industry had grown to around 1,000 private firms.³⁷⁵

Four years later, in 1968, apparently inspired by Defence Minister P.W. Botha’s trips to France to study the French armaments industry, Pretoria established the Armaments Development and Production Corporation (Armcor), with the government as sole shareholder.³⁷⁶ Armcor was initially meant to take over and consolidate any existing state-owned arms manufacturers, oversee arms imports and promote South African military exports, and only establish new businesses to produce “strategic” arms and equipment or equipment that the private sector could not economically produce.³⁷⁷

In 1977 the United Nations Security Council adopted Resolution 418, which imposed a mandatory and universal arms embargo on South Africa. In that same year, the Armaments Board and Armcor were merged into a single state-owned entity that was responsible for both the procurement, and increasingly, the manufacturing of the SADF’s arms and equipment. This “second” or “new” Armcor enthusiastically took on the twin tasks of procuring equipment for the SADF and designing equipment and weapons that met South Africa’s extensive and unique security needs. When Armcor was founded in 1968, the government capitalized the firm with approximately R100 million. By 1982, Armcor boasted R1.3 billion in assets. Its workforce grew from around 12,000 employees in 1974 to over 30,000 by the mid-1980s, and by 1981 it was the eighth largest firm in South Africa by assets.³⁷⁸

³⁷⁴ Matthews (1988), 8.

³⁷⁵ Batchelor and Willett, 29; J. Paul Dunne, “The Making of Arms in South Africa,” *The Economics of Peace and Security Journal* 1.1 (2006): 40.

³⁷⁶ Landgren, 45-6.

³⁷⁷ Dunne, 40.

³⁷⁸ Landgren, 46-7.

5.4.2a Armscor: Products and Operations

By the heyday of South Africa's nuclear weapons program in the mid-1980s, Armscor had grown to become a sprawling enterprise. While Armscor was solely state-owned, it was governed by a ten-person board of directors which was often dominated by research scientists and South African businessmen. The Chief of the SADF and the SADF's Chief of Staff for Finance were the government's only representatives on the board.³⁷⁹ This meant that Armscor could bring in private sector executives to help streamline the company's operations, and maximize efficiency.³⁸⁰ Despite having a captive customer in the SADF, Armscor's large role in the South African economy arguably created some positive benefits for private sector contractors, who often had to upgrade their own supply chains in order to meet Armscor's specifications (e.g. quality control, smaller manufacturing tolerances, or developing new products) which could then be sold on conventional commercial markets, and vice-versa).³⁸¹ This attitude may also explain why Armscor embarked on its major push to export more of its hardware overseas beginning in the early 1980s (described later in this chapter), since the SADF could no longer absorb all of Armscor's output, and some factories were operating far below capacity.³⁸²

Nevertheless, the SADF was still Armscor's largest single customer (until the firm was split up into a public procurement agency and a state-owned arms manufacturer in the 1990s). So, to meet the needs of the SADF's land, sea, and air wings by the 1980s Armscor was broadly diversified. Armscor, its subsidiaries, or its private subcontractors produced over 90% of the SADF's equipment. This meant everything from rifle ammunition and radios, to anti-tank and

³⁷⁹ Landgren, 48; Batchelor and Willett, 209.

³⁸⁰ Landgren, 48.

³⁸¹ Matthews (1988), 11.

³⁸² Terrill, 11.

anti-air missiles, to sophisticated artillery (the infamous G5 howitzer), to armoured vehicles. Where the South African economy was too small, or lacked certain capabilities, such as in designing and building jet aircraft or main battle tanks, Armscor imported foreign equipment and modified and adapted it for the SADF's needs. Examples include the Atlas Cheetah and the Oliphant. The South African Air Force's Atlas Cheetahs were completely rebuilt and reengineered Dassault Mirages, which Pretoria had purchased before the embargo. The Oliphant was a rebuilt and reengineered version of the British Centurion main battle tank. Given Armscor's size, it is unsurprising that not all of its products were geared towards military customers. For example, Musgrave Manufacturers and Distributors, an Armscor subsidiary that made and distributed small arms, sold commercial versions of the SADF's 5.56mm R4 and R5 assault rifles, and offered semi-automatic pistols to the South African civilian market.³⁸³ Table 5, below, lists Armscor's major subsidiaries and stand-alone facilities, as of 1989.

Table 5 Armscor: Major Subsidiaries and Facilities, 1989

<i>Subsidiaries</i>	<i>Sector/Services</i>
Atlas Aircraft	Military aircraft
Telcast	High-technology alloys
Eloptro	Electro-optics
Infoplan	Computer services
Kentron	Guided weapons
Lyttleton Engineering Works	Small arms, cannon and artillery
Musgrave	Small arms
Naschem	Large-calibre ammunition
Pretoria Metal Pressings	Small-calibre ammunition
Somchem	Propellants and explosives
Swartklip	Pyrotechnics and grenades
Houwteq	Missile systems, satellites, and remote sensing equipment
<i>Facilities</i>	
Advena/Kentron Circle	Nuclear weapons design and manufacture
Institute for Maritime	Naval research

³⁸³ Langdren, 130, 133

Technology	
Overberg Test Range	Missile test range
Alkantpan	Ballistic test range
Paardefontein	Antenna test facility
St. Lucia	Missile and artillery test range
Milistan	Systems analysis
Gennan Systems	Engineering
Gerotek	Vehicle test range

Table reproduced from Batchelor and Willett, 37, with some modifications.

Table 5, of course, does not fully cover the range of Armscor's activities. Given that Armscor worked extensively with the South African private sector, much of its work involved it acting as a general contractor. Armscor was, for example, the general contractor for Rooikat armoured cars, while its subsidiary Lyttleton Engineering Works would supply the turret and guns to private sector Sandrock-Austral, which would built the chassis and hull, integrate the weapons, and deliver the final product.³⁸⁴ While getting a complete picture of all the lines of business Armscor was involved in at its height is difficult, Armscor's Executive General Manager, Johan van Vuuren did note in 1988 that the company was managing thirty to forty "major systems" for the SADF and "150 or so smaller projects which may be small in content, but are no less important."³⁸⁵

While Armscor was building nuclear weapons, it also began to make a major push to find overseas customers. In 1982 the company established a dedicated international marketing and exports arm, known as Nimrod.³⁸⁶ That same year, Armscor made an unexpected appearance at the Greek Defendory Exposition and followed up this appearance by participating in the '84, '86, and '88 FIDA International Air Show, in Santiago, Chile.³⁸⁷

³⁸⁴ "Armscor Comes of Age," *Jane's Defence Weekly*, 20 July 1991.

³⁸⁵ "Armscor Now Selling to 23 Countries," *Jane's Defence Weekly*, 23 January 1988.

³⁸⁶ Batchelor and Willett, 33.

³⁸⁷ Terrill, 9; Landgren, 176.

Armcor's efforts to promote its products to foreign customers appear to have paid off. By 1989, arms sales were South Africa's third biggest export earner, after gold and coal.³⁸⁸ While a good deal of those sales came from private firms, Armcor was South Africa's single biggest manufactured goods exporter in 1987.³⁸⁹ Overall, from 1982 to 1989, weapons made up between 0.1% and 0.9% of South Africa's exports, and the proportion of total arms production that went to export markets ranged from 1.9% to 20.3% over the decade, and averaged around 10%, meaning that the South African arms industry was more export-oriented than South Africa's automobile and electrical machinery sectors.³⁹⁰ By the end of the decade, Armcor was selling weapons to some 23 countries (including Argentina, Chile, Indonesia, Iraq, Morocco, and Sri Lanka).³⁹¹ The exact value of Armcor's exports is difficult to pin down. Johan van Vuuren claimed that in 1988 alone Armcor sold R1.8 billion (USD 927 million) to overseas customers, while Batchelor and Willett estimate that South Africa as a whole only exported R 269 million worth of arms that year.³⁹²

By the time that South Africa's nuclear weapon program was terminated, it appears that the program was more-or-less just one of many Armcor weapon programs. It was also a relatively small program, with estimates that around 100 employees worked on Armcor's nuclear weapons in the early 1980s, and around 300 worked on the project in 1989.³⁹³ The nuclear weapon program was a small slice of Armcor's business – in 1984, Armcor had 33,000 employees, and when subcontractors were included, Armcor boasted as many as 103,000

³⁸⁸ Ron Matthews, "The ARMSCOR Paradox," *RUSI Journal* 134.4 (1989): 44.

³⁸⁹ Ibid.

³⁹⁰ Batchelor and Willett, 44.

³⁹¹ Matthews (1988), 21; Matthews (1989), 44-5; Landgren, 176-82; Stockholm International Peace Research Institute, *SIPRI Arms Transfer Database*, 2016.

³⁹² "Armcor Now Selling to 23 Countries"; Batchelor and Willett, 218.

³⁹³ Albright, 43.

employees in 1986.³⁹⁴ According to Armscor, the nuclear program cost around 10 million rand in the early 1980s, and the annual cost grew to 20-25 million rand in 1989.³⁹⁵ If these figures are accurate, it meant that Armscor's nuclear weapons activities absorbed around 0.6% of Armscor's annual expenditure in 1981-82.³⁹⁶ There simply was not much of a nuclear weapons organization in South Africa – the South African nuclear bomb was one weapon among many made by South Africa's military industry, and one that did not attract a great deal of financial or human resources.

5.4.3 The SADF and Nuclear Weapons

While the SADF played a role in developing South Africa's nuclear weapons policy from 1979 until the program was terminated, it did not appear to be a particularly enthusiastic participant. That does not mean that there were no advocates for nuclear arms in the armed forces. For example, a year after the AEB began its effort to build a nuclear explosive, some SADF officers demonstrated a nascent interest in acquiring nuclear weapons. In 1975, Lt. Gen. Raymond Fullerton Armstrong sent a memorandum to Adm. Hugo Biermann, Commandant General of the SADF which appears to have outlined a rationale for South Africa to acquire ballistic missiles equipped with nuclear warheads.³⁹⁷ This interest predates the agreed upon date in the literature when the South African government authorized the assembly of the country's first nuclear explosive. However, it also describes a different type of nuclear deterrent than the one that the South African cabinet and Armscor ultimately settled upon. Without additional documentation from the time, it is hard to conclude much more than that the Armstrong

³⁹⁴ Landgren, 46-47.

³⁹⁵ Albright, 45.

³⁹⁶ Figure estimated using numbers from Albright, 44-45, and Landgren, 46.

³⁹⁷ For a discussion of the memorandum, see Peter Liberman, "Israel and the South African Bomb," *Nonproliferation Review* 11.2 (2004): 46-80.

memorandum (also known as the Jericho memorandum) is an interesting artifact, but it may simply reflect the fancy of a single (or group of) officers.

In fact, there is some anecdotal evidence that the SADF was not universally enamoured of the nuclear weapons project. To understand why, it is important to recall the South African cabinet's rationale for acquiring an arsenal of nuclear bombs in the first place. Virtually all accounts of the program's history agree that Pretoria's principle rationale for building nuclear weapons was to use them as part of a crude deterrence/coercion strategy. This strategy's baseline was to create uncertainty about South Africa's nuclear capabilities in the minds of its adversaries - similar to the Israeli concept of "nuclear opacity" – and to keep Pretoria's rivals guessing about whether South Africa had nuclear weapons. This would, in principle, act as a weak form of deterrence.³⁹⁸ Were opacity to fail, and South Africa appeared seriously threatened by its neighbours, Pretoria would privately and quietly reveal its nuclear arsenal to the United States and/or the Soviet Union, with the hope that the US would intervene diplomatically on South Africa's behalf, and/or that the USSR would restrain the forces threatening the country. If that in turn failed, South Africa would publicly demonstrate the fact that it had nuclear weapons, by detonating a weapon, probably somewhere over the Atlantic Ocean.³⁹⁹ Of course, this meant that the nuclear weapon program offered little to the SADF at the time, which was overwhelmingly preoccupied with the war in Angola.

Accordingly, General Constand Viljoen, who served as the Chief of the SADF from 1980 to 1985 later claimed to have little use for Armscor's nuclear weapons:

³⁹⁸ Avner Cohen and Benjamin Frankel. "Opaque nuclear proliferation." *The Journal of Strategic Studies* 13, no. 3 (1990): 14-44.

³⁹⁹ Sagan (1996-7), 60; Reiss (1995), 7-44.

I was never in favour of the whole idea of nuclear capability...Remember I was a student of revolutionary war: I knew you don't win a revolutionary war with a nuclear bomb...My resistance to the nuclear programme was not against the idea that South Africa would have a nuclear potential. I think that did have some advantage, but at that state I felt the threat was from a revolutionary war. It was not one in which nuclear capabilities would have counted. I often said: "Let's rather buy tanks or guns."⁴⁰⁰

Personnel from KC also suggest that the SADF seemed ambivalent about the nuclear weapons program, which caused some operational challenges for Armscor. André Buys, who worked for the AEB before moving to KC, recalls that once he arrived at Kentron Circle, Armscor employees explained to him that Kentron would take the same standard approach to designing and building the bombs that Armscor used for all major projects. This specifically meant that one of the first stages of the process would be sitting down with the end user and determining the user's requirements. This posed a difficulty, since the nuclear strategy devised by cabinet members was purely a deterrent strategy. The SADF, at least in the early days of the weapon project, did not have a specification for Armscor, and no clear operational doctrine for deploying or using South Africa's nuclear bombs. Eventually, Brigadier John Huyser, of the SADF's strategic planning division, told KC personnel to "just make a bomb."⁴⁰¹ Buys also noted that he sensed that the SADF's top priority was the Border War (with Angola), and that most in the SADF simply did not see a useful role for nuclear weapons in that conflict.

⁴⁰⁰ Hamann, 168.

⁴⁰¹ Gould, 117.

5.5 The Twilight of the Bomb

South Africa's National Party appointed Frederik Willem de Klerk, who had served in Prime Minister and President P.W. Botha's cabinets since 1978, as interim president in 1989, after P.W. Botha suffered a minor stroke. F.W. de Klerk subsequently won the presidency in September 1989, and quickly formed a cabinet committee to study acceding to the NPT.⁴⁰² It was de Klerk taking the presidency, along with the December 1988 Tripartite Agreement (precipitated by the battle of Cuito Carnavale) between Angola, Cuba, and South Africa to grant Namibia independence and to have Cuban and South Africa troops withdraw from Angola, that appears to have been the proximate triggers that led to the end of South Africa's nuclear weapon program. While Botha entertained the idea of getting rid of Pretoria's nuclear weapons in 1987 and 1988, it is unclear how serious these proposals were.⁴⁰³

However, by the time de Klerk took office, the situation in Angola had begun to cool considerably. While the SADF had withdrawn from Angola the year before, the United States had publicly pledged to continue to provide material support to Pretoria's Angolan allies, the National Union for the Total Independence of Angola. Cuba also began withdrawing its troops from Angola on a mutually agreed upon timetable in early 1989.⁴⁰⁴

Beginning in 1989, South Africa also entered what would prove to be its most severe recession in decades.⁴⁰⁵ To shore up South Africa's public finances, de Klerk took advantage of the improvement in South Africa's international security situation to restructure South Africa's defence establishment. This included the SADF - Armscor's chief customer - beginning a major

⁴⁰² Liberman (2001), 73.

⁴⁰³ Ibid.

⁴⁰⁴ Kathryn O'Neill and Barry Munslow, "Ending the Cold War in Southern Africa," *Third World Quarterly* 12.3/4 (1990-1991): 81-96.

⁴⁰⁵ Peter Batchelor and Paul Dunne, "The restructuring of South Africa's defence industry," *African Security Review* 7.6 (1998): 27-43; Pieter Laubscher, "A New Recession-Dating Algorithm for South Africa," Stellenbosch Economic Working Papers: 06/14 (University of Stellenbosch, 2014).

downsizing program. Changes included: reducing the term of service for conscripted white males from two years to one, starting in 1990; cutting the SADF's full-time personnel from around 115,000 in 1989 to 78,000 by 1993, and; closing five air force bases and disbanding ten squadrons.⁴⁰⁶ The SADF's procurement activities (i.e. purchasing new weapons and equipment) were particularly hard hit, with eleven projects cancelled, and another forty-nine delayed by 1990.⁴⁰⁷ The rapid decline in procurement can be seen in Figure 5.2, below.

Figure 5.2 South African Defence Force/South African National Defence Force Procurement, 1985-1995

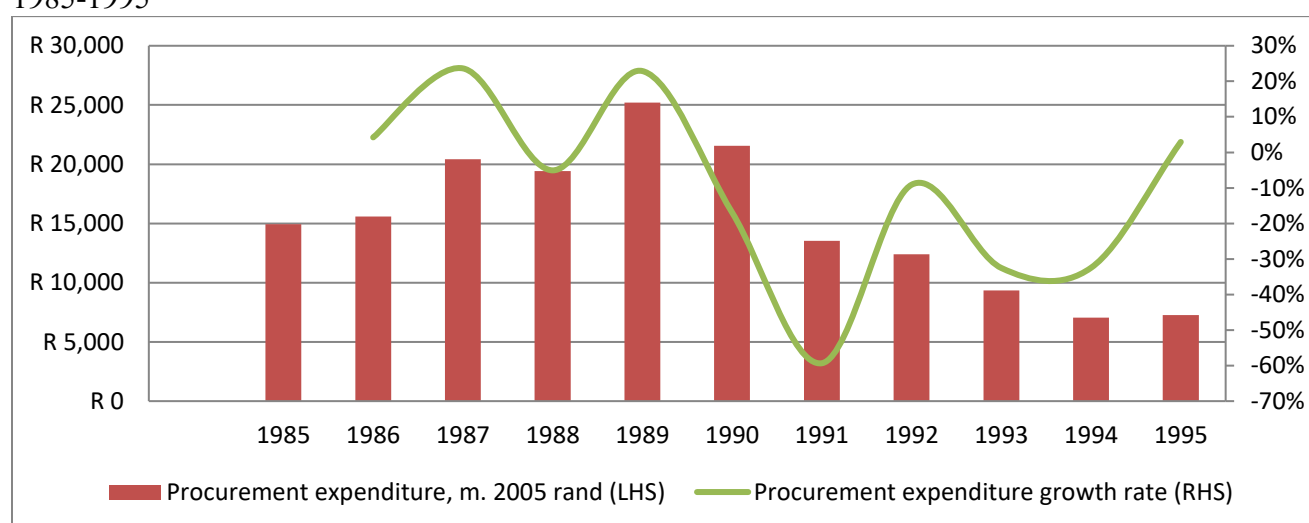


Figure 5.2 procurement expenditures from Batchelor and Willett, pp. 217-222. Estimates made using deflation data from the World Bank's World Development Indicators.

From 1990 to 1991 alone, the SADF cut procurement spending by nearly 60%. These cuts to defence spending hit Armscor directly, forcing the company to lay off around 10,000 employees between 1989 and 1993.⁴⁰⁸ Procurement spending on goods made by Armscor alone dropped 25% (around R1.3 billion) between 1990 and 1991 alone.⁴⁰⁹ It was in this climate that Richardt van der Walt, Hannes Steyn, and Jan van Loggerenberg (employees of the Atomic Energy Corporation, Armscor, and the Air Force, respectively) claim that when the SADF and

⁴⁰⁶ Batchelor and Willett, 69-70.

⁴⁰⁷ Ibid.; Peter Batchelor, "Militarisation, Disarmament and Defence Industrial Adjustment: The Case of South Africa," Ph.D. diss., University of Cambridge, 1997.

⁴⁰⁸ Ibid., 71.

⁴⁰⁹ Estimated from data in Batchelor and Willett, 220.

Armcor were asked to identify programs that could be cut from the defence budget, the two organizations offered the nuclear weapons program as a candidate to the cabinet. Giving up the ballistic missile and space launch vehicle program was not included in this proposal.⁴¹⁰ Their claim that Armcor had lost interest in the nuclear weapons program is corroborated by a memorandum to Herbert Beukes, then South Africa's Ambassador to the United States. The memorandum (authored by Richard Carter, which matches the name of de Klerk's press secretary), from the South African foreign ministry, describes the content of a conversation held in November 1989 between officials from foreign affairs, the AEC, and Armcor, about the future of South Africa's nuclear weapons program.

In the memo, Carter informed Beukes that the AEC, feeling that the African National Congress was inevitably going to come to power, believed that it was important for South Africa to accede to the NPT as soon as possible.⁴¹¹ The AEC's hope was that if Pretoria joined the treaty, then the AEC would be able to enter the international nuclear fuel market and offer a full suite of services, including enrichment, fuel fabrication, and disposal and reprocessing. According to Carter, Armcor was unequivocal about its preferences: "Armcor no longer committed to a weapon program. Feel that a satellite and/or conventional delivery system program is worth focusing on. Considerable financial saving."⁴¹²

Whether Armcor's claim that cancelling the nuclear weapons program would lead to financial savings was a truthful reflection of their thinking at the time, or a tactical effort to present a small, dead-end program as a major cost-cutting initiative to the de Klerk government is unclear. As noted earlier, Armcor employees claim the nuclear weapons program's costs

⁴¹⁰ Van der Walt et al., 99.

⁴¹¹ "Letter, Richard Carter to Herbert Beukes," November 17, 1989, History and Public Policy Program Digital Archive, South African Foreign Affairs Archives, A-M. Obtained and contributed by Anna-Mart van Wyk, Monash South Africa. <http://digitalarchive.wilsoncenter.org/document/116003>

⁴¹² Ibid.

amounted to R25 million annually by the late 1980s. To put this in perspective, this was equivalent to around 0.4% of the SADF's procurement expenditures in 1989, and 12% of South Africa's arms exports that year.⁴¹³ However, Armscor's desire to get rid of its nuclear bomb program, while keeping the related (but ultimately separate) missile/orbital launcher program is consistent with Armscor doubling down to protect its core purpose – developing and selling weapons and associated hardware – while sacrificing the parts of the organization that were not critical to its ongoing existence and success. Accordingly, three years later, Armscor began to look beyond the military market for civilian customers for the satellites made by Houwteq, one of its subsidiaries.⁴¹⁴

Finally, Buys recalls de Klerk's reasoning when he announced that he was terminating the nuclear weapon program. Buys believed de Klerk was anticipating the end of white minority rule in South Africa, and felt that the nuclear weapon program risked serving as a distraction or an impediment to negotiations with the opposition parties. Dismantling the program would therefore remove it from the bargaining table and hopefully ease what many Afrikaaners were anticipating was going to be an already difficult process. When de Klerk gave the order to terminate the program, Buys claims that there was little resistance inside KC. In his words, "there were one or two people who were concerned about their futures after the closure of the programme, but there was no one who did not want closure."⁴¹⁵ Buys also personally felt that the decision made sense: if the bombs were meant to be used as political tools to deter a Soviet-backed, large-scale military move against South Africa, then there was no longer any need for them. The war in Angola had cooled down as Cuba began its withdrawal from the country, and

⁴¹³ If we compare the nuclear weapon expenditures to arms exports in other years, the cost of the weapons program is even smaller. In 1987, when apartheid-era South African arms exports may have peaked, the cost of Armscor's nuclear weapons activities would have equalled around 5.5% of arms exports.

⁴¹⁴ Batchelor and Willett, 95, 97.

⁴¹⁵ Gould, 119.

there was a general sense that if there was no threat to deter against, nuclear weapons were no longer needed.⁴¹⁶ Apartheid South Africa, after all, developed its military forces and defence doctrine to counter a specific adversary. It was not aimed at countering general over-the-horizon threats, or as a general deterrent meant to dissuade unforeseen enemies.

In the end, the vast majority of Armscor's product lines had nothing to do with nuclear weapons, and virtually all of them had much greater long-term sales potential. Armscor was first and foremost a conventional weapons producer, and its future simply did not hinge on its nuclear weapon program. Nuclear weapons had outlived their usefulness for the SADF, and Armscor could not sell nuclear bombs to foreign customers.⁴¹⁷ Instead, Armscor had a large catalogue of existing conventional arms and equipment, ranging from mine-protected vehicles, to unmanned aerial vehicles, to a range of towed and self-propelled howitzers (which it was actively trying to sell to Thailand, the UAE, and Turkey, amongst others). When de Klerk and his cabinet decided to terminate the nuclear weapon program, there was little upside for Armscor to resist the policy and fight against it. The company was already facing a substantial decline in its fortunes, and hanging on to a small, secretive weapon program whose sole customer had given up on it, and

⁴¹⁶ Ibid.

⁴¹⁷ The clearest statement in the academic literature about when countries will furnish each other with the means to make nuclear bombs is Kroenig's theory of strategic nuclear proliferation. According to this theory, if a state has the means to build nuclear weapons, it will share those means (either by providing weapons, weapon designs, or designs for fissile material manufacturing facilities) with another country, so long as the second country shares a common enemy with the first, and that the sending (or exporting country) does not have the means to project conventional military power into the receiving country (since if the sending country will lose the option of using force against the receiving country in the future, if the receiving country acquires nuclear weapons). See Kroenig (2010). However, Kroenig's argument rests on an important, but unspoken assumption, namely that the transfer he describes is essentially a barter trade, and thus the countries involved must address what economists call "the coincidence of wants." Specifically, this means that not only must Kroenig's first two conditions be met, but that the receiving country must also want to acquire nuclear arms. Unless we assume that all countries are innately desirous of nuclear arms, this means that the country must believe that once furnished with the sensitive technology, that it can manufacture the weapons, develop a doctrine for their use (or threat of use) that can help them achieve specific goals, and that their armed forces can successfully adopt, control, and deploy them, amongst other things. This sets a high bar for a country that might want to transfer or sell nuclear weapons to another state, not to mention the challenges posed by third countries that might oppose the transfer. For these reasons, the counterfactual case where South Africa did not abandon its nuclear weapon program and Armscor found a way to sell the weapons to foreign military customers should be considered to be implausible.

with no suitors waiting in the wings, made little sense. Instead, Armscor needed to focus on meeting the rapidly changing needs of the SADF, and perhaps even more importantly in the fiscal climate of the late 1980s and early 1990s, finding foreign customers for its wares. Armscor's organizational essence, in other words, was making conventional weapons and equipment that military customers wanted and needed. Nuclear weapons only fit that description as long as the South African cabinet wanted them.

5.5.1 South Africa: The Counterfactual Case and Conclusions

Given the role Armscor's organizational interests played in the termination of South Africa's nuclear weapon program, it is worth entertaining the counterfactual: if the bomb program had stayed with the AEC would it have been more likely to have survived past the early 1990s?

This is an important question, and that this thesis cannot definitively answer. That being said, if the Botha government had decided to leave the nuclear bomb program in the AEC and decided that it wanted deployable nuclear weapons, then it is reasonable to conclude that the AEC would have needed to expand its budget, number of personnel, and make some capital investments in order to research, design, and build South Africa's nuclear arsenal. The details of the government's decision to move the nuclear bomb project from the AEC to Armscor remain a mystery. However, retrospective comments made by individuals who worked in or around the bomb program hint that some of the reasoning behind the decision was that Armscor already had the capability to develop the AEC's nuclear explosive into a nuclear weapon. In a counterfactual scenario where the Botha government decided to keep the bomb program in the AEC it seems

plausible that AEC would in turn acquire and develop its own expertise and capabilities to build the bombs, rather than seconding Armscor personnel and facilities to the AEC.⁴¹⁸

So, if the AEC continued to run the bomb program, and had to acquire new personnel, facilities, expertise, and equipment to do so, then it is reasonable to speculate that making nuclear bombs would have been a relatively larger part of their overall activities in the late 1980s in this counterfactual scenario (recall that the AEC still subcontracted some work for Armscor). The AEC, which was a nuclear science organization that mostly worked on civilian applications, would have become a nuclear science organization much more heavily weighted towards military applications.

Whether this would have been sufficient to prevent the de Klerk government's effort to cancel South Africa's nuclear bomb program is doubtful. By the late 1980s the wars on South Africa's borders were over, the economy was in dire straits, and there is evidence that the armed forces had little interest in nuclear weapons. Thus, the de Klerk government had few reasons to continue their nuclear weapon program. However, it is entirely reasonable and consistent with this study's evidence to strongly suspect that if the AEC retained control of the program there may have been a stronger nuclear bomb lobby inside the government. A nuclear bomb-making AEC would have had relatively strong preferences in favour of nuclear weapons (compared to the historical AEC) and it is reasonable to conclude that AEC leadership would have made significant efforts to impose themselves in any debates within the South African government about the future of the country's nuclear weapon program, with the goal of maintaining or expanding the program.

⁴¹⁸ This is because if the Botha government moved the bomb project to Armscor because of Armscor's expertise and capabilities, it would make little sense to keep the project in the AEC and still use Armscor employees and assets. Doing so would be inefficient and beg the question why Armscor was not in full control of the project.

Armcor's behaviour in the late 1980s was ultimately consistent with the ideal type specialized organization. Faced with the prospect of losing major parts of its business due to defence cut backs, Armcor, rather than defending a small piece of its empire, focused on preserving the larger pieces. Even the fact that Armcor had spent tens of millions of rand expanding Kentron Circle/Advena in 1988-9 with the expectation that if the nuclear weapon program continued, that the SADF would need new weapons once the first generation of bombs reached the end of their service lives (or miniaturized weapons that could be mated to a missile) fits this overall pattern of behaviour.⁴¹⁹ Armcor's would have valued its investments that were supposed to materialize in some sort of payoff in the future less than the facilities, projects, and lines of business they had at that moment. While losing that future payoff may have been seen as regrettable at the time, there was no longer any future in that line of business. South Africa's nuclear bombs were gone, but the overwhelming core of Armcor remained intact.

5.6 Conclusions: Switzerland and South Africa

The history of both Switzerland and South Africa's nuclear weapon activities offer additional evidence that organizational imperatives can help create the conditions for nuclear abandonment. To be clear, the Swiss military's and Armcor's narrow organizational interests were not the only factors leading these two countries to abandon their nuclear weapon activities. In both cases, the international political climate and the decline in nuclear (in the Swiss case) and conventional military threats (in the South African case) appear to have made the decision to abandon the two countries' nuclear weapon activities easier. However, in both instances, there is a clear case to be made that the priorities and interests of the organizations in charge of the nuclear weapon activities made abandoning the nuclear option more likely. In Switzerland, this

⁴¹⁹ Van der Westhuizen and Le Roux, 179-180; Albright, 45.

was because the armed forces simply had other pressing policy goals that it wanted to needed to achieve. This meant that the Swiss military deprioritized its nuclear weapons mission, and made little progress towards acquiring nuclear weapons (or developing a realistic and feasible plan to do so), while the original impetus for acquiring those arms – fear of a world where nuclear arms were used in a regular fashion like conventional arms – faded. Thus, when the executive branch of the Swiss government began to re-evaluate whether it needed nuclear weapons, the organization in charge of the country's nuclear weapon activities ultimately had little to lose. Moving nuclear weapon planning and preparations to an inter-departmental organization (the AAA) did not threaten the Swiss military's budget or clout within the government. Finally, when the Swiss government decided to terminate all nuclear weapons planning efforts, members of the AAA had even less to lose, since the members of the committee were all attached to permanent organizations that would continue to exist regardless of Switzerland's nuclear weapon policy.

In South Africa, the causal chain was similar, but also featured some important differences. Unlike the Swiss armed forces, Armscor's nuclear weapon activities did not grind to a proverbial halt. Instead, when the South African government gave Armscor the mission to take South Africa's rudimentary nuclear explosive and turn that prototype into a militarily deployable and usable weapon, Armscor did so. By the end of the 1980s, Armscor was even ready to expand its nuclear weapons assembly line if necessary. However, like the Swiss military, nuclear weapons were not a priority for Armscor, because Armscor was first and foremost a diversified military-industrial manufacturer. When faced with evidence that its biggest customer was cooling on the idea of nuclear weapons while also cutting back spending on Armscor's conventional weapons and military equipment, Armscor went as far as to suggest that ending the nuclear program to the government.

The common element in each case was the fact that neither organization found a reason to prioritize conducting and preserving its nuclear weapon activities over other activities that were closer to their organizational *raison d'être*. When confronted with a government that was considering making a major change in its nuclear weapons policy, neither organization ultimately had a strong incentive to challenge that decision or make the case for continued nuclear weapon activities.

Thus, these two cases offer at least two distinct paths that lead from organizational imperatives to an environment that is amenable to nuclear abandonment. The first path, which occurred in Switzerland, was a relatively apathetic organization, which all things being equal would prefer to acquire nuclear weapons, but when confronted with a list of policy demands that demanded attention, nuclear weapons, which previously had not been part of the Swiss military's core mandate, fell down the priority list. This led to slow progress in the actual nuclear weapon activities, meaning that there were relatively few resources directly committed to the nuclear weapons effort, and therefore little risk to the military's interest, once the government decided to cancel the policy. Furthermore, the Swiss military had other avenues (e.g. purchases of new conventional weapon systems) to meet their organizational needs. In this first causal chain, the organization in charge of nuclear weapons simply had other, more pressing priorities, which caused it to neglect the nuclear file.

The second path, which occurred in South Africa, saw an organization that was not dedicated to executing nuclear weapons policy nevertheless execute it quite effectively. Armscor may not have been zealous about its nuclear weapon activities, but it conducted them efficiently and effectively. When Armscor was confronted with a difficult economic and political environment, namely, one where its sales were drying up, and the organization looked to be

heading into a difficult period, the nuclear weapons program became an unproductive asset. Rather than try to preserve a line of business with a limited customer base (and declining interest from its only existing customer), Armscor was content to abandon it. In this second causal chain, the organization in charge of nuclear weapon activities consolidated its efforts, to focus on the activities that would keep the organization viable in the long run.

Both of these scenarios are also compatible with this study's overall claim. Organizational imperatives do not only need to cause states to acquire nuclear weapons, as others have argued, but organizational imperatives can be associated with nuclear abandonment. Militaries and arms manufacturers are not automatically nuclear weapon advocates, but instead can be apathetic towards nuclear weapon activities, or be willing to sacrifice those activities to achieve other organizational goals.

6 Conclusions

6.1 Organizational Imperatives and Nuclear Abandonment: Contributions to the Literature

This study began by asking a relatively simple question: why do states terminate their nuclear weapon activities? Of the approximately thirty countries that have initiated activities to research, design, and build nuclear weapons since 1941, the vast majority have terminated those efforts at some point in time, and today only nine are known to have active nuclear weapon programs. Developing a thorough understanding of why states stop their nuclear weapon activities may give governments ideas, data, and insight into ways to tailor policies that are intended to convince or coerce states that conduct nuclear weapon activities to end those activities.

Ultimately, the question of why states end their nuclear weapon programs is a question about human behaviour. Why do groups of people (in this case) national governments act as they do? As with most questions about human behaviour, this study assumes that most decisions are the product of multiple causes. Individuals rarely make important decisions due to the influence of a single social, economic, or biological factor, and this study likewise assumes that governments do not make policy decisions on the basis of a single data point or factor. Thus, the hypothesis that this study offers and tests – that the nature of the organization that runs a country's nuclear weapon activities is related to the likelihood that the government will abandon that nuclear weapon program – is not the only explanation as to why states stop their nuclear weapon programs. Instead, this study's claim is compatible with other explanations for nuclear weapon program abandonment.

This study also offers a general explanation for nuclear abandonment. As laid out in chapter four, the study's hypothesis passes a number of statistical tests on a sample of over six hundred country-years from 1950 to 2000. The single major limit on this study's scope is the three states – Belarus, Kazakhstan, and Ukraine – that “inherited” Soviet nuclear weapons after the dissolution of the USSR in 1991. This study's overall logic is not applicable to these three states since none of them deliberately embarked on a policy to research, develop, design, and/or manufacture nuclear weapons.

Despite that limitation, this study still offers an explanation that appears to apply in the vast majority of cases of nuclear abandonment. In that regard, it makes a novel contribution to the literature and our understanding of when and why governments make major changes to their nuclear arms policies. As chapter two of this study argued, there is no shortage of explanations for why governments terminate their nuclear weapon activities. There are, however, good empirical and methodological reasons to suspect that many of these explanations are not generally applicable. Instead, they seem to apply to certain countries at certain times. While the current literature is undoubtedly useful for understanding specific cases of nuclear abandonment, it is by no means clear that it offers generalizable explanations of the phenomena. This is particularly important to understand when developing policy. It is impossible to precisely predict the future behaviour of national governments. However, identifying generalizable patterns of past behaviour (rather than fixating on the details of past behaviour) does offer a tool to make predictions about the broad contours of future behaviour. To put things more concretely: we do not know precisely how the policies of the world's nine nuclear-armed states will change in the future, but a general explanation for nuclear abandonment, based on organizational imperatives, does tell us where to look for clues to some future behaviour.

In addition to offering a general explanation for nuclear abandonment, this study also provides a novel explanation. While other studies have suggested that organizational interests may play a role in determining whether a country acquires (or fails to acquire) nuclear weapons, those studies have rested on a number of rigid assumptions. Walsh, for example, argues that government organizations that stand to benefit professionally from a nuclear weapon program – such as atomic energy agencies, or a country’s air force – will lobby on behalf of a nuclear weapon program, while other branches of government will instinctively agitate against developing nuclear arms. Walsh’s logic is similar to the canonical logic that Sagan describes where nuclear policy is pushed on the executive branch of the government from below, by organizations that would benefit professionally from managing a nuclear weapon program on behalf of the rest of the government. What Sagan describes, and Walsh echoes, is commonly known as the “bureaucratic politics” explanation of nuclear proliferation (and in the case of Walsh, abandonment). According to this logic, organizations involved in nuclear weapons activities are typically advocates for continuing and expanding nuclear weapon activities.

As chapter three explains, this thesis’s hypothesis is both compatible with that classic argument about nuclear proliferation (that organizations within the state lobby their governments to acquire nuclear weapons), while also making novel predictions that organizations that according to the standard logic should have strong pro-nuclear preferences (such as arms manufacturers and armed forces) can in fact be apathetic about nuclear weapons, and may even prefer to abandon their nuclear weapon activities. Thus, while this study’s findings are consistent with some elements of this standard logic the relationship between organizational imperatives and nuclear weapon activities, this study offers a novel explanation for how these imperatives can affect nuclear weapon policy and help facilitate nuclear weapon program termination.

A final contribution worth noting is that this study uses a relatively ignored level of analysis and exploits previously overlooked variation in nuclear weapon organizations, and draws a clear line to how the characteristics of those organizations help create final policy outcomes. Looking at nuclear weapon organizations – rather than solely assessing the states that these organizations are in – offers analysts additional variation and data to work with. Observing nuclear weapon organizations also helps make sense of similar policy outcomes in different states. For example, this study’s organizational hypothesis of nuclear abandonment gives a compelling explanation for why two different states, such as Russia and Israel, retain their nuclear weapon activities, but also why two different states, such as Switzerland and South Africa, abandoned theirs. This is because by focussing on the characteristics of the nuclear weapon organizations, analysts can identify similarities (or differences) that would otherwise be obscured by looking at the broad characteristics of the countries in question.

To summarize, this thesis makes several contributions to the literature. It provides a broadly applicable, general explanation for nuclear abandonment in a field where general explanations are rare. It also provides an explanation that is compatible with existing explanations. Thus, it contributes to the literature by accounting for additional unexplained variation, and offers another analytical tool for understanding policy outcomes. This study’s explanation is also novel. It challenges the existing logic about the relationship between organizational interests and nuclear weapons, and provides evidence that organizations that analysts typically assume are in favour of nuclear weapons may in fact be apathetic or agnostic about them or have other priorities to pursue, helping create the conditions for nuclear

abandonment. Finally, it brings new data and a level of analysis that the literature has largely overlooked to bare on the question of what causes nuclear abandonment.

6.2 Directions for Further Research

This study's findings also point to some potential directions for additional research. The first and most obvious is why do governments assign their nuclear weapon activities to certain types of organizations? Given that there is a significant correlation between abandonment and organizational type, this is a potentially interesting question. One potential hypothesis is that organization type is a function of a latent variable, namely, how strongly a government wants to acquire nuclear weapons. If, for example, a government wants to prioritize acquiring nuclear arms, then it most likely will want to establish a bespoke nuclear weapons research organization. If, instead, acquiring nuclear weapons are relatively unimportant to a government, or the impetus for acquiring nuclear arms is coming from a specific organization or group within government, the executive branch may assign that task to an existing organization. It is even conceivable that the executive branch might deliberately assign a program to an unsuitable organization with the twin goals of pacifying demands for a nuclear weapon program from within the government, while also setting up conditions that will make it easier to abandon in the future. These are but two hypothetical possibilities. However, if a predictable relationship between which type of organization nuclear proliferators assign their nuclear activities to, and other observable variable exists, such a relationship could be a useful tool for identifying serious proliferation threats and sorting them out from less concerted efforts. Such a finding (along with this study's core finding) could also act as a crude guide for identifying hard cases where organizational resistance to

abandonment is likely to be high, and where it is likely to be relatively lower. Resources and policy interventions could be assigned accordingly.

A second clear application for this study's findings and further research is in designing and implementing non-proliferation policies. Take the Islamic Republic of Iran, for example. As countries (and the IAEA) seek to monitor, verify, and enforce the Joint Comprehensive Plan of Action (JCPOA), should they cast their eyes beyond known nuclear sites and the activities of the Atomic Energy Organization of Iran? Does it make sense to spend resources monitoring other Iranian government entities, such as various subsidiaries of the Ministry of Defence and Armed Forces Logistics (MODAFL)? This study suggests that paying attention to the activities and politics of the MODAFL (and other elements of the Iranian government) makes a certain amount of sense. After all, Iran's past nuclear weapon activities were housed inside the defence ministry (with potential ties to the Army of the Guardians of the Islamic Revolution).⁴²⁰ In many ways, the JCPOA represents a blow to the MODAFL, since if Iran abides by the agreement, the MODAFL could permanently lose control of a potentially influential project. The permanent end of Iran's nuclear weapon activities would mean that the MODAFL have lost some political power, funding and prestige. Thus, understanding how the MODAFL views the JCPOA, and if attitudes inside of the organization are warming or cooling to the deal may provide some insight into the likelihood that Iran will uphold its end of the deal, or if an attempt to break out of the agreement is in the works. Of course, careful study of the defence ministry may also reveal that, as this study would predict, the nuclear file was (and is) not particularly important to the organization, and that despite the MODAFL's public hostility to the JCPOA, the group may have no desire to undermine it or break out of it. While this would be a positive development from the

⁴²⁰ International Atomic Energy Agency, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, GOV/2011/65.

point of view of the other signatories to the JCPOA, it would also be useful knowledge for developing one's Iran policy. However, the overall point is that this research offers a clear and compelling reason to not just monitor the activities of and debates within the Atomic Energy Organization of Iran and the Iranian executive branch, but also within the MODAFL.

A third avenue for future research is to identify scenarios under which organizational pressures to reduce or eliminate the nuclear arsenals of the nine nuclear-armed states might evolve. It is by no means ordained that the world's nuclear-armed states will keep their nuclear weapon programs in perpetuity. This research, in fact, offers some guidance as to how these nations might eventually abandon their nuclear weapons. One counterintuitive pathway to nuclear abandonment is as follows: if nuclear weapons continue to be broadly (though not universally) rejected as legitimate weapons of war, and militaries in nuclear-armed countries prioritize acquiring and maintaining conventional munitions and weapon systems over nuclear ones (e.g. military demand for nuclear weapons declines), organizations such as the U.S. Department of Energy could simply see nuclear weapons becoming a less important (in terms of budget, capital allocation, and human resources) part of their policy portfolio. If this were to occur, organizational resistance to further cuts in the size of the nation's nuclear arsenal could soften. The obvious action-oriented research agenda that follows is one that seeks to identify implementable ways to reduce the fiscal and professional importance of nuclear weapon activities to existing organizations.

A fourth avenue for research is determining if there is a significant interactive relationship between other aspects of a state or government and organizational imperatives, and the likelihood of abandonment. Chapter four alludes to this possibility by presenting evidence that high levels of organizational specialization in consolidated democracies and high levels of

organizational specialization in the presence of strong legal constraints on executive action may reduce the likelihood of nuclear abandonment. Further focussed academic research on the possibility of these relationships is warranted, particularly since these preliminary findings appear to be in conflict with the popular notion that nuclear arms and democracy are incompatible.

6.3 Final Comments

This study makes a strong argument, and provides ample evidence to suggest that classic explanations for why states stop their nuclear weapon activities are incomplete. While explanations that draw from classic themes in academic international relations literature, such as balances of power, hard security challenges, the pacifying effects of trade on interstate relations, or the normative effects of ideas and the socializing effect of the expectations of other governments are appealing, explanations based on these concepts seem incomplete. Such explanations appear to often lack generalizability, and also seem to better explain nuclear weapon abstinence rather than nuclear program abandonment.

This study offers a generalizable, falsifiable, probabilistic explanation that complements the existing literature and accounts for some of the unexplained variation in which countries abandon their nuclear weapon activities, and when. It does so by exploiting previously ignored natural variation in how states organize their nuclear weapon activities, and brings original data to the analytical challenge. It also provides a novel explanation for nuclear abandonment that also refines some of the thinking about how organizational imperatives affect not just nuclear weapons activity abandonment, but nuclear weapons acquisition as well. This study's findings also offer policy analysts new ideas about what actors and organizations within a government

they should be looking at when trying to divine nuclear intentions. Thus, this study should contribute some policy-relevant analysis to debates over nuclear weapons policy, in addition to its academic contribution.

7 Appendices

7.1 Nuclear Weapon Programs: Differentiating Between Policies and Technologies

To perform the empirical analysis in chapter four, this study differentiated between three unique dimensions of a state's nuclear weapon activities. This appendix describes how the quantitative nuclear proliferation literature has operationalized the concept of a nuclear weapon program, the methodological shortcomings of the existing approach, and how this thesis operationalizes the concept.

7.1.1 Operationalizing Nuclear Weapon Programs

Any study of nuclear weapon activities that seeks to identify correlates or causes of nuclear abandonment or proliferation using large-*n* statistical methods needs to operationalize the concepts of nuclear weapon activities or a nuclear weapon program.

The broadly used approach, offered by Singh and Way and built on by Jo and Gartzke, is to think about nuclear weapon activities as happening along a spectrum, operationalized using an ordinal scale.⁴²¹ Singh and Way characterize states as: not having a nuclear weapon program; as conducting “exploratory activities,” as actively pursuing nuclear weapons (which generally means that a government has given a concrete order to develop a nuclear bomb); or as being in possession of nuclear arms.⁴²² In simple terms this can be thought of as characterizing country-years according to their “degree” of nuclear weapon activities.

While at first glance this coding seems adequate to capture the variation in nuclear weapon activities, it suffers from an important methodological flaw. Namely, it collapses at least two (and possibly more) qualitatively different concepts into a single ordinal scale (which, by

⁴²¹ Singh and Way; Jo and Gartzke.

⁴²² Examples of other studies that have operationalized nuclear weapon programs in a similar way are Jo and Gartzke (2007) and Kroenig (2009).

definition, only measures a single concept). Ideally, the two concepts that Singh and Way combine (which are the state's policy and the extent to which it has made technological progress towards building a nuclear bomb) should be operationalized as two variables, rather than as one. This thesis takes that step by separately operationalizing technological progress using the *Fissile materials* variable. This thesis also operationalizes a third dimension, which is how the program is organized. These three unique concepts (or dimensions) are by no means exhaustive, but should be treated as separate variables, since they describe different things.

7.1.2 Dimension 1: Policy Directive

The first dimension that most analysts will be interested in is the state's policy directive. In simple terms, this can be treated in a binary fashion: either a government has issued a directive to conduct nuclear weapon activities, or it has not issued such a directive. However, the historical reality is often more nuanced. Instead of a simple yes/no policy, states have had a number of policies that include (but are not limited to) making plans to acquire nuclear weapons, building the technological and industrial infrastructure and facilities to make fissile materials, and building nuclear weapons. Analysts have referred to countries as going through stages of proliferation, or "degrees of nuclearness."⁴²³

Singh and Way identify three such stages. These are: situations where national security policymakers direct government organizations to explore the nuclear weapons option; where government directs the relevant organizations to develop the ability to acquire nuclear weapons, and; where states actually build (or otherwise acquire) nuclear arms. Exploration is taken to mean conducting paper studies to assess the economic cost, technology and human resource requirements, the military necessity or utility of nuclear weapons for the country in question, and so forth. Pursuit is assumed to mean undertaking the necessary technical, engineering, economic,

⁴²³ Singh and Way, p. 866.

and military preparations to build or otherwise acquire nuclear weapons. This could include, but is not limited to: establishing an organization to manage the effort, conducting research into weapon physics, acquiring non-fissile weapon materials (such as high accuracy detonators or neutron sources), building fissile material plants and manufacturing fissile material, building a facility to assemble nuclear weapons), or entering into a diplomatic agreement with another country to acquire nuclear weapons from them (as West Germany and Italy did with France, and as Saudi Arabia has been rumoured to have done with Pakistan).⁴²⁴

While the terms “explore” and “pursue” convey what a government’s policy goal is, they do not convey the degree to which the government has achieved those goals. For example, one of Singh and Way’s criteria for coding a state as pursuing nuclear weapons is that there must be an explicit order to acquire nuclear weapons. Such an order is not incompatible with that government also lacking any of the necessary technical and scientific infrastructure to do so. When West Germany and Italy, for example, entered into an agreement with the French government in 1957 to jointly manufacture nuclear weapons, neither country had any fissile material facilities on its soil. Similarly, in 1958, when the Swiss cabinet ordered the Swiss armed forces to begin planning to acquire nuclear weapons, Switzerland’s weapon-specific scientific and technical infrastructure was nearly non-existent. Thus, simply because a government has decided, as a matter of policy, that they wish to “pursue” a nuclear weapon, this does not mean that their investment matches their intent. We should not conflate phenomena that are often the result of efforts to achieve a policy (such as large fiscal expenditures or the creation of dedicated

⁴²⁴ Singh and Way, for example, claim that a country must meet one of three criteria to be counted as pursuing a nuclear weapon: there must be a cabinet-level policy directive to do so, or the country must be making “movement toward weaponization,” or they must have developed or tried to develop a “single use technology.” See Singh and Way, p. 866.

government organizations), with policy declarations or goals. A state's official policy is one thing and the ends to which they have gone to achieve that policy is another.

So while we should think of states' nuclear policies in a more nuanced fashion than simple binary terms, fine-grained distinctions between "exploration" and "pursuit" (especially if those distinctions are made on the basis of whether government organizations achieved certain technical milestones) are probably too difficult to make with any consistency. In addition to the methodological problems posed by collapsing multiple concepts into a single measure, the primary and secondary sources available that describe the activities of the thirty-some countries that have at least seriously investigated building nuclear weapons in the 20th and 21st centuries are simply inadequate to identify discrete differences between policies to investigate or pursue nuclear weapons. While this data is available for some cases, such as the People's Republic of China, where China's nuclear weapon activities essentially began with an order from Mao Tse Tung to build a nuclear bomb, for others, the history is simply too shadowy and opaque.⁴²⁵

7.1.3 Dimension 2: Technical Preparations/Accomplishments

The second dimension that Singh and Way's operationalization of nuclear weapon programs captures is the program's technical preparations. While Singh and Way claim that policy direction or technological preparations can substitute as indicators that a state is/has pursuing/pursued nuclear weapons, these two concepts should be explicitly measured and operationalized separately. Ultimately, in social sciences, a variable is simply an operationalization of an attribute of some person, place, or thing.⁴²⁶ Policy directives from authoritative government officials and the technology choices of a government organization

⁴²⁵ John Wilson Lewis and Xue Litai, *China Builds the Bomb* (Stanford, CA: Stanford University Press, 1988), pp. 35-9.

⁴²⁶ Earl R. Babbie, *The Practice of Social Research*, 13th ed. (Belmont, CA: Wadsworth, Cengage Learning, 2013), 14-18.

building a nuclear weapon are clearly two different attributes of the same “thing” (a nuclear weapons program). Collapsing them into one measure makes little sense, since policy directives and technological success need not be correlated. For example, a country might be seriously pursuing nuclear weapons, but might also be encountering difficulties in acquiring fissile materials. Libya’s nuclear engineers, for example, had difficulty getting their gas ultracentrifuges to work correctly. Technological stagnation, failure, or incompetence should not be confused with a lack of political desire or ambiguous policy directives. Thus, policy directives should be measured using one scale, and technical progress should be measured using another.

7.1.4 Dimension 3: Organization

The third dimension of a state’s nuclear weapon activities is the aforementioned matter of which type of organization manages and executes the state’s nuclear weapon activities. This dimension is described in chapters one and three.

Table 7.1 offers some illustrative examples of the policy, technical, and organizational dimensions of a state’s nuclear weapon activities.

Table 7.1: Three Dimensions of Nuclear Weapon Activities

Ordinal Scale	<i>Policy Directive</i>	<i>Technical Accomplishments</i>	<i>Organization</i>
0	None.	None.	None.
1	Exploratory work (e.g. an assessment of the fiscal costs, technological requirements, and/or how a nuclear weapon would work in a state's foreign or defence policy portfolios).	<p>Fundamental research into weapon physics and design.</p> <p>Laboratory-scale fissile material production (i.e. annual production of several SWU of enrichment or gram quantities of plutonium).</p>	Activities are housed in an organization that has major priorities that are unrelated to nuclear science or weapon activities.
2	Pursuit of a nuclear weapon (e.g. active efforts to acquire a nuclear weapon or the means to acquire one).	<p>Weapon design; research and development of triggers, neutron sources.</p> <p>Pilot-scale fissile material production (i.e. annual production of ~50 to a few hundred SWU or hundreds of grams to several kilograms of plutonium).</p>	Activities housed in an organization that has a pre-existing mandate that does not involve nuclear science and engineering/weapons.
3	Acquisition (e.g. manufacture of all the necessary components of a nuclear weapon. Could include assembly and detonation).	<p>Machining of fissile material for weapons; assembly of weapons; testing of weapons.</p> <p>Commercial- or industrial-scale fissile material production (i.e. annual production of >1,000 SWU, > tens of kilograms of plutonium).</p>	Activities are housed in a specialized nuclear weapons organization, or the organization's principal task is nuclear science and engineering.

A brief hypothetical example helps explain the benefits of treating policy directives and technological accomplishments as distinct variables. Using a Singh and Way-type operationalization, an analyst who observes a country-year where a government had issued a directive to acquire nuclear weapons (a value of 2 in the *Policy Directive* column), but no

evidence that the government acquired any fissile material production facilities or conducted any fundamental or applied physics research (a value of 0 in the *Technological Accomplishments* column) would be faced with an analytical dilemma. How should they characterize that state's "degree of nuclearness" in that year? Do they code the country-year as exhibiting relatively advanced nuclear weapon activities (on the basis of the policy directive) or do they code it as a low degree of activities (on the basis of the technological accomplishments)? If both policy directives and technological accomplishments are collapsed into a single variable, then either choice is defensible (the analyst may even opt to split the difference between the two).

7.1.5 Operationalization of Nuclear Weapon Programs in this Study

This thesis has deliberately avoided attempting to differentiate between whether a state was "exploring" or "pursuing" nuclear weapons. Instead, the empirical tests in chapter four examined the population of states that conducted nuclear weapon activities between 1950 and 2000. This decision has the effect of using a binary measure of a government's policy directive (e.g. either a state was conducting nuclear weapon activities or it was not conducting them) to characterize the policy dimension of a nuclear weapon program. This is akin to collapsing categories 1, 2, and 3 of the *Policy Directive* column in Table 7.1 into a single category.

Since eliminating states with no nuclear weapon activities from the sample produces a non-random sample, this decision may produce biased coefficients. As noted in chapter four, I used a Heckman selection equation to test for this possibility. The results of the Heckman equations (reported in Appendix II) suggest that the non-random nature of the sample did not introduce significant bias to the results.

As a robustness check, the fully specified estimates from chapter four were reproduced with an ordinal variable (drawn from Singh and Way) that is meant to capture whether a state

was exploring, pursuing, or had acquired nuclear weapons. The coefficients of *Organization* remained statistically significant in these estimates. The associated regression table is in Appendix II.

7.2 Appendix II – Empirical Estimates with Sample Selection, Panel Estimators, and Policy Directive Controls

The data and results described in section 4.9.5 are listed below in Tables 7.2 and 7.3.

Model 7 is a two-stage Heckman estimate that includes *Organization* and a single time dummy.

Model 7.2 is a fully specified model, roughly equivalent to Model 1.3. Model 7.1 was specified by dropping insignificant regressors from the selection equation in Model 7.2 until all remaining terms in the selection equation had statistically significant coefficients. Readers will note that *Polity* remains in the selection equation of Model 7.1. This is because the higher-order term *Polity X NPT* remained significant. All the terms in the outcome equation of Model 7.1, except for *Organization*, are insignificant. Model 7.3 is roughly equivalent to Model 1.4. It uses five-year, rather than annual, data.

Table 7.2 Summary Statistics for Two-Stage Heckman Estimates

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>Abandon</i>	770	.0311688	.1738868	0	1
<i>Organization</i>	677	2.539143	.6132327	1	3
<i>MIDs</i>	7275	2.264385	4.217404	0	66
<i>Allies</i>	7468	.4422871	.4966913	0	1
<i>Rivals</i>	9970	2.800251	18.68699	0	482.3528
<i>Fissile Materials</i>	9980	.1628257	.6184205	0	3
<i>Trade</i>	6708	53.29353	48.20882	.03	770.48
<i>NPT</i>	8124	46.68143	38.78277	0	97.89
<i>Polity</i>	7438	-.4991933	7.474555	-10	10
<i>PolityXNPT</i>	7438	2.928787	444.8882	-978.9	978.9
<i>GDP</i>	6733	5.77381	5.97808	.281	44.048
<i>GDP²</i>	6733	69.1	147	.078961	1940

Table 7.3 Two-Stage Heckman Estimates

Probit with sample selection	Model 7	Model 7.1	Model 7.2	Model 7.3 (five-year data)
Outcome equation (nuclear abandonment)				
Organization	-.612*** (.133)	-.739*** (.1787)	-.752*** (.183)	-.766** (.26)
MIDs		-.0425 (.0287)	-.034 (.026)	-.132 (.075)
Ally		-.183 (.206)	-.227 (.219)	.207 (.446)
Rival		.0008 (.029)	.0004 (.026)	-.002 (.033)
Fissile materials		-.154 (.166)	-.1247 (.157)	-.475 (.417)
Trade			.006 (.006)	.02** (.008)
NPT Norm		-.005 (.008)	-.008 (.007)	-.008 (.013)
Polity		-.024 (.028)	-.015 (.03)	-.032 (.048)
Polity X NPT		.0007 (.0005)	.001 (.0005)	.001 (.0009)
GDP		-.02 (.08)	-.03 (.08)	-.09 (.1)
GDP ²		-.002 (.003)	-.003 (.003)	-.002 (.005)
T	.004 (.031)	.031 (.161)	.047 (.16)	-.182 (.125)
T ²		-.0002 (.004)	.00003 (.004)	.006 (.004)
T ³		1.41 x 10 ⁻⁶ (.00004)	-2.82 x 10 ⁻⁶ (.00004)	-.00005 (.00004)
Constant	-.58 (4.219)	-.295 (1.701)	-.985 (1.714)	3.159 (1.949)
Selection equation (nuclear activities)				
MIDs		.142*** (.026)	.137*** (.025)	.122*** (.023)
Ally		-.78* (.362)	-.857* (.372)	-.607* (.28)
Rival		-.013* (.0059)	-.012* (.006)	-.011 (.006)

Fissile materials		.819*** (.129)	.804*** (.127)	.825*** (.1437)
Trade			-.009 (.005)	-.007 (.005)
NPT Norm		-.012** (.004)	-.01* (.004)	-.012** (.004)
Polity		.042 (.0241)	.044 (.024)	.032 (.023)
Polity X NPT		-.001** (.0003)	-.001** (.0003)	-.001** (.0003)
GDP		.1** (.05)	.2** (.05)	.2** (.05)
GDP ²		-.004* (.002)	-.005* (.002)	-.006* (.003)
T	.021 (.003)	.113 (.079)	.133 (.08)	.068 (.067)
T ²		-.001 (.003)	-.002 (.003)	-.0003 (.002)
T ³		2.09 x 10 ⁻⁶ (.00002)	6.27 x 10 ⁻⁶ (.00002)	-4.82 x 10 ⁻⁶ (.00002)
Constant	-2.001 (.122)	-3.8*** (.748)	-3.749*** (.781)	-2.884*** (.667)
N	8,022	5,772	5,747	1,343
Clusters	194	156	155	156
rho	-.013 (1.811)	.148 (.312)	.251 (.314)	-.242 (.782)
Wald test	Prob > chi ² = 0.994	Prob > chi ² = 0.64	Prob > chi ² = 0.445	Prob > chi ² = 0.766

Robust standard errors are clustered by country and are in parentheses below coefficients. Statistically significant coefficient estimates are in bold and are denoted by *($p < 0.05$), **($p < 0.01$), ***($p < 0.001$).

Table 7.4 Panel Estimators and *Policy Directive* Control Variable

	Model 7.2	Model 7.2.1	Model 7.2.3	Model 7.2.4
Organization	-.611*** (.16)	-.622*** (.169)	-.763** (.252)	-.703** (.203)
Policy Directive			-	-.68** (.198)
MIDs			-.05 (.029)	-.024 (.024)
Ally			-.072 (.273)	-.105 (.179)
Rival			-.001 (.028)	.011 (.027)
Fissile materials			-.241 (.15)	.121 (.141)
Trade			.008 (.007)	.003 (.006)
NPT Norm			-.006 (.007)	.004 (.008)
Polity			-.022 (.033)	-.031 (.036)
Polity X NPT			.0007 (.0005)	.001 (.001)
GDP			-.06 (.09)	.1 (.1)
GDP ²			-.002 (.004)	-.006 (.004)
T		-.032 (.091)	.022 (.169)	.059 (.148)
T ²		.001 (.003)	.0004 (.005)	-.001 (.004)
T ³		-1.05 x 10 ⁻⁶ (.00002)	-4.46 x 10 ⁻⁶ (.00004)	.00001 (.00003)
Constant	-.456 (.36)	-.284 (.88)	-.127 (2.05)	-.427 (1.761)
N	677	677	667	667
Groups	29	29	28	28
Pseudo R ²	-	-	-	0.245

Robust standard errors are clustered by country and are in parentheses below coefficients. Statistically significant coefficient estimates are in bold and are denoted by *($p < 0.05$), **($p < 0.01$), ***($p < 0.001$). Models 7.2 – 7.2.3 use random effects panel estimators. Model 7.2.4 uses a standard probit estimator, with robust errors clustered by country, and includes the variable *Policy Directive*, described in section 7.1.2.

7.3 Appendix III – Sources Used to Code Nuclear Weapon Organizations

Algeria

Albright, David and Corey Hinderstein. “Algeria: Big Deal in the Desert?” *Bulletin of the Atomic Scientists* 57.3 (2001): 45-52.

Journal Officiel de la Republique Algerienne, presidential decree 82-45, February 2 1982, p. 128; presidential decree 82-215, July 6 1982, pp. 889-892; presidential decree 84-273, September 23 1984, p. 1054; presidential decree 86-72, April 9 1986, pp. 364-366; presidential decree 88-59, March 22 1988, p. 345

Khelfaoui, Hocine. “Scientific Research in Algeria: Institutionalisation versus Professionalisation.” *Science, Technology & Society* 9.1 (2004): 75-101.

Usa, Ibp. *Global Research Nuclear Reactors*. Volume 1. Washington, D.C.: International Business Publications USA, 2011.

Argentina

Carasales, Julio C. “The So-Called Proliferator That Wasn’t: The Story of Argentina’s Nuclear Policy.” *Nonproliferation Review* 6.4 (1999): 51-64.

Hymans, Jacques. “Of *Gauchos* and *Gringos*: Why Argentina Never Wanted the Bomb, and Why the United States Thought It Did.” *Security Studies* 10.3 (2001): 153-185.

Australia

Walsh, James. “Bombs Unbuilt: Power, Ideas, and Institutions in International Politics.” PhD dissertation, Massachusetts Institute of Technology, 2001.

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7.4 Appendix IV – Sources Used to Code Fissile Material Facility Data

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