The Myth of the Poor Man's Atomic Bomb and the Politics of Proliferation

Poor Toulabi, Biejan

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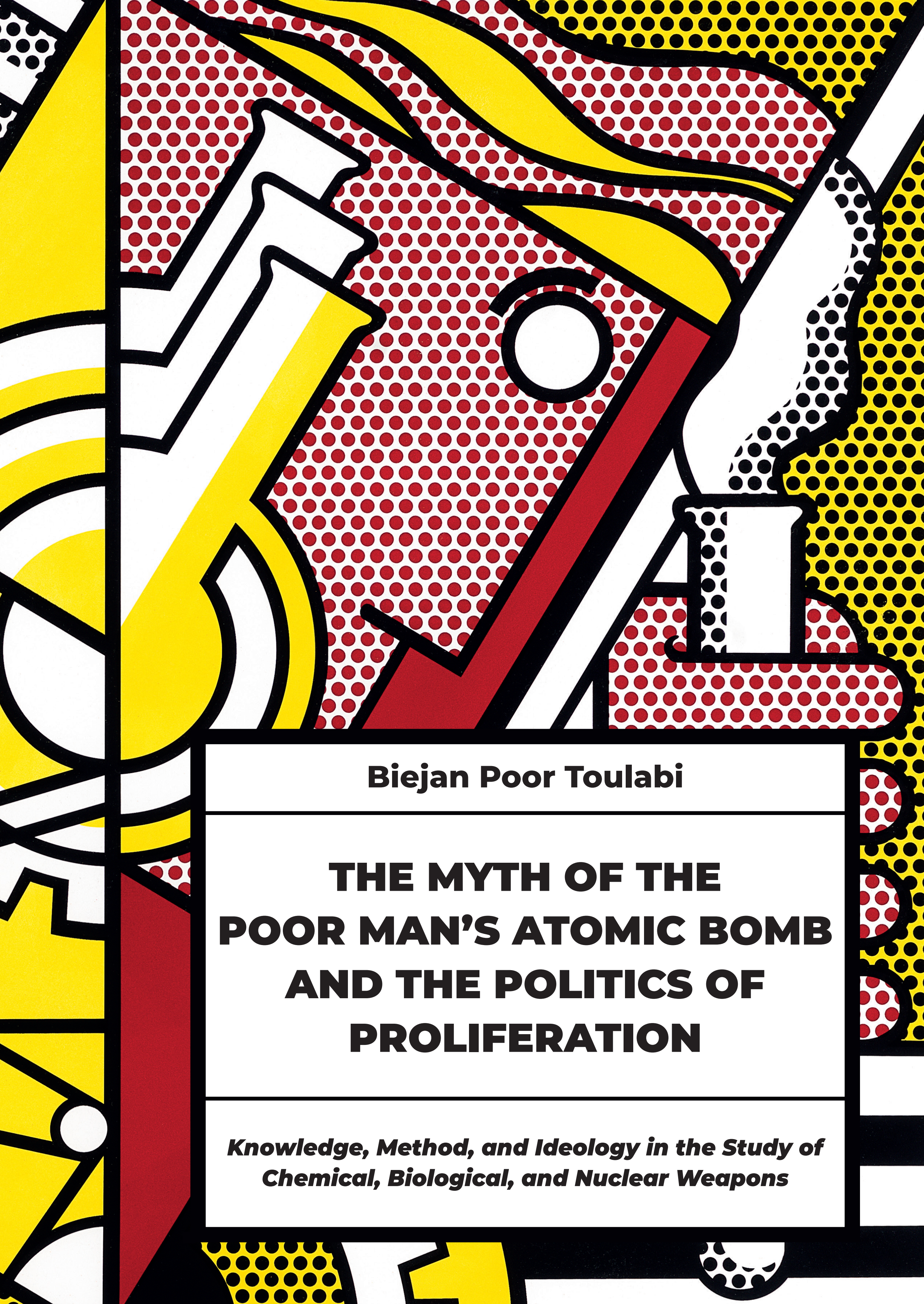

Biejan Poor Toulabi

THE MYTH OF THE POOR MAN'S ATOMIC BOMB AND THE POLITICS OF PROLIFERATION

Knowledge, Method, and Ideology in the Study of Chemical, Biological, and Nuclear Weapons

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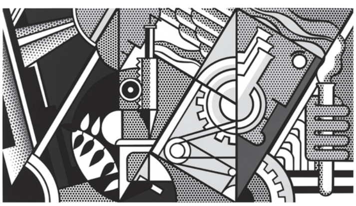

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The Myth of the Poor Man's Atomic Bomb and the Politics of Proliferation

Knowledge, Method, and Ideology in the Study of Chemical, Biological, and Nuclear Weapons

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LIST OF ABBREVIATIONS

ACDA	Arms Control and Disarmament Agency
AIPAC	American Israel Public Affairs Committee
BND	Bundesnachrichtendienst (West-German Federal Intelligence Service)
BW	Biological weapon
B(T)WC	Biological (and Toxin) Weapons Convention
BWRP	Bacteriological Warfare Research Panel
CB	Chemical and biological
CBM	Confidence building measure
CBN	Chemical, biological, and nuclear
CBW	Chemical and biological weapons
CD	Conference on Disarmament
CIA	Central Intelligence Agency
CNA	Coincidence Analysis
csQCA	Crisp-set Qualitative Comparative Analysis
CW	Chemical weapon
CWC	Chemical Weapons Convention
CWFP	Chemical weapons production facility
DIA	Defense Intelligence Agency
DRB	Defense Research Board
DRPC	Defense Research Policy Committee
fsQCA	Fuzzy-set Qualitative Comparative Analysis
GDR	German Democratic Republic
HEMED	(Israel Defense Force) Science Corps
IAEC	Israel Atomic Energy Commission
IIBR	Israel Institute of Biological Research
ISG	Iraq Survey Group
IR	International Relations
ISS	International Security Studies
NATO	North Atlantic Treaty Organization
NPT	(Nuclear) Non-Proliferation Treaty
NTI	Nuclear Threat Initiative
MEWMDFZ	Middle East Weapons of Mass Destruction Free Zone
mvQCA	Multi-value Qualitative Comparative Analysis
NBC	Nuclear, biological, and chemical
OPCW	Organisation for the Prohibition of Chemical Weapons
OTA	Office of Technology Assessment
PLA	People's Liberation Army
PMAB	Poor man's atomic bomb

QCA	Qualitative Comparative Analysis
SADF	South African Defense Forces
SIPRI	Stockholm International Peace Research Institute
SGTEB	Sous Groupe de Travail et d'Études Biologiques
SNIE	Special National Intelligence Estimate
SVR	Foreign Intelligence Service of the Russian Federation
TQCA	Temporal Qualitative Comparative Analysis
UK	United Kingdom
UN	United Nations
UNMOVIC	United Nations Monitoring, Verification and Inspection Commission
UNSCOM	United Nations Special Commission
US	United States (of America)
USSR	Union of Soviet Socialist Republics
WHO	World Health Organization
WMD	Weapon of Mass Destruction
WWI	World War I
WWII	World War II

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This dissertation would not have materialized were it not for the support of colleagues, friends, and family. These pages are dedicated to them.

I have to begin with expressing my gratitude to my supervisors Wolfgang Wagner and Barbara Vis. They have been involved with this project from its earliest inception by supervising my Master's thesis, which analyzed competing explanations of nuclear weapons spread and reversal. As I was exploring possible topics for a doctoral project around the theme of nuclear weapons, Wolfgang's fateful suggestion to think about the relationship between different classes of unconventional weapons ultimately gave rise to this dissertation. As the project took a more 'critical' approach over time, his encouragements were coupled with wise counsel on the possible (academic) career implications of this direction. This dissertation has benefitted immensely from Barbara's methodological rigor and detailed feedback, especially as I grappled with the quantitative and QCA chapters. More importantly, the flexibility and freedom my supervisors afforded me during this process was an important factor in getting the project done as an unfunded candidate.

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Biejan Poor Toulabi,
Amsterdam, February 2021

1

Introduction: The ‘Poor Man’s Atomic Bomb’ and the Politics of Proliferation

INTRODUCTION

Just recently, the world commemorated the centenary of the end of World War I (WWI), the first armed conflict in the modern era to feature the large-scale use of chemical and biological weapons (CBWs). The horrific experiences of gas warfare during WWI ushered in a century that would see states employ CBWs at different times, such as Italy's use of chemical weapons during its colonial wars in Ethiopia and Libya in the 1930s,[1] Japan's use of biological and chemical weapons in China during the 1930s and 1940s,[2] the United States' use of chemical weapons during the Vietnam War,[3] and Iraq's use of chemical weapons during its war with Iran as well as against its own Kurdish and Shi'a populations in the 1980s and early 1990s.[4] These weapons have remained prominently on the policy agenda in recent years as Syrian government forces employed chemical weapons throughout the country's ongoing civil war and nerve agents were used in the poisonings of Kim Jong-Nam, Sergei Skripal, and Alexei Navalny.[5]

Notwithstanding the recent cases of chemical weapons use, the post-Cold War era has been characterized by a number of notable chemical and biological disarmament and non-proliferation successes. In this period, the number of states that possessed CBWs reached its lowest point since World War I. The Chemical Weapons Convention, one of the signature disarmament achievements of the era, has been an important driver of this trend. Remarkably, it took just ten years for the agreement to reach near universal membership since entering into force in 1997.

On the non-proliferation front, Iraq and Libya—two countries that were long suspected of clandestinely developing or even possessing chemical, biological, and nuclear weapons—either wound down their weapons programs or were found to have done so years prior. Following months of secret negotiations with the United States and the United Kingdom, Libya announced in 2003 that it would dismantle its chemical and nuclear weapons program in exchange for the lifting of sanctions and the normalization of relations with the West. Subsequent inspections by British and American experts revealed that a long-suspected biological weapons program did not even exist.[6] The standoff over Iraq's suspected weapons programs in the late 1990s and early 2000s was the principal rationale for the United States-led invasion of Iraq in 2003. However, following the removal of Saddam Hussein from power, coalition inspectors found no evidence of ongoing clandestine weapons programs. A U.S. government report later concluded that Iraq had actually terminated its chemical,

1 Sbacchi 2005; Mallett 2003, 17.
2 Harris 1995; Yang 2006, 34–39; Grunden 2017.
3 Paxman and Harris 1982, 190–196.
4 Duelfer 2005b, 5.
5 Hubbard 2020; Paddock and Sang-Hun 2017; Wintour and Eddy 2018; Schwirtz and Eddy 2020.
6 Commission on Intelligence Capabilities 2005, 252–253.

biological, and nuclear weapons programs a decade prior to the invasion.[7] Unfortunately, the effects of this "colossal error in judgement", as then-Senator John Kerry called it, have been devastating as violence, instability, and political crisis have gripped Iraq and the wider region since.[8]

The spread of unconventional weapons—chemical, biological, and nuclear (CBN)—among states has remained one of the most visible and persistent international policy issues to this very day.[9] Nonetheless, as we will shortly see, there has been surprisingly little scholarly effort to understand to what extent CBWs have spread among states and the factors that drive CBW spread and restraint.

IN THE NUCLEAR SHADOW: ECONOMICS OF ATTENTION & THE (RE)CONSTRUCTION OF CBWS AS A 'POOR MAN'S ATOMIC BOMB'

Policymakers and experts have given relatively limited attention to CBWs compared to nuclear weapons. United Nations (UN) Secretary General U Thant already drew consideration to the disparate policy focus in a 1968 report: "the question of chemical and biological weapons has been overshadowed by the question of nuclear weapons, which have a destructive power several orders of magnitude greater than that of chemical and biological weapons."[10] Nuclear weapons have dominated the research agenda in the field of International Relations, and its sub-field of International Security Studies (ISS), as well.[11] Even as the scholarly community's gaze widened beyond strictly state-centric military conceptions of security during Cold War détente in the 1970s, but also after the end of the Cold War, the attention paid to unconventional weapons skewed heavily in favor of the nuclear kind.

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7 Duelfer 2005a; Duelfer 2005b; Duelfer 2005c.

8 Reynolds 2004.

9 CBN weapons can be considered unconventional weapons as they cause damage through chemical, biological, or radiation effects on life processes. This distinguishes them from conventional weapons (such as bullets, explosives, and incendiary weapons) whose ability to damage comes from kinetic energy release. Nuclear weapons also cause damage through the release of kinetic energy (namely, massive explosion), but this energy is the result of a nuclear reaction rather than the chemical reaction of a conventional explosive. Chemical, biological, and nuclear weapons are often referred to as 'weapons of mass destruction' (WMD). However, this moniker is highly politicized, ignores that chemical and biological weapons cause little kinetic damage, exaggerates the scale upon which a single chemical weapons can produce harm, and ignores that the lethal effects of biological weapons are highly variable; see Enemark 2011. For these reasons, I will mostly avoid the use of the term 'WMD' in favor of categorizing the three weapons systems as CBN/NBC weapons or unconventional weapons.

10 UN Secretary General 1968, 4.

11 Buzan and Hansen 2009, 19; Walt 1991, 214. 'ISS' may not be universally recognized as a designator for the sub-field. Following Buzan and Hansen, I use 'ISS' as an umbrella term to include works by scholars that might refer to themselves as belonging to fields such as 'security studies', 'international security', 'strategic studies', or even 'peace research'. See Buzan and Hansen 2009, 1.

The discrepancy in scholarly attention becomes plainly visible when taking a look at the published articles in two prominent scholarly journals that deal with issues related to unconventional weapons. In *International Security*, an influential and prestigious journal focusing on International Security Studies, 127 of the articles published in the period 1974-2014 mentioned "nuclear" in the title, while "chemical" and "biological" were only mentioned in 5 and 6 titles, respectively. In the *Nonproliferation Review*, a journal that was founded after the Cold War to specifically study "the causes, consequences, and control of the spread of nuclear, chemical, and biological weapons", the word "nuclear" was mentioned in 486 titles in the period 1994-2019, whereas "chemical" and "biological" were mentioned in only 39 and 45 titles, respectively.

That nuclear weapons have received the bulk of the attention after WWII does not mean that policymakers and experts have been unconcerned with CBWs. On the contrary, the invention of the atomic bomb in the 1940s and the introduction of the novel concept of 'weapons proliferation'—the notion of a rapid, uncontrolled, and undesirable spread of unconventional weapons—in the 1960s presented a new modality through which CBWs would be (re)cast as a cheap, attractive, and easy to acquire alternative to nuclear weapons: a 'poor man's atomic bomb'.

To fully appreciate the significance of this discursive shift we have to briefly consider the 'pre-nuclear history' of CBWs. Chemical and biological weapons emerged in the early twentieth century as an essential product of the Second Industrial Revolution. The establishment of a chemical industrial base among the industrialized countries of the West in the second half of the 1800s introduced the possibility of military applications of novel toxic compounds.[12] Focused CW research, development, and production programs took shape especially among the large European industrial powers (Germany, France, and the United Kingdom) during World War I and the spread of offensive chemical warfare capabilities accelerated after the war as many industrialized countries set up CW programs supported by technology transfers and other forms of assistance from the large industrial powers. The interbellum also saw the introduction, and later abandonment, of CWs by European states in their colonies in the 'Third World'.[13] Around the same time, the development of modern microbiology, and with it the advancement and general acceptance of the germ theory of disease, made the isolation and culturing of pathogens for use as warfare agents possible.[14] As a result, many of the same (industrialized) states—among which, Germany, France, the United Kingdom, the Soviet Union, Canada, the United States, and Japan—founded BW programs during World War II.[15]

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12 Zanders 1995, 91. On the link between the development of the field of organic chemistry during the late 1800s and early 1900s and the advent of chemical weapons, see Croddy 2002, 133–136.

13 Zanders 1995a, 93.

14 Croddy 2002a, 222.

15 Most of these programs took shape after World War I and in the lead-up to World War II. However, there is some evidence that Germany and France may have already conducted some sabotage operations with BW agents during World War I, see Ibid.; Wheelis 1999.

The concern over CBWs spreading to states outside industrial core quickly emerged as World War II drew to an end. A report on biological warfare that was prepared for the U.S. Secretary of War in November 1945 warned that, "unlike the development of the atomic bomb and other secret weapons during the war, the development of agents for biological warfare is possible in many countries, large and small, without vast expenditures of money or the construction of huge production facilities."[16] UN Secretary General U Thant noted some years later that CBWs, "may be even more dangerous than nuclear weapons because they do not require the enormous expenditure of financial and scientific resources that are required for nuclear weapons. Almost all countries, including small ones and developing ones, may have access to these weapons which can be manufactured quite cheaply, quickly and secretly in small laboratories and factories."[17]

This idea that CBWs present an acute danger because they are a relatively cheap and easy to acquire alternative to nuclear weapons found expression in the metaphor of the 'poor man's atomic bomb' (PMAB). The metaphor and its constituent connotations were aptly captured by U.S. Senator Charles Percy during a 1984 congressional hearing:

> We all know that any proliferation of nuclear weapons threatens humanity. Now we are learning that for other, less costly, easier-to-make weapons, far less sophistication is required, although they may pose a threat approaching the horror of nuclear war and nuclear arms. That is why some are calling chemical and biological weapons the poor man's atomic bomb."[18]

The use of the 'poor man's atomic bomb' metaphor in relation to chemical and biological weapons occurred as early as the late 1940s,[19] but the metaphor started to gain traction in policy and academic circles in the 1960s in connection with Egypt's use of chemical weapons in the North Yemen Civil War and during negotiations of the Nuclear Non-Proliferation Treaty (NPT).[20] By the 1980s, U.S. government officials were routinely sounding the alarm about the 'poor man's atomic bomb', warning that as many as two dozen (mostly 'Third World') states had already acquired or were on the verge of acquiring CBWs.[21] This vision of rapidly spreading biochemical danger among 'developing' states

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16 Merck 1945, 6.

17 UN Secretary General 1968, 4.

18 U.S. Senate Committee on Foreign Relations 1984, 34.

19 For instance, a book review in a 1949 issue of the *Bulletin of Atomic Scientists* made note of the use of the term in the contemporary "popular literature" and even formulated some early critiques of it, see McLean 1949, 354.

20 Stockholm International Peace Research Institute 1973, vol. II, 153.

21 See, for instance, DeFrank and McDaniel 1989; Darst 1988; Webster 1988, 11; E.g. Bush 1989c; U.S. House Committee on Armed Services 1989, 39f.; U.S. Senate Committee on Foreign Relations 1989, 29f.

was burned into the public's consciousness as threat assessments were eagerly repeated in a plethora of news reports and in academic and policy-oriented publications throughout the 1980s and 1990s.

As we will shortly see, there are crucial problems with these assessments of the magnitude and nature of the spread of CBWs. For one, estimates about the number of states that have pursued and possessed CBWs have routinely been wildly inflated. Second, the notion of a 'poor man's atomic bomb' does not actually reflect which countries have pursued and possessed CBWs and their reasons for doing so. Unfortunately, though, the idea that CBWs are a cheap and easy to acquire alternative to nuclear weapons and, therefore, have spread widely remains a commonly accepted view among policymakers and experts.[22] In fact, scholars in the fields of International Relations (IR), or its sub-field of International Security Studies (ISS), have made few efforts to study the extent to which CBWs have spread among states after World War II and the motivations of states for embarking embark on or terminating CBW programs.[23] This dissertation addresses these very issues by means of the following research question:

To what extent have chemical and biological weapons spread among states and what has driven the spread and rollback of chemical and biological weapons programs after World War II?

From this emerges a critique of two broadly accepted ideas about CBWs: (1) that CBWs have spread widely (i.e., 'proliferated'), particularly among states in the 'Third World'; and (2) that this supposed spread has occurred because CBWs are an easy and readily available alternative to nuclear weapons. This study repudiates the underlying technological and security determinism of the 'poor man's atomic bomb' thesis and, more generally, the 'proliferation paradigm', which presents the spread of unconventional weapons as an inevitable consequence of the availability of technology and systemic pressures, to the exclusion of social and political contingencies.

Throughout this dissertation, I show that, contrary to the assessments and predictions over the years, CBWs have actually not proliferated widely nor have so-called 'developing' states been especially partial to them. I also show that the spread of unconventional weapons is a complex social and political phenomenon in which decisions to embark on or end CBW programs are shaped by a constellation of domestic conflict conditions, external security considerations, and normative and legal constraints.

In the remainder of this introductory chapter I will first take a brief historical flight

22 See Carus 1991; Harris 1992; Lord Lyell 1996; U.S. Assistant Secretary of Defense for Public Affairs 1997; Venter 1999; Horowitz and Narang 2014; Headley 2018.

23 'ISS' may not be universally recognized as a designator for the sub-field. Following Buzan and Hansen, I use 'ISS' as an umbrella term to include works by scholars that might refer to themselves as belonging to fields such as 'security studies, international security', 'strategic studies', or even 'peace research'. See Buzan and Hansen 2009, 1.

through the attention that scholars and policymakers have given to the spread of CBWs since the 1950s. Second, I will discuss the challenges of relying on the 'poor man's atomic bomb' to explain and predict the spread of CBWs. Third, I will outline the gaps in the existing research into the spread of CBWs that this dissertation will address. Fourth, I will lay out the methodological framework for tackling these gaps. Finally, I will conclude with an outline of the structure of the dissertation.

A BRIEF HISTORY OF THE STUDY OF CBWS

The scholarly attention to the problem of CBWs started taking root in the late 1950s and 1960s. Of particular importance to this development was the Pugwash Conferences on Science and World Affairs, which has convened CBW expert meetings, bridging the East-West divide, since 1959. In the decades since, these meetings have been attended by hundreds of participants from dozens of countries.[24] In the mid-1960s Pugwash's CBW efforts were concentrated in a Pugwash Biological Weapons (BW) Study Group, which would go on to organize regular expert workshops and policy research projects for Pugwash members to collaborate on.[25] The launch of the BW Study Group initiated a decades-long Pugwash commitment to solving the problem of CBWs, which was instrumental in the establishment and subsequent implementation of, among others, the 1972 Biological Weapons Convention (BWC) and the 1993 Chemical Weapons Convention (CWC).[26] Fortuitously, the early years of the BW Study Group coincided with the founding of the Stockholm International Peace Research Institute (SIPRI), a project initiated by the Swedish government and parliament to commemorate 150 years of unbroken Swedish peace in 1966. Due to generous financial support from the Swedish government and SIPRI's international connections in the CBW world, SIPRI's CBW program was perfectly positioned to subsume the Pugwash BW Study Group's research projects.[27]

One of the earliest SIPRI-led CBW projects was an important six-volume study entitled *The Problem of Chemical and Biological Warfare* that was published between 1971 and 1975. This ambitious undertaking was intended to provide a "comprehensive survey of all aspects of chemical and biological warfare and of the problems of outlawing it" to disarmament negotiators and their delegations during CBW negotiations in Geneva.[28] Around this time two other influential expert studies on CBWs were prepared under auspices of two intergovernmental organizations. The first was a report on the effects of CBW use prepared

24 Kaplan 1999; Robinson 1998.
25 Robinson 1998, 236. A separate Chemical Weapons (CW) Study group would be established in the early 1970s.
26 Kaplan 1999; Robinson 1998.
27 Robinson 1998, 238.
28 Stockholm International Peace Research Institute 1971, vol. I, 7.

by the UN Secretary General in 1969 at the behest of the UN General Assembly.[29] The second was a study on the health aspects of CBWs released by the World Health Organization (WHO) in 1970.[30] Fittingly, the directories of consulted experts of these two reports consisted of a veritable who's who of Pugwash and SIPRI affiliates.

By the 1970s, a small but dedicated community of experts was pushing forward research on the topic of chemical and biological weapons. The substantive focus of this research lied heavily on the technical, medical, and military aspects of CB warfare and the challenges for international control of CBWs.[31] The majority of the experts involved had a natural or life sciences background (primarily, chemists, microbiologists, physicians, and physicists) and only a few contributors hailed from the social sciences or humanities. And, while attention was paid to allegations of CBW use, among others in the first two of the aforementioned SIPRI volumes,[32] little investment was made in studying states' CBW histories or the drivers of states' CBW behavior, topics typically of interest to historians and political scientists.

Until the end of the 1970s, the worry about a spread of CBWs was not of acute concern to policymakers or the general public. Most known CBW possessors at that time had acquired their arsenals in the first half of the twentieth century and there seemed to be little change in the number of CB-armed states in the first three decades after World War II.[33] Notably, the United Kingdom ended its possession of both chemical weapons and biological weapons in the mid-1950s. France and the United States ended their BW programs at the end of the 1960s, while the United States put a moratorium on CW production at the same time. That Egypt joined the CBW possessors club, evidenced by its use of chemical weapons in Yemen in the 1960s, was of concern and initiated early discussions in U.S. government circles about the dangers of the 'poor man's atomic bomb.'[34] However, the prevailing policy frame was still very much that of the East-West rivalry, with a focus on the CBW capabilities of the two superpowers—from both a qualitative and quantitative perspective—and the spread of CBWs to their clients in NATO and the Warsaw Pact. In typical Cold War fashion, this resulted in flurries of public accusations, such as when China and the Soviet Union accused American troops of using BWs during the Korean War or when the United States charged the USSR with violating the BWC after an outbreak of anthrax occurred in the Russian city of Sverdlovsk in 1979.[35]

Public attention to CBWs shifted into high gear in the 1980s as indications began to pop up that these weapons were beginning to spread into the 'Third World'. The watershed moment was

29 UN Secretary General 1969.

30 World Health Organization 1970.

31 Typical topics were, for instance, the question of international verification systems, on-site inspections, medical defense, methods for analysis of agent samples, and confidence-building measures.

32 Stockholm International Peace Research Institute 1971, vol. I; Stockholm International Peace Research Institute 1973, vol. II.

33 Burck and Flowerree 1991, xix.

34 Stockholm International Peace Research Institute 1973, vol. II, 153.

35 On the charges against the United States during the Korean War, see Chen 2009; Moon 1992. On the Sverdlovsk incident, see Leitenberg 1991.

Iraq's brazen and repeated use of chemical weapons against Iran from 1983 onward. Around this time, U.S. government officials began to warn, on and off the record, about an increasing number of developing countries attempting to acquire CBW capabilities as a cheap and easy to acquire alternative to nuclear weapons: a 'poor man's atomic bomb'. In 1983, a Special National Intelligence Estimate (SNIE) prepared by the U.S. intelligence community, portions of which were leaked to the media, noted that "the past decade has seen an ominous proliferation of chemical weapons acquired by Third World states."[36] Following unofficial briefings on the SNIE, media soon reported that 13 countries in the Middle East, South and East Asia, and Africa possessed chemical weapons in addition to the known possessors (the United States, USSR, and France).[37] Secretary of Defense Weinberger asserted in a Senate testimony in February 1985 that, "more than 15 nations are believed to possess chemical weapons, and many more are capable of acquiring them."[38] Two weeks later, Deputy Assistant Secretary of Defense Welch testified to the same committee that "about 16" "mostly Third World" states had taken up CWs by the early 1980s, adding that CWs have "been called the Poor Man's Atomic Bomb and indeed it does fit into this idea of a cheap mass destruction weapon."[39]

Throughout the remainder of the 1980s, U.S. government officials repeatedly issued dire warnings about the spread of the 'poor man's atomic bomb' among 'Third World' countries.[40] In a 1989 interview President-Elect Bush, likened CBWs to a "poor man's atomic bomb", while a year earlier CIA Director Webster and CIA Deputy Director Gates characterized chemical weapons in these terms and predicted a "rapid spread [of them] among developing countries."[41] By the late 1980s, estimates of the number of new 'proliferators' had risen yet again. Officials were repeatedly warning the public that as many as two dozen states, most indeed from the 'Third World', were pursuing, or had already acquired, chemical or biological weapons, and many more could do so shortly.[42] CIA Director Webster, for instance, indicated in a 1989 testimony before the Senate Committee on Foreign Relations that, "as many as 20 states may be developing chemical weapons, and we expect this trend to continue" and that "at least 10 countries are working to produce both previously known and futuristic biological weapons."[43] These public statements by officials went hand in hand with a barrage of investigative reporting that was, "stimulated by leaked official papers and attributable official briefings, and both sustained by and sustaining a motley of academic and political commentators."[44] By the early 1990s, U.S.

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36 Director of Central Intelligence 1983, 10.

37 The most complete lists of countries named in the SNIE were published in Ember 1985; Ember 1986. But also see, among others, Anderson 1984; Halloran 1984; Oberdorfer 1985.

38 U.S. Senate Committee on Armed Services 1985, 437.

39 Ibid., 1540.

40 Burck and Flowerree 1991, 172–175.

41 DeFrank and McDaniel 1989; Darst 1988; Webster 1988, 11.

42 E.g. Bush 1989c; U.S. House Committee on Armed Services 1989, 39f.; U.S. Senate Committee on Foreign Relations 1989, 29f.

43 U.S. Senate Committee on Foreign Relations 1989, 30.

44 Robinson 1991, 33.

government officials asserted that the numbers of states pursuing or possessing CBWs was still increasing. Secretary of Defense Cheney gave the highest number on the record when he told the American Israel Public Affairs Committee (AIPAC) in 1990 that, "23 foreign countries have confirmed or suspected chemical warfare programs and 10 have or may have biological warfare programs."[45] Just a year later Cheney predicted during a Senate hearing that 30 countries would have chemical weapons and 10 would have biological weapons by the year 2000.[46]

Public attention to the spread of CBWs tapered off as the end of the Cold War went by and the United States entered its brief unipolar moment. The adoption and entry into force of the CWC in the 1990s meant that there finally was an unequivocal prohibition on the development and possession of chemical weapons. Its success was quickly apparent as more than a hundred states had already became party to the Treaty in the year it entered into force, a mere four years after its adoption. Frequent warnings of rapid CBW proliferation among 'Third World' states by Reagan and Bush era officials simmered down in the mid-1990s, but were soon replaced by warnings of 'WMD proliferation'—of the nuclear, biological, and chemical kind—by so-called 'rogue-states'.[47]

Although the political context—i.e., the East-West rivalry—had changed, the end of the Cold War had little effect on the intensity of scholarly attention to nuclear weapons; it just shifted the attention even further to the question of nuclear proliferation.[48] Rather than withering away, the study of the causes and consequences of nuclear spread experienced a veritable renaissance in the late 1990s and early 2000s.[49] Meanwhile, the study of the (non-) spread of chemical and biological weapons has received but a fraction of the attention among political scientists. While some in-depth case studies of CBW programs,[50] some theoretical work on the causes of CBW spread,[51] and one recent quantitative investigation of the 'poor man's atomic bomb' thesis[52] have been published, the volume of available CBW literature is dwarfed by the number of studies on nuclear weapons.

Unfortunately, the limited scholarly attention to the spread of CBWs from 1945-1980 coupled with the 'Third World' proliferation and 'rogue state' narratives of the 1980s through to the mid-2000s have severely hampered our understanding of the dynamics of CBW spread. Indeed, the commonly accepted view among many policymakers and academics still seemsto be that CBWs have spread widely in the past and that they are a cheap and easy to acquire alternative to nuclear weapons: 'a poor man's atomic bomb'.[53]

45 Cheney 1990.
46 U.S. Senate Committee on Armed Services 1991, 16–17.
47 Onderco 2014, 7–8.
48 Buzan and Hansen 2009, 170.
49 Sagan 2011.
50 For example, Wheelis, Rózsa, and Dando 2009; Geissler and van Courtland Moon 1999; Balmer 2001; Avery 2013; Gould and Folb 2002.
51 For example, Martin 2002; Koblentz 2003; Koblentz 2013.
52 Horowitz and Narang 2014.
53 See Carus 1991; Harris 1992; Lord Lyell 1996; U.S. Assistant Secretary of Defense for Public Affairs 1997; Venter 1999; Horowitz and Narang 2014; Headley 2018.

PROBLEMATIZING THE 'POOR MAN'S ATOMIC BOMB' THESIS

The 'poor man's atomic bomb' thesis consists of two separate but related components and when the term is used, one may refer to either one of them or both at the same time. First, the thesis advances a theory of process. By this I mean that it proposes an interpretation of the magnitude and the speed of the historic diffusion of CBWs among states and a prediction of what this process will look like in the future. This is reflected in the idea that CBWs have spread widely and at a fast, perhaps even accelerating, pace—i.e., that they have 'proliferated'—and will continue doing so. Second, the thesis advances an explanation of state behavior or, more specifically, a theory of why states have a desire for CBWs. In short, this involves the idea that CBWs are a cheap, (relatively) easy to acquire, and effective replacement for nuclear weapons, which makes them desirable to states, particularly 'poor' ones that are situated in conflict-ridden regions of the 'Third World'.

Two key assumptions lie at the basis of these conceptions of process and behavior that are advanced by the 'poor man's atomic bomb' thesis. The first of these two assumptions is that technological developments, once set in motion, are unstoppable.[54] This 'technological determinist' interpretation of unconventional weapons spread gained traction in the 1960s and 1970s when experts began to think about which countries would join the club of nuclear weapons possessors next. Since then, techno-determinism has come to dominate thinking about chemical, biological, and nuclear weapons and has played a particularly powerful role in US security policy.[55] From this perspective, 'proliferation' is the consequence of the availability of technology and prospective proliferators are seen as "a mass of 'Nth' countries."[56] Technology is the driving force behind weapons spread and "governments 'decide' to go nuclear because the technology is available, thereby making technical/financial costs manageable and the opportunity irresistible."[57] The 'poor man's atomic bomb' thesis is an application of this techno-economic determinist view, as the ubiquity of chemical and biological technology and knowhow after World War II coupled with the relative ease and affordability of applying them towards the production of CBWs—especially when compared to the efforts required for producing nuclear weapons—is assumed to be sufficient for the spread of CBWs.

The second assumption underlying the 'poor man's atomic bomb' thesis is the contention that nuclear weapons inevitably spread because they are so uniquely compelling to rational and unitary states seeking to survive in an anarchic and competitive international system.

54 Vogel 2013, 46.

55 Hymans 2012, 6–9; Vogel 2013, 46.

56 Betts 1993, 105f.

57 Meyer 1984, 9.

This idea is closely associated with the structural realist school of International Relations.[58] It is most known in both policy and scholarly discourse through the "chain reaction" and "falling dominoes" metaphors that imply that states 'proliferate' in response to one another in a bid to maintain a balance of power.[59] The next step in this train of thought is that states that are incapable of acquiring the 'absolute weapon' will resort to more easily available alternatives like chemical and biological weapons. This infuses the PMAB thesis with a flavor of structural determinism to go with the aforementioned techno-economic determinism.

Yet, in the face of the historical record the 'poor man's atomic bomb' thesis faces two serious flaws. For one, the assessments of and predictions about the spread of CBWs are wildly inflated. Second, the 'poor man's atomic bomb' narrative of the type of countries that have pursued CBWs and their reasons for doing so is inaccurate. As for the first: in the late 1980s and early 1990s a few CBW experts already criticized the official assessments and allegations, as well as the journalists and experts that ran with that information.[60] They noted that many assessments and allegations suffered, among others, from a lack of concreteness and detail, were not well-supported, could not be independently verified, mistook legitimate industrial or defensive activities for offensive military activities, conflated pursuit with possession, and much more. The late Julian Perry Robinson, arguably the most eminent CBW expert of the last fifty years, summarized these problems as follows: "the resultant body of literature—conspicuous gaps, largely undocumented, much of it tendentious and speculative, rarely critical, often contradictory, always unverifiable, and beset by ambiguities—is quite useless as a dependable source of information."[61]

Second, the notion of a 'poor man's atomic bomb' does not accurately describe which states have pursued CBWs and their reasons for doing so. As discussed earlier, many industrialized states of the West already erected CW and BW programs in the first half of the twentieth century and they maintained CB weapons well into the second half of the century. The much-discussed subsequent spread of CBWs among 'developing' states outside the industrial center, on the other hand, has not been as prevalent as frequently stated. Besides, the 'poor man's atomic bomb' thesis obscures the differing tactical and strategic functions of chemical weapons, biological weapons, and nuclear weapons. Neither

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58 Sagan 1996, 57–59; Ogilvie-White 1996, 45; Hymans 2006, 456. Some authors argue that technological determinism is an inherent feature of structural realist theory, see Herrera 2012, 28–29; Schörnig 2014, 70–71. According to variants of realist thought in International Relations—i.e., classical realism and offensive (structural) realism—states do not merely seek to maximize security (in the sense of maintaining the balance of power), but seek to maximize relative power positions. See Mearsheimer 2001, 22. In these accounts, states will seek any material capability (including nuclear weapons) that will aid in increasing their relative power when it is available to them. Of course, this is merely an application of the technological imperative discussed above.

59 Pelopidas 2011, 303; Sagan 1996, 58–59; Potter and Mukhatzhanova 2008, 159.

60 See, among others, Zilinskas 1990, 59; Burck and Flowerree 1991, 157–162; Harris 1989b, 39–41; Robinson 1991, 22–25.

61 Robinson 1991, 33.

chemical nor biological weapons can destroy physical edifices, unlike nuclear weapons or conventional explosives. Chemical weapons also have to be delivered in large quantities to approach the fatal effects of a nuclear weapon, while they are less fatal against well-protected troops and populations than many conventional explosives.[62] Biological weapons, on the other hand, can potentially cause widespread fatalities if delivered under the right conditions against unprotected populations.[63] Yet, their delayed and unpredictable effects combined with the secrecy required for a successful large-scale attack make them an unreliable strategic deterrent at best.[64]

As Brad Roberts noted, "given the unfamiliarity of many analysts with chemical and biological weapons, there is a tendency to equate these weapons with their nuclear counterparts."[65] In reality, many (former) nuclear weapons possessors—e.g., the United States, France, South Africa, Soviet Union/Russia, Israel, India, and China—concurrently maintained CBW programs alongside their nuclear weapons programs for a long time, while some of them still do to this very day. And, of the non-nuclear states that pursued CBWs, very few did so for the purpose of acquiring a strategic weapon in the way that nuclear weapons can be used. Indeed, as the 1970s SIPRI study on CBWs already noted, "the 'poor man's deterrent' proposition has never, to our knowledge, been voiced by a 'poor man.'"[66]

Despite the appeal and parsimony of the PMAB thesis, its techno-determinist and structural realist underpinnings tend to over predict the spread of CBWs. If the ubiquity of chemical and biological knowhow and materials—and thus the relative ease of acquiring CBWs—drives the spread of CBWs, it is peculiar that not more states have resorted to developing these weapons.[67] However, the supposed ease of building functional CBW deterrents is misleading. The development of biological weapons, in particular, presents tremendous scientific, financial, and organizational barriers not unlike those a country faces trying to develop nuclear weapons.[68] More importantly, though, it should be obvious that capability is only a necessary rather than a sufficient condition for developing CBWs.

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62 Office of Technology Assessment 1993b, 52–54.

63 Martin 2002; Office of Technology Assessment 1993b, 52–55.

64 Koblentz 2003.

65 Roberts 1997, 16.

66 Stockholm International Peace Research Institute 1971, vol. V, 101. In fact, the only leader to publicly refer to the proposition was the speaker of the Iranian Parliament Hashemi Rafsanjani, who stated in 1988 that, "chemical and biological weapons are a poor man's atomic bombs [*sic*] and can be easily produced. We should at least consider them for our defense...Although the use of such weapons is inhumane, the [Iran-Iraq] war taught us that international laws are only drops of ink on paper." See Carus 1991, 35. The latter part of the quote is important and indicates that Rafsanjani's exhortation has to be understood in the context of the Iran-Iraq war and Saddam's repeated use of CWs. Rafsanjani implies that CWs are useful, even legitimate, as an in-kind deterrent when others possess and use CWs rather than making an argument about their utility as a replacement for nuclear weapons.

67 Betts and Lavoy have, among other authors, made similar arguments in regards to nuclear weapons, see Betts 1993, 104–106; Lavoy 1993, 194–195.

68 Ben Ouagrham-Gormley 2014.

Weapons do not suddenly spring into existence. Technical and industrial capability must be combined with some motivation for states to embark on CBW programs.[69]

While some states that have pursued CBWs have indeed faced external security threats—often cited as the prime driver of demand for unconventional weapons—many states facing similar circumstances have never shown interest in CBWs. This is unsurprising as threats have to be filtered through elite perceptions before they can influence armament decisions. This also presents evidentiary problems for the structural realist explanation of the historical spread of unconventional weapons. As Sagan noted, analysts often work back in time, trying to find the national security threat that must have caused a proliferation event.[70] This is tricky insofar as security model explanations rely on statements by leaders that have a vested interest in portraying their choices as serving the national interest. This represents the 'national interest' as shared *faits accomplis* even though they may constitute the parochial concerns of elites or even shared interests of a ruling class.[71] Moreover, such explanations require a "correlation in time" between the occurrence of a security threat and a proliferation decision, which may be incongruent with the historical record.[72]

The fundamental problem of the PMAB thesis, and more broadly the proliferation image, is the exclusion of the role of politics and human agency in the spread of unconventional weapons. Understanding the dynamics of CBW spread, restraint, or reversal requires consideration of the social and political factors that influence the "willingness" of actors to select a behavioral option from a range of alternatives in addition to the "opportunity" provided by environmental and structural conditions.[73] Several alternative theories of CBW spread and reversal have been proposed that focus, among others, on the role of domestic challenges to the rule of sitting regimes, behavioral and legal norms against the use and possession of CBW, and different types of external security benefits and challenges that CBWs provide to states.[74] These different strands of the literature on CBW spread and reversal are discussed at length in Chapter 5.

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69 This does not mean that weapons development is a highly rational and linear process with a narrowly defined endpoint. Nor is capability necessarily antecedent to an interest in military applications of said technologies. Capabilities may be sought *because* there is an interest in military applications or as a hedge to afford the state an option to embark on weapons development at a future time. Of course this does not mean that all (or even many) states have a dormant desire to build unconventional weapons. That would be a determinist fallacy as discussed above. As Itty Abraham has described in the nuclear realm, technology is essentially ambivalent, containing within itself simultaneously potential civilian and military applications, which makes it impossible for either path to be predetermined. See Abraham 2010; Abraham 2006; Abraham 1998.

70 Sagan 1996, 63.

71 As Marx wrote, "The ideas of the ruling class are in every epoch the ruling ideas." See Marx and Engels 1998, 67. Sagan presented a 'domestic politics model', which envisages unconventional weapons as political tools to promote bureaucratic or parochial interests, as an alternative to the 'realist security model'. See Sagan 1996, 63–73.

72 Sagan 1996, 63.

73 Siverson and Starr 1990, 48–49.

74 On CBWs and regime security see Koblentz 2013. On norms see, among others, Price 1997; Tucker 2000, 35–36. On external security considerations, see ibid., 29–35.

GAPS IN EXISTING RESEARCH

This dissertation addresses four gaps in the literature on chemical and biological weapons. *First*, there is still a lack of scholarly attention to the question of why policymakers and scholars have systematically overestimated (and over predicted) the spread of CBWs among states in the post-WWII period. This question is addressed in-depth in Chapter 2 by looking at how faulty research methodologies and the social context in which knowledge is created about unconventional weapons create and sustain inflated estimates of the spread of the 'poor man's atomic bomb'.

Second, there are next to no systematic scholarly accounts of which countries have had CBW programs in the post-WWII period.[75] While some in-depth case studies of the more well-known CBW programs have been published,[76] the CBW activities of many states are not well known. Much of the available information on the spread of CBWs comes from vague and difficult to verify U.S. government allegations against other countries and from subsequent press reports and nongovernmental analyses that have repeated these allegations. I address this gap by introducing a new dataset of state-run CBW programs (indicating when states have pursued and when they have possessed CWs and BWs) in the post-WWII period in Chapter 3, accompanied by detailed case synopses in Chapters 6 and 7.

Third, despite its popularity the 'poor man's atomic bomb' thesis has rarely been systematically tested.[77] I have already discussed the shaky conceptual and theoretical foundations of the PMAB thesis and the empirical inconsistencies it faces earlier in the present introductory chapter. As a next step, I subject the PMAB thesis to a number of quantitative tests in Chapter 4, using the new CBW dataset.

Fourth, unlike the expansive quantitative literature on the causes of nuclear weapons spread, no systematic empirical studies exist on the drivers of CBW spread and reversal. While the policy and scholarly fields have focused on the PMAB thesis as the explanation of CBW spread, other accounts of CBW spread and reversal exist. However, few attempts have been made to study these different theoretical accounts of CBW spread and reversal among the universe of cases. Moreover, the empirical literature has largely focused on why states embark on chemical, biological, and nuclear weapons programs, while neglecting the study of the reversal of such programs. This is especially true for the quantitative literature, which has almost exclusively examined the factors that increase or decrease the risk of 'proliferation' rather than reversal. I address these gaps by applying Quantitative Comparative Analysis

75 Two exceptions are a dataset of CBW pursuit and possession by Horowitz and Narang, which is discussed in-depth in Chapter 2, and an overview of BW programs by Carus, see Horowitz and Narang 2014; Carus 2017.

76 See, for instance, Balmer 2001 on the United Kingdom's BW program; Gould and Folb 2002 on South Africa's CW and BW programs; Lepick 2009 on France's BW program.

77 The one exception is a study by Horowitz and Narang, which offers a quantitative test of the PMAB thesis. See Horowitz and Narang 2014. However, their findings should be approached with skepticism due to the reliance on faulty CBW data (see Chapter 2 of this dissertation).

(QCA), a configurational comparative data analysis method grounded in set theory, to investigate which pathways lead states to embark on or give up the pursuit and possession of CBWs in Chapter 5.

DATA AND METHODS

This dissertation adopts a mixed-methods approach by combining different methods of data collection and analysis, both qualitative and quantitative. Mixed-method approaches are usually associated with triangulation. In research practice triangulation means different things to different authors.[78] For the purposes of this study, I see triangulation, first, as ensuring the validity of conclusions by employing different methods and sources of data collection and analysis.[79] In Chapter 2, I show that experts have played a part in establishing the view that CBWs have spread widely, particularly among 'poor' states, by relying overwhelmingly on vague and unverifiable U.S. government assessments and allegations. In collecting my own data on CBW programs in the period 1946-2010, I consider a wide variety of primary and secondary sources, among which public and declassified government reports from different countries; speeches and statements of leaders; scholarly studies; news archives; reports by non-governmental organizations; and, reports by intergovernmental organizations. The process of collecting data is described in detail in Chapter 3 and is augmented with extensive case narratives in Chapters 6 and 7.[80] This new CBW data is subsequently used in different, complementary, empirical analyses. I start with a qualitative and descriptive analysis of the CBW data in Chapter 3, allowing me to address the extent to which CBWs have spread and discuss some initial insights as to why states have sought and given up CBWs. As I will discuss in further detail below, the remainder of the dissertation consists of a large-N quantitative study of the 'poor man's atomic bomb' thesis of CBW spread and a medium-N Qualitative Comparative Analysis (QCA) of the complex causes of CBW spread and rollback.

The second view of triangulation concerns the idea that different methods provide unique insights.[81] Quantitative and qualitative methods and techniques have their own particular strengths and shortcomings and each can be useful for answering different questions and for providing different insights about the same question. The central concern of quantitative methods is to estimate the average effect of one or more causes across a large population rather than explaining outcomes in particular cases. This is known as the effects-of-causes

78 Bergman identifies four different meanings of triangulation in the literature. Bergman 2008.

79 Ibid., 23–25.

80 These case narratives describe the available evidence, analyze how the evidence is weighed, and make note of uncertainties and alternative specifications.

81 Bergman 2008, 27.

approach.[82] Concurrently, quantitative methods are especially useful for assessing the net (or non-overlapping) contribution of different independent variables on variation in the outcome.[83] These two characteristics make quantitative approaches suitable for testing the strength of the 'poor man's atomic bomb' thesis in a large-N analysis in Chapter 4. From a methods point of view, this should be a soft test for the 'poor man's atomic bomb thesis specifically and structural realist and technological determinist theorizing in general, due to their emphases on parsimony and explanatory power. Accordingly, failing to 'pass the test' should aid in building a substantial case against them.

While the quantitative analysis in Chapter 4 yields important insights about the PMAB thesis, the statistical results are inconclusive about the role of many of the control variables hypothesized to be drivers of CBW spread and reversal. This is because quantitative methods have trouble dealing with complex causation, such as the possibility that causes can occur as combinations of conditions or that multiple paths can be taken towards an outcome.[84] Qualitative methods, on the other hand, are concerned with explaining how different causes combine to produce outcomes in particular cases (the causes-of-effects approach).[85] This is particularly useful for investigating under which conditions states begin or end CBW programs in a medium-N analysis in Chapter 5. I do this by applying Qualitative Comparative Analysis (QCA), a case-sensitive comparative method based on Boolean logic that considers how the presence and absence of conditions, either individually or in particular combinations, are sufficient or necessary for an outcome to occur in different groupings of cases.[86]

Large-N Quantitative Analysis

Since the renaissance of the field of proliferation studies in the early 2000s, scholars have increasingly turned to the use of quantitative methods to study the causes and consequences of weapons spread. Almost all of the studies since have focused on nuclear weapons. One notable exception is a study by Horowitz and Narang that investigates the relationship between demand for CBWs and nuclear weapons, which allowed them to consider whether states treat CBWs as complements or as substitutes (akin to a 'poor man's atomic bomb'). This dissertation's quantitative investigation of the 'poor man's atomic bomb' thesis will follow Horowitz & Narang's research design, with one key difference: I use the new CBW dataset that is presented in Chapter 3.[87] The validity of the 'poor man's atomic bomb' thesis is contingent on the use of reliable data on the spread of CBWs. As I describe in Chapter

82 Mahoney and Goertz 2006, 230–231.
83 Ibid., 235. Bell cites the ability to adjudicate between theories as a standard against which the usefulness of the quantitative proliferation literature is to be judged, see Bell 2016, 521.
84 Mahoney and Goertz 2006, 234–237.
85 Ibid., 230; 234–236.
86 The canonical texts on QCA are Ragin 1987; Ragin 2000. A more recent introductory book on the method is Schneider and Wagemann 2012.
87 Horowitz and Narang 2014.

2, the popularity and acceptance of the 'poor man's atomic bomb' thesis both feeds and, in turn, is reinforced by assessments that CBWs have spread widely among 'poor' states.[88] Substituting the key CBW data while keeping the rest of the research design constant allows me to perform a clean comparison of the results of this test of the 'poor man's atomic bomb' thesis with previously published work by Horowitz and Narang.

I will briefly describe the approach of the quantitative analysis here, although it is elaborated on more extensively in Chapter 4. I use a standard cross-sectional time series dataset that covers the period 1945-2000 and take the country-year as the unit of analysis. Even though my own CBW dataset covers the post-WWII period until 2010, I restrict the analysis to the period 1945-2000 to be able to compare the findings with Horowitz and Narang's study. Right censoring the data at the year 2000 only cuts off a few countries that continued pursuing or possessing CBWs. As most of these countries were nuclear weapons possessors, their exclusion should work against my expectation that states do *not* treat CBWs as replacements for nuclear weapons and in favor of Horowitz and Narang's finding that states do. I, then, perform survival regression analyses to estimate the probability of an event occurring, in this case that a state will initiate pursuit of chemical, biological, or nuclear weapons (the dependent variable) in a particular year given that it has not done so until that point conditional on a number of covariates.[89] The use of survival models (also known as event history, hazard, or duration models) is common in the quantitative nuclear weapons scholarship.[90] The data on CBW programs are taken from the dataset introduced in Chapter 3 of this dissertation and are directly imputed in Horowitz and Narang's replication data file. The data on nuclear weapons programs originate from a study by Gartzke and Kroenig.[91] The analysis further incorporates a set of control variables that might influence the probability that a state pursues chemical, biological, or nuclear weapons.[92]

88 See Chapter 2.

89 On survival models, see Box-Steffensmeier and Jones 2004.

90 See, for instance, Singh and Way 2004; Kroenig 2009; Sasikumar and Way 2009; Bleek and Lorber 2014; Reiter 2014; Horowitz and Narang 2014.

91 Gartzke and Kroenig 2009.

92 Eleven control variables are considered. The total number of shared land borders and whether or not a country has a nuclear-armed ally account for a state's security environment. Gross domestic product per capita (GDPpc) and gross domestic product per capita squared (GDPpc^2) control for a country's relative wealth. A country's membership of the relevant treaties that govern the spread of unconventional weapons (Biological Weapons Convention, Chemical Weapons Convention, and Nuclear Non-Proliferation Treaty) control for the impact of international legal instruments. For each treaty, a system variable is included as well that measures the proportion of states in the international system that have signed the treaty. Finally, a domestic unrest variable measures the amount of riots, strikes, or antigovernment demonstrations a country has faced relative to the size of its population.

Qualitative Comparative Analysis[93]

In this dissertation I also apply Qualitative Comparative Analysis (QCA) to study under which conditions states have embarked on or given up CBW programs. QCA is a configurational comparative method that has found numerous applications by scholars of international relations, foreign policy analysis, and conflict studies.[94] The choice for QCA is based on the observation that the spread and rollback of unconventional weapons programs, like many other social phenomena, is a complex one.[95]

In terms of causality, complexity can manifest itself in three ways.[96] First, complexity can occur as *conjunctural causation*, which means that a combination of conditions can lead to an outcome. Second, it can occur through *equifinality*, meaning that there are multiple paths, covering different groupings of cases, through which an outcome can come about. Third, complexity can manifest itself as *causal asymmetry*, which means that a particular condition can lead to different outcomes depending on the context. Quantitative methods have great difficulty dealing with this conception of complexity.[97] Qualitative case studies, on the other hand, are well suited for dealing with complex causation but make it more difficult to consider a greater number of cases and observe whether patterns exist.[98] A set-theoretic method like QCA combines the best of both worlds as it is especially suited for dealing with causal complexity and can handle small, intermediate numbers, and even large numbers of cases.[99] Moreover, regardless of case number, QCA approaches cases holistically in the sense that each individual case is considered as a complex whole that should be understood rather than overlooked in the course of the analysis.[100] In practice, this means that the researcher can engage in a dialogue between theory and cases throughout the research process, which requires that the case be well-known rather than anonymous.[101]

Due to its set-theoretic nature, QCA makes claims about the *sufficiency* and *necessity* of set relations. Essentially, QCA considers how the presence and absence of conditions, either

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93 This section describes some of the core tenets of QCA as a method. I will further elaborate on the research design of the QCA study in Chapter 5.

94 See, among others, Kiser, Drass, and Brustein 1995; Harvey 1999; Chan 2003; van der Maat 2011; Pinfari 2011; Thiem 2011; Mello 2014; Grynaviski and Hsieh 2015; Haesebrouck and Thiem 2018; Bobić 2019; Mello 2019.

95 Sagan 1996, 63, 85; Bell 2016, 521; Singh and Way 2004, 861; Jo and Gartzke 2007, 167.

96 Schneider and Wagemann 2012, 5–6.

97 Mahoney and Goertz 2006, 234–237; Ragin 2008, chap. 10; Thiem, Baumgartner, and Bol 2016, 757–764.

98 Mahoney and Goertz 2006; Bennett and Elman 2007.

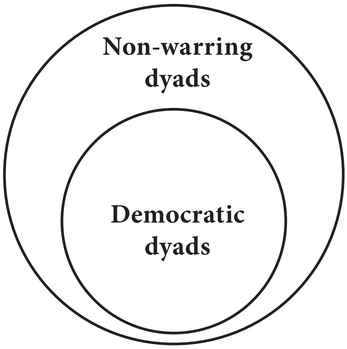
99 Schneider and Wagemann 2012, 78–79, 317; Thiem 2016, 491–492; Thomann and Maggetti 2020, 362–363.

100 Rihoux and Lobe 2009, 223.

101 Berg-Schlosser et al. 2009, 6. This is not possible with quantitative approaches as they sacrifice case-sensitivity in favor of calculating average effects across a sample. Yet, there are some limits to this, even with QCA. While QCA has no trouble dealing with large numbers of cases from a technical point of view, it would be difficult for a researcher to account for all these cases. Hence, as Vis noted, "With a higher number of cases, the […] analysis paints more of the broad picture […] From a qualitative perspective, this is a price to pay indeed." See Vis 2012, 192.

individually or in particular combinations, are sufficient or necessary for an outcome to occur.[102] This is useful for social scientists as social theory often makes set-theoretic claims. The democratic peace thesis, for instance, proposes that democracies do not go to war with one another. We can reformulate this statement in set-theoretic terms: democratic dyads are a (near-)perfect subset of non-warring dyads (see **Figure 1.1**). Naturally, other paths towards peaceful relations between states can be taken (indicating *equifinality*) and the correlation between democracy and absence of war may therefore be low. However, we can still say that relations between democracies may be *sufficient* for the absence of war.[103] Thus, a cause (either a single condition or a combination of conditions) is considered to be sufficient when it produces an outcome on its own.[104] In more formal terms, an argument of causal sufficiency is supported when it can be demonstrated that occurrences of a condition, or a combination of conditions, are sub-sets of occurrences of the outcome. Using the example of the democratic peace: demonstrating that (nearly) all instances of dyads of democratic countries are also non-warring gives empirical support to the argument that the presence of democracy in two states is a sufficient condition for peaceful relations between them.

Figure 1.1: Euler diagram representing the relationship between non-warring dyads and democratic dyads



On the other hand, a cause is considered to be necessary if it is always present when an outcome occurs.[105] In the context of QCA, the presence of causal necessity is established when it can be shown that occurrences of the outcome are a sub-set of occurrences of a condition.[106] Returning to the democratic peace example: demonstrating that (nearly) all instances of non-warring countries are also democracies yields support for a hypothetical argument that the presence of democracy in two states is a necessary condition for peaceful relations between them.

102 In the language of set-theoretic methods, like QCA, the *explanans* is referred to as a (causal) condition, while the *explanandum* is known as the outcome.

103 Ragin 2008, 16.

104 Schneider and Wagemann 2012, 57.

105 Ibid., 69.

106 Ragin 2008, 53.

Generally speaking, three variants of QCA exist: *crisp-set* QCA, *fuzzy-set* QCA, and *multi-value* QCA.[107] I will apply a mix of crisp-set and multi-value QCA in Chapter 5, but it is useful to already discuss the nature of each here. Crisp-set QCA (csQCA) was the original iteration of the QCA as introduced in a seminal book by Charles Ragin.[108] Crisp sets are dichotomies that, for instance, indicate whether a country is considered to be in the set of democratic countries (crisp score of 1) or out the set of democratic countries (crisp score of 0). A later addition, fuzzy-set QCA (fsQCA), maintained these dichotomies but introduced a "membership score" so that cases can be assigned a degree of membership in a defined set.[109] Thus, countries can be fully out the set of democracies (fuzzy score of 0), fully in the set of democracies (fuzzy score of 1), or any degree in between. Yet, many social phenomena do not present themselves in crisp or fuzzy dichotomies, and for some questions it may be useful to consider multinomial categories (e.g., autocracy, anocracy, and democracy); this is made possible by multi-value QCA (mvQCA).[110]

Some QCA methodologists have criticized mvQCA's set-theoretic status. As I will be applying mvQCA in this dissertation, this criticism requires brief elaboration and a rebuttal. The criticism has revolved chiefly around the question of whether multi-value conditions can be considered sets.[111] The critics' argument is that the value of 0 has lost the meaning of negation or absence in mvQCA as it combines multiple sets into one condition.[112] This argument, however, wrongly assumes that crisp conditions only refer to one set.[113] Quite the opposite, in csQCA the two possible values (0 and 1) actually refer to *different* sets. Take the crisp condition "democratic countries", which can take two values: "democratic country" and "not-democratic country". These values refer to two different sets: the set of democratic countries and the set of not-democratic countries. If a country is out the set of democratic countries (value of 0 on the condition "democratic countries") it is then necessarily in the set of not-democratic countries.[114] Staying with this example, a multi-value condition allows the researcher to further break down the set of not-democratic countries if the inclusion of this variation is deemed relevant for the study. Thus, a multi-value condition "regime type" that can take three values (0 = autocracy, 1 = anocracy, 2 = democracy) simply combines

107 A more recent addition, TQCA, enables one to also capture the temporal nature of causal interactions, see Caren and Panofsky 2005; Ragin and Strand 2008. Alternatively, Baumgartner has introduced Coincidence Analysis (CNA), a set-theoretic cousin of QCA based on a novel algorithm, as a technique for identifying causal chains, see Baumgartner 2009; Baumgartner 2013. I will not elaborate further on these two options as I will not be looking into temporality or causal chains. Moreover, neither TQCA nor CNA have been widely applied yet.

108 Ragin 1987.

109 Ragin 2000.

110 Haesebrouck 2015; Cronqvist and Berg-Schlosser 2009.

111 See, among others, Schneider and Wagemann 2012, 258–263.

112 Vink and Van Vliet 2009, 272; Vink and Vliet 2013, 212; Schneider and Wagemann 2012, 258–259.

113 Haesebrouck 2015; also see Thiem 2013, 204–206.

114 The set "not-democratic countries" simply covers all cases that are not members of the set "democratic countries," given the definition used by the researcher. As we will see, the set "not-democratic countries" can cover multiple other sets.

three sets, with the earlier set of not-democratic countries being broken down in two sets: the set of autocratic countries and the set of anocratic countries. A case that is, for instance, in the set autocratic countries (value of 0 on the condition "regime type") is then necessarily out of the set of anocratic countries and out of the set of democratic countries.

OUTLINE OF THE DISSERTATION

The remainder of the dissertation consists of seven chapters. Three papers, of which one is currently under review while the second and third will be submitted soon, make up Chapters 2 through 5.[115] Chapters 6 and 7, in turn, comprise in-depth analyses of, respectively, all CW and BW programs in the period 1946-2010. Finally, Chapter 8 concludes with a summary of findings and discusses the implications of this study for scholarship and policy.

Chapter 2

Chapter 2 investigates how the idea that the spread of chemical and biological weapons is rampant and that it primarily happens among 'poor' or 'developing' countries has come to exist and persist.[116] One half of the answer can be found in prevalent research designs and methodologies. Through an in-depth case study of a recently published political science dataset of CBW programs,[117] this chapter shows that imprecise concepts, a blind trust in proliferation charges originating from the U.S. government, and persistent circular referencing sustain inflated estimates and faulty allegations.[118]

Second, the chapter looks beyond methodological issues and considers the underlying social context in which knowledge about unconventional weapons is produced. This reveals an interplay between governmental and non-governmental analyses that creates, feeds, and entrenches the dominant epistemological paradigm that 'weapons of mass destruction' are inherently desirable and will therefore inevitably spread among states. This chapter not only adds to the debate about the spread of CBWs, but also enriches a growing body of literature that scrutinizes biases in quantitative political science datasets[119] and critical security studies scholarship on the social construction of knowledge in the realm of unconventional weapons.[120]

115 One of the papers is divided in two chapters in this dissertation (Chapters 3 and 4).
116 The article on which Chapter 2 is based is under review.
117 Horowitz and Narang 2014.
118 Ibid.
119 See, for instance, Colgan 2019; Braut-Hegghammer 2019; Montgomery and Sagan 2009.
120 See, among others, Mutimer 1997; Krause and Latham 1998; Pelopidas 2011; Pelopidas 2016.

Chapter 3

Chapter 3 then introduces a new dataset of state-run CBW programs in the period 1946-2010, based on the lessons derived from Chapter 2. During the data-collection effort, available information was meticulously traced back to the original source, in order to prevent circular citations that so often reinforce faulty and unverifiable allegations. Great care was also taken to substantially widen the analytical base of the data. To that end, a wealth of new and more diverse sources were considered in addition to well-known and oft-cited official and unofficial U.S. government reports, among which (recent) case-studies by social scientists and historians, reports by non-governmental and intergovernmental organizations, officially sanctioned histories, and investigative journalism. The ensuing dataset provides a more reliable and more accurate picture of the historical spread of CBWs.

Several important observations can be gleaned from the data. The number of states that have pursued and possessed CBWs is noticeably smaller than commonly assumed, particularly among 'developing states'. Most historical CBW programs, especially in the post-WWII era, have been relatively small and have had limited objectives. Only the Cold War-era biological weapons programs of the United States and the Soviet Union actually had the objective of fielding weapons that could produce fatalities in the same order of magnitude as nuclear weapons. These programs were also the only ones large and sophisticated enough to be able to do so. Finally, the majority of states that have pursued or possessed CBWs have eventually reversed course. Taken together, these findings cast serious doubt on the belief that CBWs have 'proliferated' or that they are a 'poor man's atomic bomb'.

Chapter 4

Where Chapters 2 and 3 scrutinize extant beliefs about the magnitude and nature of CBW spread from a conceptual, methodological, and qualitative empirical point of view, Chapter 4 takes a quantitative approach to studying the drivers of CBW spread and restraint. Taking the CBW dataset introduced in Chapter 3 as the dependent variable, I reanalyze Horowitz and Narang's quantitative test of the 'poor man's atomic bomb' thesis.[121] Although Horowitz and Narang report that the pursuit of nuclear weapons increases likelihood of CBW pursuit while nuclear possession lowers the odds of CBW pursuit—an indication that states may treat CBWs as replacements for, rather than complements to, nuclear weapons—my reanalysis finds that neither nuclear pursuit nor possession have a statistically significant effect on CBW pursuit. Moreover, very few control variables that are traditionally hypothesized to be determinants of proliferation offer robust explanations of CBW pursuit and possession in the statistical analysis. This finding is in line with a recent meta-analysis of the quantitative proliferation literature that found that previous studies have generally failed to offer strong explanations of the drivers of unconventional weapons

121 Horowitz and Narang 2014.

spread. This has serious implications for the field of proliferation studies, as regressional methods may be less suited to studying what is essentially a rare event (i.e., the spread of chemical, biological, and nuclear weapons) that is likely to have complex causes.

Chapter 5

While a few studies theorizing the causes of CBW spread and some single or few-case comparative case studies of CBW programs have been published, no study has yet attempted to synthesize theory and empirics. This chapter introduces the first systematic inquiry into the causes of CBW spread and reversal among the universe of cases. The chapter departs from the proposition that states' decisions to embark on or terminate unconventional weapons programs are shaped by a complex constellation of pressures and constraints.[122] Qualitative Comparative Analysis (QCA) is used to investigate under which conditions states begin or end CBW programs. QCA is particularly suited to this task as this method can model causal complexity and allows for the consideration of intermediate-N phenomena like the spread of unconventional weapons. The method has distinctive advantages over regressional methods because it accounts for the possibility that (1) combinations of conditions can jointly produce an outcome (*conjunctural causation*); (2) different paths to an outcome may exist (*equifinality*); and (3) the explanations for the occurrence and non-occurrence of the outcome may consist of different conditions (*causal asymmetry*).

This chapter makes several important contributions to the study of unconventional programs. The results of the analyses confirm the expectation that different pathways, often consisting of a combination of conditions rather than a single explainer, lead different groupings of states to begin or end the pursuit or possession of CBWs. This is not only a significant theoretical finding, but also demonstrates the promise of QCA as a method for studying chemical, biological, and nuclear weapons programs. The chapter further, advances the literature on the causes of unconventional weapons spread by examining not only why states embark on CBW programs, but also why they terminate these programs. This is an important contribution since the *reversal* of weapons programs is understudied in the empirical literature, particularly so in the quantitative proliferation literature.

Turning to the chapter's main findings and theoretical insights, I find that national security considerations play a more nuanced role in shaping demand for CBWs than often theorized. The results reveal that external security conditions have a causal effect with other conditions in most pathways in which they occur. Moreover, nuclear-armed adversaries play a relatively limited role in CBW pursuit and possession. In most cases where adversaries are salient in CBW decisions, it concerns the presence or absence of CBW-armed or conventionally stronger rivals rather than NW-armed ones. Moreover, the pursuit of nuclear weapons played a role in only a handful of cases of initiation of CBW

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122 See, for instance, Sagan 1996, 85; Bell 2016, 521.

pursuit or possession. These findings cast further doubt on the popular view that CBWs are essentially a cheap and easy to acquire alternative to nuclear weapons.

Second, I find that some regimes turn to CBWs as a means of dealing with domestic challenges to their rule. High domestic unrest combines with external security threats to produce paths towards CW pursuit, CW possession, and BW pursuit. High unrest even makes up a path by itself towards BW possession. Conversely, low domestic unrest or the occurrence of regime transition combines with the lack of external threats to cause the end of CW pursuit, end of BW pursuit, and end of BW possession. Moreover, the occurrence of regime transition was sufficient by itself to produce paths towards the end of CW possession and BW pursuit.

Third, the QCA results emphasize the importance of treaties as constraints on demand for CBWs, as the majority of paths towards the start of CW pursuit and CW possession include the non-existence of the CWC. Conversely, membership of the CWC is sufficient by itself for end of CW pursuit and end of CW possession. Taken together, these findings suggest that the extant literature tends to overstate the salience of structural realist explanations of CBW spread and reversal and more attention should be given to how domestic politics and regime security considerations, and international law and behavioral norms shape how states think about these weapons.

Chapters 6 & 7

Chapters 6 and 7 make up the empirical backbone of the dissertation by chronicling the state-run CBW programs in the post-World War II era. Each entry describes the available information for that case, analyzes how the available information is weighed, discusses how coding decisions are made, and makes note of possible alternative coding specifications Moreover, the entries reflect on the uncertainties about what is known and what can reasonably be concluded from the balance of available evidence. Usually, datasets are presented as a collection of zeroes and ones in a spreadsheet, while "data notes" are relegated to appendices and online supplements of published datasets, if such notes are made available at all. This practice, unfortunately, obscures the rich description, context sensitivity, and nuances about (un)certainty that are—or should be—part and parcel of the data collection process. Moreover, the analysis in Chapter 2 shows that a lack of data notes can conceal crucial assumptions about concepts and methods that may have a significant impact on the reliability of the data.

This dissertation deliberately puts the CBW data front and center and invites the reader to treat the CBW chronicles as reading companions to the other chapters. The chronicles, for instance, help to illustrate the shortcomings of existing estimates that are discussed in Chapter 2. The chronicles obviously make up the empirical base upon which the CBW dataset described in Chapter 3 is built, but also provide rich illustration for the trends that are gleaned from the new dataset in that chapter. Finally, the data notes are important to the QCA analysis in Chapter 5, as they allow uncovered paths to be traced back to the individual case level. This helps to better understand, and check the veracity of, the causal mechanisms that underlie CBW pursuit and possession.

Chapter 8

The concluding chapter of this dissertation summarizes the study's main findings, discusses its methodological contributions and theoretical implications, reflects on its metatheoretical grounding, and elaborates on its implications for policymaking.

2

The Perils of Collecting Proliferation Data: The Mistaken Case of the 'Poor Man's Atomic Bomb'

SUMMARY

The popular view of chemical and biological weapons is that they are an attractive, cheap, and easy to acquire alternative to nuclear weapons: a 'poor man's atomic bomb'. Estimates that dozens of countries have pursued or acquired CBWs are severely inflated, yet have endured in governmental and non-governmental publications. This chapter investigates the ways in which the idea that the spread of chemical and biological weapons is prevalent and that it primarily happens among 'poor' countries has come to exist and persist.

INTRODUCTION

The study of the spread of chemical and biological weapons (CBWs) has lagged behind on the scholarly attention paid to nuclear weapons. Scholars have generated numerous studies of state-run nuclear weapons programs, a plethora of theories aimed at explaining the (non-)spread of nuclear weapons and what the consequences of spread are, and plenty of quantitative studies that test some of the hypotheses generated by the field. Yet, as a recent study of chemical and biological weapons notes, "the spread of chemical and biological weapons (CBWs) remains relatively underexplored".[1]

The most popular and enduring view of CBWs in policy and academic circles seems to be that CBWs are simply a cheap and easy to acquire alternative to nuclear weapons: a 'poor man's atomic bomb' (PMAB). The notion of a 'poor man's atomic bomb' first gained traction in U.S. government circles in the 1960s.[2] By the mid-1980s, U.S. officials began to publicly characterize CBWs as a 'poor man's atomic bomb' and issued dire warnings about a cascade of CBW proliferation, particularly among states in the 'Third World'. In a 1989 interview, for instance, President-Elect Bush, likened CBWs to a "poor man's atomic bomb", while a year earlier CIA Director Webster and Deputy Director Gates characterized chemical weapons in these terms and predicted a "rapid spread [of them] among developing countries."[3] Around the same time, officials were repeatedly warning the public that as many as two dozen states, most indeed from the 'Third World', were pursuing, or had already acquired, chemical weapons (CWs) or biological weapons (BWs), and many more could do so shortly.[4]

When we begin to unpack this popular notion of a 'poor man's atomic bomb', three underlying assumptions about the perceived function of CBWs (and by extension of nuclear weapons) and the history of CBWs reveal themselves. The first assumption is that CBWs (temporarily) satisfy the desire for nuclear weapons. This premise obscures the differing strategic and tactical functions of nuclear, chemical, and biological weapons. States have, in fact, pursued CBWs for a variety of reasons. Some, like the Soviet Union and the United States during the Cold War, had large and sophisticated programs aimed at developing strategic weapons for in-kind and general deterrence, while others, like South Africa and Rhodesia (present-day Zimbabwe), had rudimentary programs for the purpose of obtaining specialty weapons for assassinations and counterinsurgency operations.[5] The actual relationship between the demand for different weapons categories cannot be properly

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1 Horowitz and Narang 2014, 510.

2 Stockholm International Peace Research Institute 1973, vol. II, 153.

3 DeFrank and McDaniel 1989; Darst 1988; Webster 1988, 11.

4 E.g. Bush 1989c; U.S. House Committee on Armed Services 1989, 39f.; U.S. Senate Committee on Foreign Relations 1989, 29f.

5 On the Soviet Union and United States see Leitenberg, Zilinskas, and Kuhn 2012; Moon 2009. On Rhodesia and South Africa see Cross 2017; Gould and Folb 2000. Similarly, nuclear weapons possessors have differed significantly in their choices regarding posture and strategy. See, for instance, Narang 2014.

understood without considering program objectives, military doctrines, the selection of agent types, and the selection of dissemination and delivery systems.

The second assumption is that CBWs are merely a 'consolation prize' for 'poor' or 'Third World' states that are unable to acquire nuclear weapons. Yet, this has no basis in the historical record. All (advanced) industrialized states with nuclear weapons—the United States, the Soviet Union, the United Kingdom, and France— have also had CBWs, as have many 'wealthy countries' that have not possessed nuclear weapons (technological capability notwithstanding). Conversely, there are states that for a long time were considered too underdeveloped to acquire nuclear weapons (e.g., China, Israel, Pakistan, and North Korea) who succeeded in attaining them anyway.

The third assumption underlying the PMAB thesis is that the history of CBWs begins with the advent of nuclear weapons. This nuclear creationist reading of history obfuscates the 'pre-history' of CBWs.[6] Chemical and biological weapons existed long before the invention of the atomic bomb. Chemical weapons were widely used during World War I and before World War II many European countries had chemical weapons (and some biological weapons) research, development, and production programs supported by technology transfers and other forms of assistance from other European states.[7] This period also saw the introduction, and later abandonment, of chemical weapons by European powers in their colonies in the 'Third World'.[8]

A fundamental constraint in constructing a history of CBWs is the availability of reliable data. Due to political and security implications, states treat their current and former CBW programs with the utmost secrecy. Few states have acknowledged their (past) CBW activities and of those acknowledged programs many details remain unknown. Much of the available information about CBW programs has come from allegations by other governments. The single biggest source of proliferation information is the U.S. government. This information is usually vague and difficult to verify, yet is often repeated in press reports and other publications until it comes to be considered established fact.[9]

An influential recent study of CBW programs by Horowitz & Narang finds that states that acquire nuclear weapons are far less likely to pursue or possess CBWs, giving credence to the notion of a PMAB. The authors report that 33 states pursued and 31 states possessed chemical weapons, and that 16 states pursued and 11 states possessed biological weapons in the period 1945-2000.[10] However, this study and previous published assessments have severely overestimated the prevalence of CBW spread. A new dataset of CBW programs (see Chapter 3) shows that the number of states that have pursued and possessed CBWs is considerably lower than commonly assumed, especially among oft-suspected 'Third World'

6 I am grateful to Jean-Pascal Zanders for suggesting this point.
7 Zanders 1995a, 91–93.
8 Ibid., 93.
9 Harris 1989b, 39–41.
10 Horowitz and Narang 2014.

countries, while a follow-up quantitative investigation shows that there is no empirical support for the PMAB thesis (see Chapter 4).

The twin ideas that the spread of chemical and biological weapons is prevalent—i.e., that they 'proliferate'—and that this spread happens predominantly among 'poor' countries are well-established in governmental and non-governmental analyses. This chapter investigates the ways through which these ideas have come to exist and persist. This is done two ways. First, it is necessary to ask *why* extant analyses of CBW programs have come to inflate the threat of CBW spread, especially among 'Third World' countries. This *why* question helps to identify common shortcomings and biases of research into unconventional weapons programs. Recent research has, for instance, suggested that particular American biases have led to the underrepresentation of nuclear weapons activities of countries friendly to the United States in influential nuclear proliferation datasets.[11] By dissecting Horowitz & Narang's dataset of chemical and biological weapons programs, this chapter uncovers how imprecise concepts, a nearly blind trust in inconsistent and unverifiable proliferation allegations originating from the U.S. government, and the repetition of allegations—with one publication citing another—until allegations come to be accepted as common knowledge, leads to an incomplete and flawed view of the substance and nature of the spread of CBWs in the post-World War II era.

Second, this chapter asks *how* the understanding that CBWs are desirable and widespread, particularly among non-Western states, has come into existence and has endured. This question looks beyond issues of methodology and research design, and considers the underlying social context in which knowledge about unconventional weapons is produced. This analysis reveals an interplay between governmental and non-governmental analysis that creates, feeds, and entrenches the dominant epistemological paradigm that unconventional weapons are desirable and will inevitably spread.

A CASE STUDY IN THREAT INFLATION: HOROWITZ AND NARANG'S CBW DATASET

Horowitz and Narang's (hereinafter H&N) dataset on CBW programs follows established practices from the quantitative nuclear proliferation literature in which 'proliferation status' is measured along a continuum: 1) no interest; 2) pursuit of weapons; and 3) acquisition of weapons.[12] Confusingly, the authors present three different versions of the CBW data throughout their study. One version of the data is presented in two tables in the body of the published article.[13] The second version of the data is shown in two tables in the article's online data supplement alongside some brief comments about the data

11 Colgan 2019; Braut-Hegghammer 2019; Montgomery and Sagan 2009.

12 The three-stage framework is borrowed from Jo and Gartzke 2007.

13 Horowitz and Narang 2014, 518–520, Table 1 and Table 2.

and accompanying citations.[14] The third version can be found in the Stata data file that is used to perform the study's statistical analyses.[15] The three versions vary considerably from one another. The tables in the article and the online supplement are the most alike, with only a handful of the countries' periods of pursuit or possession differing by one or two years. The data in the replication file however deviates significantly, with seven countries having different periods of pursuit/possession, while the pursuit/possession of seven other countries is completely left out. The data in H&N's online data supplement is the most complete and matches best with the citations that the authors provide, therefore that version is used in the following analysis.

As can be seen in **Table 2.1** and **Table 2.2**, H&N have recorded 33 states as pursuing and 31 states as possessing chemical weapons during the period 1945-2000, while 16 states are recorded as pursuing and 11 states as possessing biological weapons in that same timeframe. The H&N data rely heavily on initial data collected by Horowitz in 2004, which in turn was based on "different governmental and nongovernmental compendiums that tracked WMD proliferation across time."[16] Both the Horowitz study and the H&N study privilege U.S. government data, which the authors consider more reliable because it "presumably reflects intelligence sources," when said data is in disagreement with secondary sources.[17]

Already in 1989, Harris described three problems associated with substantiating or disproving allegations of CBW activities that originate from governments.[18] First, governments often are reluctant to identify which countries have or are pursuing CBWs, instead mentioning aggregate numbers. Especially in the 1980s and early 1990s, U.S. government officials spoke ominously of dozens of states having or being close to having these weapons without forthrightly specifying which countries they were speaking of. These stated numbers were often imprecise and or even contradictory.[19] Second, government officials often do not explain how they define a chemical or biological weapons state. For instance, possessing the industrial capacity or technical knowhow to produce warfare agents, which speaks to the dual-aspect nature of chemical and biological industry and research, is very different form actually possessing stockpiled weapons.[20] Many states with a chemical or biotechnology industry fall in the former category, even though most have never developed CB weapons. Similarly, many states with a defensive CB warfare program have either produced small amounts of warfare agents, or acquired them from other countries, for the purpose of developing and testing defense materiel. Yet, these states also cannot properly be understood to have an offensive military CBW program. Third, much

14 See Table 11 and Table 12 of the study's online data supplement: http://journals.sagepub.com/doi/suppl/10.1177/0022002713509049.

15 See the study's online data supplement.

16 Horowitz and Narang 2014, 517.

17 Horowitz 2004, 27; Horowitz and Narang 2014, 517.

18 Harris 1989b.

19 Ibid., 40.

20 Ibid.

of the government supplied information is impossible to independently verify and contains little to no details about sources and analyses. This problem is compounded when reporters and experts repeat this information over and over, often without properly identifying it as originating from a single unverified source.[21] These issues provide a starting point for a framework to unpack the process that led to H&N's inflation of the number of CBW states.

First, H&N do not accurately define the core concepts they are investigating. For instance, what is a 'chemical weapon' and what does 'possession' of chemical weapons entail exactly? Moreover, the authors do not settle on any coding rules against which potential countries of interest are to be assessed, making it challenging to remain consistent during the coding process. Instead, the authors inadvertently adopt a multitude of (implicit)—and often conflicting—assumptions from the sources they consult. As a result, their study comes to include cases that should not properly be understood as having pursued or possessed CB weapons. Second, H&N do not offer a justification of coding choices other than a summation of consulted sources per case. Data notes or case descriptions document, among others, how the evidence was weighed and how the researcher deals with conflicting or lacking information. A lack of documentation makes it difficult for others to understand, evaluate, and replicate the data collection process. Third, H&N principally rely on allegations that originate from U.S. government sources: sometimes directly from government reports or statements from officials; but mostly from third party reports that repeat U.S. government allegations. Such data is often vague, flawed, inconsistent among sources and over time, difficult to independently verify, and systematically biased towards overstating threats related to unconventional weapons. These three issues are explored further in the next section.

Confusing Concepts

Determining which countries attempt to acquire or already possess chemical or biological weapons is difficult because government officials, experts, and journalists often talk about CBW activities without specifying what they mean. H&N envision states' CBW activities as either constituting 'pursuit' or 'possession' of weapons. However, H&N do not actually define what pursuit or possession entails, nor do they provide any coding rules against which states' CBW activities are assessed. There is significant difference between a state that has a capacity to produce chemical/biological (CB) warfare agents without having done so, a state that has a stockpile of CB weapons it has developed itself, a state that has received a stockpile of weapons from another state, and a state that has allowed a foreign power to deploy weapons on its territory. The lack of definitions leads H&N to stretch the concepts of 'pursuit' and 'possession' to include a wide variety of activities that should not properly be understood as encompassing either pursuit or possession.

21 Ibid., 40f.

Table 2.1: Pursuit and possession of chemical weapons (Horowitz and Narang, 2014)

	Pursuit	Possession
Afghanistan	1982-1994	
Algeria	1999-2000	
Angola	1984-1993	
Argentina	1971-1993	
Australia	1945-1973	
Brazil	1988-1993	
Burma	1988-2000	
Canada		1945-1946
Chad	1988-1993	
Chile	1988-1993	
China		1945-2000
Czechoslovakia		1945
Egypt	1945-1962	1963-2000
Ethiopia	1980-1993	
France		1945-1993
German Democratic Republic	1980-1982	1983-1989
Germany		1945
Greece		1945
Hungary		1945
India		1947-2000
Iran	1983	1984-2000
Iraq	1971-1979	1980-2000
Israel	1952-1955	1956-2000
Japan		1945
Kazakhstan		1991-2000
Laos	1988-1993	
Libya	1976-1980	1981-2000
Mozambique	1988-1993	
North Korea	1965-1987	1988-2000
Pakistan	1982-1986	1987-2000
Peru	1988-1993	
Philippines	1988-1993	
Poland		1945
Rhodesia	1975	1976-1980
Saudi Arabia	1988-1989	1990-1993
Somalia	1988-2000	
South Africa		1945-1993
South Korea	1967-1988	1988-2000
Soviet Union/Russia		1945-2000
Spain		1945
Sudan	1990-2000	
Sweden	1945-1973	
Syria	1971-1972	1973-2000
Taiwan	1970-1982	1983-2000
Thailand	1988-1993	
United Kingdom		1938-1957
United States		1945-2000
Vietnam	1975-1989	1990-2000
Yugoslavia	1958-1968	1969-2000

Table 2.2: Pursuit and possession of biological weapons (Horowitz and Narang, 2014)

	Pursuit	**Possession**
Algeria	1999-2000	
Bulgaria	1988-1993	
China	1950-1961	1962-2000
Cuba	1988-1993	
Egypt	1945-1971	1972-2000
France		1945-1973
Germany	1945	
Iran	1981-2000	
Iraq	1974-1986; 1992-2000	1987-1991
Japan		1945
Laos	1988-1993	
Libya	1988-2000	
North Korea	1965-1987	1988-2000
Rhodesia/Zimbabwe	1975	1976-1980
South Africa	1945-1975	1976-1993
Soviet Union/Russia		1945-2000
Syria	1990-2000	
Taiwan	1975-1993	
United Kingdom		1945-1956
United States		1940-1972
Vietnam	1988-1993	

A lack of proper definitions is not exclusive to H&N's study and earlier studies have drawn attention to definitional issues in allegations of CBW proliferation.[22] These problems are also found in many published allegations about CB weapons capabilities that H&N cite. These allegations are often vague and the terminology that is used in them by government officials, experts, and journalists is ambiguous. Many allegations are no more detailed than lists of countries that are described as industrially capable; considering, intending or in fact producing chemical weapons; or even seeking or attempting to develop or possess a CBW capability.[23] Many of these terms mean different things depending on who uses them and when. 'Chemical and biological weapons,' as frequently employed can mean four things: 1) CB weapons agents in the context of production capability; 2) CB weapons agents in the context of possession; 3) munitions suitable for use with CB agents, and 4) CB weapons agents combined with a suitable dissemination system (e.g. munitions or a spray tank).[24] Moreover, the term may encompass different classes of agents: either restricting the term to the 'traditional' classes of lethal antipersonnel warfare agents, or include herbicides, irritants and riot-control agents (like BZ), and even smoke munitions.[25]

22 E.g. Harris 1989b; Burck and Flowerree 1991, 157f.; Robinson 1991, 22–25.
23 Burck and Flowerree 1991, 157.
24 Ibid.; Robinson 1991, 24.
25 Robinson 1991, 25.

Ambiguity surrounding the term 'chemical and biological warfare capability' creates even more confusion, as it is often used but rarely defined by government officials, experts, and journalists. The term may say something about the ability of military forces to use CB weapons. But it is also commonly used when referring to the possession of CB agents or CB munitions inherited or obtained from a third-party without the capacity to produce them domestically, the possession of a sophisticated chemical or biological industry (which does not imply the possession of CB weapons agents), or even the ability of armed forces to operate under conditions of CB warfare.[26]

The lack of clear definitions leads H&N to identify a set of cases that can be placed on such a broad spectrum of CB activities, that subsuming them all under the headers 'pursuing' or 'possessing' CB weapons causes these terms to lose all meaning. Their dataset includes, among others, states that have not been involved in any chemical/biological weapons activity; states that have had an exclusively defensive chemical/biological warfare program aimed at protecting civilians and troops against the use of CB weapons by adversaries; states that have developed chemical and/or biological agents for assassination purposes; states that have received, bought, or inherited a limited stockpile of chemical and/or biological weapons but are incapable of producing their own; and states that have indigenously developed a (significant) stockpile of chemical/biological weapons with which they can wage offensive warfare.

An illustrative example of activities that are frequently confused with pursuit or possession of weapons can be found in the Afghan case. H&N code Afghanistan as pursuing chemical weapons from 1982-1994. Yet, one of the two sources that H&N consult indicates that "the primary CW allegation against the government of Afghanistan is of complicity in allowing the USSR to stock and use CW agents against domestic opponents." This source concludes that "it is highly unlikely that the Afghan government had any assimilated [chemical warfare] capability, even on a temporary basis or under close Soviet supervision".[27] The other consulted source merely notes that Afghanistan was mentioned in three earlier reports.[28] One of these reports describes it as a "doubtful chemical weapons state",[29] a second report refers only to unproven allegations that Soviet forces "employed a number of chemicals" in Afghanistan,[30] and a third report merely includes Afghanistan in a chart of "nations reported to have chemical weapons."[31]

Another useful example is China's chemical weapons status in the 1990s and 2000s. H&N code China as continuing to possess chemical weapons up to and through 2000 (the endpoint of their study) based on four U.S. government sources cited on a webpage of

26 Burck and Flowerree 1991, 157f.

27 Ibid., 333, 341.

28 Office of Technology Assessment 1993a, 80.

29 Harris 1989b.

30 McGeorge 1989.

31 Smolowe 1989.

the Center for Nonproliferation Studies.[32] These sources note that China is able to quickly mobilize its chemical industry to develop and produce chemical weapons. In lieu of evidence that China actually possesses stockpiles of chemical weapons or has an active program dedicated to developing such weapons, opportunity (the technical and/or industrial ability to develop weapons) is presented to support an assessment of wrongdoing. Yet, opportunity (and/or motive) alone is not enough. Opportunity has to be acted upon, which requires intent. Besides, taking opportunity (or motive) as a 'smoking gun' leads to a serious methodological problem when the data is used to analyze the causes (or consequences) of the spread of CBWs because it implicitly positions opportunity (or motive) as both *explanans* and *explanandum*.

Analysis, Justification, and Replicability

A lack of proper definitions leads to odd results but also makes it difficult to maintain consistency during the data collection process and hampers the ability of others to understand, evaluate, and replicate research. This process is made more difficult as H&N do not provide any insight into how the available evidence was evaluated, how conflicting information was weighed, and how particular coding decisions were reached. While accompanying data notes are commonly included alongside new datasets in the field of 'proliferation studies',[33] H&N merely indicate the period during which a state is judged to have pursued or possessed CBWs, together with a summation of consulted sources.[34] The interested reader can attempt to trace back the coding decisions by carefully consulting cited sources, but it is neither practical nor possible to reconstruct each one. In some cases, the sources consulted by H&N present conflicting information and it is not possible to determine why one source was prioritized over another. In other cases, the sources do not refer to any dates that correspond with the time periods during which H&N code those countries as having pursued/possessed. In yet other cases, the consulted sources do not provide any information from which it could be concluded that the countries in question actually pursued/possessed CBWs. These three issues describe more than a dozen cases judged by H&N to have pursued or possession CBWs.[35] A new dataset of CBW activities reveals that many of these cases did in fact not pursue and/or possess at any time, or did so for significantly shorter periods of time than is presented in H&N's dataset.[36]

The lack of data notes also obscures a considerable number of cases that are erroneously coded because H&N may have misinterpreted or overlooked key conclusions from sources they consulted. H&N, for instance, code Angola as pursuing chemical weapons, while

32 Center for Nonproliferation Studies 2008.

33 See e.g. Bleek and Lorber 2014; Jo and Gartzke 2007; Monteiro and Debs 2014..

34 See H&N's online data supplement: http://journals.sagepub.com/doi/suppl/10.1177/0022002713509049.

35 For chemical weapons see, for instance: Afghanistan, Egypt, Ethiopia, Libya, North Korea, Pakistan, Saudi Arabia, South Korea, Russia, and Vietnam. For biological weapons see, for instance: China, Iran, North Korea, Syria, Taiwan, and the United Kingdom.

36 See next chapter.

one of the sources they consult indicates that "there is little suspicion that Angola has any significant CW offensive capability of its own" and that if Angola was in any way connected to chemical warfare it was due to it having allowed Soviet and/or Cuban troops to use chemical weapons on its behalf against resistance forces.[37] What is most surprising is that H&N code Iraq as continuing to possess chemical weapons up to and through the year 2000 even though it had become clear in the aftermath of the 2003 invasion that Iraq had not possessed any nonconventional weapons since the early 1990s.[38] H&N even cite the final report of the Iraq Survey Group (known as the Duelfer report), which was tasked by the U.S. government to locate said weapons after the invasion, even though it states among its "key findings" that "Iraq unilaterally destroyed its undeclared chemical weapons stockpile in 1991" and "no credible indications that Baghdad resumed production of chemical munitions thereafter" were found after 2003.[39]

The lack of transparency not only obstructs the evaluation and replication of H&N's research but also obscures a bigger issue. Many published allegations about nuclear, biological, and chemical (NBC) weapons programs originate from a single unsubstantiated source and are repeated over and over again by others until they become conventional wisdom. The next section explores the importance of carefully reviewing the evidence and analyses underpinning allegations of CB weapons programs.

Evidence

Collecting information on state-run CBW activities is a challenging task as governments treat current and former CBW programs with the utmost secrecy. Few states have acknowledged their (past) activities and of those that have many details are still unknown. Reliable information about many CB weapons programs is scarce and fewer in-depth studies of specific programs exist compared to nuclear weapons. Much of the available information comes from public versions of classified U.S. intelligence reports and testimonies by U.S. government officials. These sources are often assumed to be authoritative. Yet, due to the sensitive nature of the intelligence gathering process, their assessments are often vague and contain ambiguous and imprecise language, which frequently generates more questions than answers. The reliability of governmental intelligence data on weapons programs is further hampered by selective leaks by anonymous government officials, the willful spread of misinformation intended to deceive the public and implicate adversaries, and inaccurate or uncritical press reporting.

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37 Burck and Flowerree 1991, 450. The other consulted source (Office of Technology Assessment 1993) merely notes that Angola was mentioned in an earlier report. The report in question (Harris 1989a) describes Angola as a "doubtful chemical weapons state."

38 Several of the sources cited by H&N make note of this.

39 Duelfer 2005b, 1.

H&N explicitly state that they privilege U.S. government data when it is in disagreement with secondary sources, "since it presumably reflects intelligence sources".[40] This leaves the impression that the authors at least consider plenty alternative sources of information. In reality, the evidentiary basis of the study is thin and biased towards U.S. government sources or "secondary sources" that repeat or repackage information obtained from government sources. Indeed, the authors simply ignore a plethora of available information from, among others, monographs and edited volumes,[41] journal articles,[42] studies conducted by non-governmental organizations,[43] governmental reports (among which reports on the activities of other states but also self-reporting such as the voluntary CBM (confidence-building measures) submissions related to the Biological Weapons Convention),[44] investigative journalism,[45] and reports by intergovernmental organizations such as the OPCW and UN.[46]

The inflation of the number of states that have pursued and possessed CBWs can be traced back to two broad categories of sources that H&N frequently consult: 1) various lists of suspected states that are compiled by experts and news media based on government sources; and 2) U.S. government reports and statements by officials.

The Convenient Ones: Aggregated Lists of Suspected Proliferators

H&N indicate that their study relies primarily on a few governmental and nongovernmental compendia that track the spread of NBC weapons.[47] The authors occasionally supplement these compendia with additional sources that focus on a particular case. Two of the compendia are dated but provide useful overviews of the available information on CB weapons activities at their time of publication.[48] Burck & Flowerree, for instance, summarize and evaluate the credibility of reports on dozens of suspected chemical weapons programs.[49] However, additional information has become available for many of these programs in the decades since these books were published. The other compendia are no more than aggregated lists of countries suspected of having (had) CB weapons (programs). They cite classified reports and (unnamed) government officials—or worse, cite earlier reports that themselves cite government allegations—but lack verification

40 Horowitz and Narang 2014, 517.
41 e.g. Wheelis, Rózsa, and Dando 2009; Balmer 2001; Burck and Flowerree 1991.
42 E.g. Cohen 2001; Gould and Folb 2000.
43 E.g. Nuclear Threat Initiative n.d.; Human Rights Watch 1997; International Crisis Group 2009.
44 E.g. Deutscher Bundestag 1989; Government of Canada 2011.
45 E.g. Knip 1999.
46 E.g. OPCW 2003a; UNMOVIC 2007.
47 Horowitz and Narang 2014, 517; The following compendia were used: Burck and Flowerree 1991; Center for Nonproliferation Studies 2008; Kerr 2008; Office of Technology Assessment 1993a; Stockholm International Peace Research Institute 1973, vol. II. See the authors' online data supplement: http://journals.sagepub.com/doi/suppl/10.1177/0022002713509049.
48 Burck and Flowerree 1991; Stockholm International Peace Research Institute 1973, vol. II.
49 Burck and Flowerree 1991.

and any discussion of the underlying assessments. Two such lists—one found in a report by the U.S. Congress' Office of Technology Assessment (OTA) and another found in a Congressional Research Service report prepared by Paul Kerr— are frequently cited by H&N.[50]

H&N's use of the OTA list of suspected CBW programs is the most problematic.[51] The OTA sums up in tabulated form those countries that were reported in a number of previously published sources to "have, or to be trying to acquire, chemical or biological warfare capabilities".[52] The previously published sources consisted of either U.S. government reports and testimonies by U.S. government officials, or news reports and policy publications that repeated U.S. government allegations. The authors of the OTA report caution the reader about the significance and reliability of the list, noting that it is "in no way to be considered authoritative or comprehensive" as it "merely recorded the countries listed in [...] the cited publications".[53] Nonetheless, H&N use the OTA list as the primary or even the only source for coding eight cases of chemical pursuit and four cases of biological pursuit; almost all of them so-called 'Third World' states.[54] Curiously, H&N code all these cases as *pursuing* in a specific range of years (1988-1993), even though the OTA does not provide any description or dating of the reported countries' CBW activities.

Kerr's list records for 26 countries whether they are "seeking", or are "likely", "known" or "suspected" to have a "chemical, biological, or nuclear weapons capability".[55] Most of Kerr's assessments either lack a source to substantiate the claim or they are supported merely by U.S. government sources that are based on classified intelligence. While Kerr assesses 25 countries to have some CW capability, he only provides a short description in a footnote for eight of them. The notes for three of these countries lack citation of sources, while four exclusively cite U.S. government reports. Of the 13 countries assessed to have some BW capability, only four are accompanied by an explanation (of which only two are accompanied with proper citation, again with U.S. government data). Many of these allegations are uncritically accepted as fact by H&N.[56]

As these two examples illustrate, lists of suspected proliferators are unreliable sources of information. They consist largely of governmental allegations—predominantly of U.S. origin—that are often repeated until they become 'common knowledge.' Due to a lack of any form of analysis combined with the opaque nature of the intelligence data on which government pronouncements are based, scholars should treat these lists with

50 Office of Technology Assessment 1993a; Kerr 2008.

51 Office of Technology Assessment 1993a, 80, 82.

52 Ibid., 79. The OTA included 11 reports for chemical weapons and 6 reports for biological weapons.

53 Ibid.

54 The CW cases are: Afghanistan, Angola, Brazil, Chad, Chile, Ethiopia, and Laos. The BW cases are: Bulgaria, Cuba, Laos, and Vietnam.

55 Kerr 2008, 20.

56 H&N, for instance, code Kazakhstan as possessing CWs based exclusively on Kerr's unsubstantiated allegation that it "reportedly retained some Soviet-era CW stockpiles." Ibid.

great skepticism. They are at best a preliminary set of potential cases that warrant further research, rather than reliable sources of data. To be fair, H&N occasionally note that a country can alternatively be specified as not pursuing because their coding is "reliant on [the] OTA [report]". This indicates that they recognize the problem of relying on these lists of suspected proliferators. Nonetheless, such cases are still included as pursuing/possessing in their quantitative tests of the 'poor man's atomic bomb' hypothesis.

The Presumably Authoritative Ones: U.S. Government Sources

The majority of H&N's assessments are derived from U.S. government reports on alleged CBW programs. Yet, publicly available government assessments often: 1) lack transparency about methods, sources, and analysis; 2) are couched in imprecise and ambiguous language; and 3) are inconsistent among different sources and vary significantly over time.

The principal problem with government sources is the lack of transparency, which is a product of the sensitive nature of intelligence gathering and the varying degree of certainty about the collected information. Public versions of intelligence reports (for instance, the biannual '*Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions*,' also known as the Section 721 report), or public statements by government officials derived from classified reports, usually present only a conclusion intended for public consumption. They may state as little as: "country X is believed to possess chemical weapons." However, the evidence and analysis, and the nuances and qualifications that contextualize the assessment, are not disclosed. Withholding this information may be necessary for protecting the identity of sources and methods of the intelligence community, but it makes independent validation of intelligence assessments impossible. When exceptions are made and (some) of the underlying evidence and assessments are presented, it is often for political objectives.[57]

The second problem with government sources is that public versions of intelligence assessments are frequently couched in vague or ambiguous language. Official statements often speak of a 'chemical weapons capability', a 'biological warfare capability' or a 'chemical weapons state,' but these terms are usually left undefined.[58] Do they, for instance, mean that a country has a stockpile of these weapons ready for use with the capability to produce more as required or does it only mean that the country has a scientific and industrial base that could be used for agent production? To illustrate this ambiguity, it is useful to consider some public statements on this matter by U.S. government officials. In 1991, the Director of U.S.

57 Burck and Flowerree 1991, 154. Think, for instance, of U.S. Secretary of State Powell's presentation on Iraq's alleged weapons programs before the UN Security Council on February 5, 2003 or Israeli President Netanyahu's presentation on the theft of a purported trove of documents proving that Iran was still developing nuclear weapons on April 30, 2018. The Iraqi allegations turned out false as no weapons were found after the 2003 invasion. Much of the information contained within the Iranian "nuclear archive" has been known by the IAEA for years and confirms that the Iranian nuclear weapons development program was halted in 2003. See Lewis 2018; Arnold et al. 2019.

58 Burck and Flowerree 1991, 162; Harris 1989b, 40.

Naval Intelligence, Rear Admiral Thomas Brooks, told a Congressional committee that "at least fourteen countries outside of NATO and the Warsaw Pact currently have an offensive chemical warfare (CW) capability".[59] Two years earlier, the Director of the U.S. Arms Control and Disarmament Agency (ACDA), Major-General William Burns told the Senate Foreign Relations Committee that around 20 states, including the United States and the Soviet Union, have a *sufficiently large chemical industry* to produce a militarily significant quantity of lethal chemical agents but "no more than a handful [of nations], five or six," actually such a significant stockpile.[60] Later that year, the Assistant Secretary of State for Politico-Military Affairs, Richard A. Clarke told a conference in Canberra that "there are 22 nations that have chemical weapons in their inventories, controlled by the military and ready for use."[61] Yet, the following days both Clarke and his deputy spoke to the press about the 22 nations as being suspected of either *having chemical weapons* or *being capable of possessing* them.[62] Taken together, these statements illustrate the imprecise nature of the terms 'chemical warfare/weapons capability'. In the manner frequently employed by U.S. government officials it seems to include not only the handful of states that actually possess a military significant stockpile of weapons, but also those with an industrial and scientific base that allows the production of agents with military applications, and perhaps even states that possess agents for the purpose of a defensive program aimed protecting against CBW use. If that is so, statements of 20 or more CBW states should be taken with a grain of salt.[63]

Third, intelligence assessments are often inconsistent and can change significantly over time, as evidenced by the history of assessments about Iran's CW status. From the 1990s until 2003, U.S. intelligence reports asserted that Iran had an active offensive chemical weapons program. During this period, public reports described in no uncertain terms specific military capabilities, agent stockpiles, delivery systems, and even deployments of chemical weapons.[64] From 2003 onwards, assessments about Iran's CW status in these reports quickly declined in certainty. While the 'Section 721' report covering the first six months of 2000 stated that Iran "already has manufactured and stockpiled several thousand tons of chemical weapons, including blister, blood, and choking agents, and the bombs and artillery shells for delivering them", the report covering the first half of 2003 downgraded this assessment to "likely has already stockpiled blister, blood, choking, and probably nerve agents—and the bombs and artillery shells to deliver them—which it previously had manufactured".[65] In the report covering the second half of 2003 the assessment was downgraded yet further to "may have already stockpiled" until all

59 U.S. House Committee on Armed Services 1991, 106.
60 Smith 1989.
61 Robinson 1991, 21f.
62 Ibid.
63 Robinson 1992, 62.
64 U.S. Department of Defense 1997, E.g.; Director of Central Intelligence 2001a.
65 Director of Central Intelligence 2001a; Director of Central Intelligence 2003b.

references to stockpiles and delivery systems were replaced from 2004 onwards by the assessment that Iran "continued to seek production technology, training, and expertise from foreign entities that could further Tehran's efforts to achieve an indigenous capability to produce nerve agents".[66]

The Iranian example discussed above illustrates how intelligence assessments change significantly over time. This calls into question the wisdom of relying on them as heavily as policymakers, academics, experts, and journalists do. The treatment of this case also exemplifies the worrying manner in which experts often uncritically rely on selective pieces of intelligence assessments, without contemplating the broader context of intelligence assessments or considering alternative sources. In this case—but also others—H&N prioritize worst-case reports even though intelligence assessments have been inconsistent and have been significantly downgraded over the years, leading to the overestimation of the number of states, particularly those from the 'Global South', that have actually pursued and/or possessed CBWs.

EPISTEMIC PROBLEMS: CONSTRUCTING EXPERT KNOWLEDGE

Inflated estimates of the interest in chemical and biological weapons are not a problem limited to a particular publication. The foregoing analysis of H&N's dataset reveals that the inflation of the CBW threat is common in government analyses, expert analyses, and press reports. Imprecise concepts, the prevalence of inconsistent and unverifiable intelligence reporting, and the repetition of allegations—with one publication citing another—until allegations come to be accepted as common knowledge play a considerable role in enabling inflated estimates in analyses of the spread of CBWs. However, the inflation of threat—and more broadly, the shortage of reliable information of CBW programs—is not merely a consequence of problems with methods and techniques of data collection. It rather points towards a structural issue where many influential voices in the expert community and in government were saying that numerous countries—especially 'Third World' ones—were trying to acquire or had already acquired CBWs. To understand *how* the notion that CBWs have widespread appeal, particularly among 'poor' or 'Third World' states, came to exist and became so entrenched requires the consideration of the social context in which knowledge about unconventional weapons is constructed.

The central descriptors that we often use when we speak about unconventional weapons—terms like 'poor man's atomic bomb' and 'proliferation'—are not merely convenient figures of speech or neutral analytical categories but rather metaphors that invoke emotions, construct and reinforce particular analytical frames, and structure possible policy responses.[67] The 'poor man's atomic bomb' moniker symbolizes the tacit

66 Director of Central Intelligence 2004; Deputy Director of National Intelligence for Analysis 2006a.

67 On metaphors in security studies see e.g. Mutimer 1997, 194ff.

assumption that the spread of CBWs is ubiquitous among 'poor states' or those states that are unable to attain a nuclear arsenal, requiring constant scrutiny and, when necessary, intervention. In turn, the 'poor man's atomic bomb' notion is an extension of a particular understanding of the history and imagined future of non-conventional weaponry that is broadly shared by policymakers and experts.

The dominant way that experts and policymakers understand and speak of the spread of chemical, biological, and nuclear weapons is through the application of the 'proliferation' metaphor. The term 'proliferation' was lifted from the field of cellular biology, where it describes the process of cellular reproduction, and introduced in the discourse about unconventional weapons in the early 1960s at a time when American analysts began to concern themselves with how many countries (and which ones) might acquire nuclear weapons next.[68] The timing is significant because, as Pelopidas argues, "what might have remained a mere simile was concentrated into a metaphor: the increase in the number of actors with nuclear weapons is not *like* proliferation; it *is* proliferation".[69] The proliferation metaphor brings to mind the self-begetting nature of the spread of weapons—just as cells multiply themselves—with human agency powerless to restrain it.[70] This technologically determinist process of weapons proliferation is imagined to take place as a chain reaction to one state crossing the threshold, like the proliferation of cells after the division of an initial 'mother cell', against the background of an inevitable spread of underlying technologies. 'Proliferation' also evokes a pathological association as subjects (whether patients or states) have to be monitored from the outside for cancerous growths and outside intervention is promoted as necessary to prevent further growth and metastasis.[71]

The idea that weapons 'proliferate' primes the analyst to treat uncertainty by means of suspicion: states are scrutinized as a 'proliferation risk' and the worst case is presented as the most likely.[72] Policymakers and experts would rather overemphasize a perceived threat and be wrong—ultimately, one was only being 'realistic' and 'prudent'—than be labelled naïve or perceived as 'weak on security'. This view overlooks positive outcomes (that the intentions of a country were misunderstood or that preferences change) and ignores or expunges past errors in judgment. This cognitive framework necessarily positions the proliferation of weapons as the central analytical and policy problem to be solved as opposed to, for instance, disarming extant possessors. It is not entirely coincidental that in the dominant Western discourse about highly destructive weapons 'theirs' are framed

68 The first widely published use of the term in connection to nuclear weapons can be found in Wohlstetter 1961.
69 Pelopidas 2011, 302.
70 Mutimer 1997, 202f.; Pelopidas 2011, 302.
71 Pelopidas 2011, 302.
72 Abraham 2010, 54.

as problematic, while 'ours' are not.[73] By highlighting foreign threats that are yet to occur, the threats posed by weapons on the territory of the analyst herself can be ignored. Indeed, President Kennedy's famous forecast that a U.S. president in the 1970s might have "to face a world in which 15 or 20 or 25 nations may have [nuclear] weapons" was made in 1963, right after the introduction of the proliferation metaphor in the public debate about nuclear weapons and just before the United States' nuclear arsenal would reach its peak.[74]

The notion of a 'poor man's atomic bomb' is a variation on the proliferation theme: since nuclear weapons are understood as inherently desirable it is only prudent to assume that 'poor' states that cannot have them will resort to (relatively easier to acquire) CBWs as an alternative. The first uses of the term 'poor man's atomic bomb' can be traced back to the late 1940s, while the notion really began to gain traction in the 1960s when Egypt employed chemical weapons during its intervention in the North Yemen Civil War and during negotiations of the Nuclear Non-Proliferation Treaty.[75]

By the 1980s, U.S. officials were routinely warning the public that as many as two dozen states might be developing, or had already acquired, chemical or biological weapons and many more could join shortly.[76] The timing of the CBW threat presentation and the background against which it occurred is significant. By then, the long-held prediction that a dozen or more states would join the nuclear club had not materialized. Many western allies that were expected to attain nuclear weapons had in fact changed their calculus or were dissuaded from doing so by the United States. Moreover, among the states in the 'Global South' most countries simply had no interest in nuclear weapons at all, had shown restraint or reversed course, or did not succeed at all. It is also ironic that the presentation of a new CBW threat emanating from the 'Third World' took place while the United States had already embarked on its own ambitious CW rearmament program a few years prior.[77] The notion that states that have the ability and motive to proliferate will do so clearly has no basis in the historical record. Yet, it is meaningful that this view is promoted by countries, like the United States, that have 'proliferated' themselves and are projecting their own fears, prejudices, and decision-making rationales onto others.[78]

Potter & Mukhatzhanova write that the tendency to view the spread of weapons "in terms of automaticity and contagion is not confined to the United States or to a particular political or professional orientation […] it is equally visible among U.S. officials in past and current

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73 Gusterson 1999, 114. For example, the presentation by U.S. officials in the 1980s of a CBW threat emanating from the 'Third World' took place against the background of the United States' own CW rearmament program. See Smart 1997, 70f.

74 As quoted in Test Ban: Choice Between Risks 1963, 37.

75 For instance, a book review in a 1949 issue of the *Bulletin of Atomic Scientists* made note of the use of the term in the contemporary "popular literature" and even formulated some early critiques of it, see McLean 1949, 354. Stockholm International Peace Research Institute 1973, vol. II, 153.

76 E.g. Bush 1989c; U.S. House Committee on Armed Services 1989, 40; U.S. Senate Committee on Foreign Relations 1989, 29f.

77 Smart 1997, 70f.

78 Abraham 2010, 50.

administrations, international organizations, scholars, nongovernmental analysts and media pundits."[79] While this is true, it cannot be denied that the production of knowledge about unconventional weapons is dominated by government officials, scholars, and analysts from the United States. Indeed, the vast majority of published political science datasets regarding such weapons are of American origin.[80] The foregoing dissection of Horowitz & Narang's prominent study reveals how doubtful allegations about CB weapons programs and pessimistic predictions about the spread of CBWs—often originating from U.S. government sources—are reproduced in official statements, press reports, research by analysts, and scholarly works.[81] This close interplay between governmental and non-governmental analysis creates an ill-fated mutually constitutive cycle that produces, feeds, and, ironically, proliferates, a dominant view that chemical, biological, and nuclear weapons are desirable and will spread.

The analysis presented in this chapter supports the assessment that the field of proliferation studies has not sufficiently dealt with epistemic problems related to the acquisition and use of expert knowledge.[82] These problems have disastrous real-world consequences. The 2003 invasion of Iraq on the false premise that it possessed WMDs was not only possible because of faulty intelligence and the Bush administration's weaponization of said intelligence, but also because the expert community largely echoed the faulty assessment that Iraq had these weapons.[83] As others have argued, it is necessary to reassess the history of chemical, biological, and nuclear weapons in order to understand and counter the biases and orthodoxies of the proliferation paradigm, and with it the notion of a 'poor man's atomic bomb,' that paints these weapons as inherently desirable and their spread inevitable.[84]

Part of the solution lies in exercising more reflexive scholarship that, among others, reflects on biases and forms of self-censorship in the study of unconventional weapons.[85] Similarly, undergraduate and graduate syllabi can be diversified by incorporating alternative views that are present in, for instance, post-colonial, feminist, and other critical studies scholarship.[86] Finally, closer scrutiny of funding structures and the revolving door between government, academia, and think tanks is necessary to better understand how dominant discourses are reproduced as academic institutions, think tanks, government agencies, and interest groups compete for financial resources, policy relevance, and political access and support.[87]

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79 Potter and Mukhatzhanova 2010, 2.

80 Braut-Hegghammer 2019.

81 These issues are not exclusive to Horowitz & Narang's study.

82 Vogel 2014, 42.

83 Even scholars that opposed the war often supported the assessment that Iraq possessed WMDs. See, for instance, an advertisement opposing the Iraq War that was placed by thirty-three influential US-based International Relations scholars in the New York Times on September 26, 2002: War With Iraq Is Not In America's National Interest 2002.

84 Pelopidas 2011, 309; Mutimer 1997, 215f.

85 The reflexive scholarship in security studies has rarely focused on unconventional weapons. For some recent work on nuclear weapons see, Pelopidas 2016; Abraham 2006; Colgan 2019; Braut-Hegghammer 2019.

86 E.g. Mathur 2014; Cohn 1987; Krause and Latham 1998.

87 Craig and Ruzicka 2013.

HOW TO STUDY WEAPONS PROGRAMS: PRACTICAL SUGGESTIONS

To conclude, some practical suggestions for the empirical study of NBC-weapons programs may be in order. These relate to three categories: sound concepts, sound research habits, and sound evidence. In many allegations about weapons programs and reports of the spread of CBN weapons, key concepts (such as 'chemical weapons capability' and 'biological warfare capability') are left undefined. Yet, these terms can mean different things, at different times, when used by government officials, experts, and journalists. Analysts should ensure that the core concepts under consideration are properly defined in order to safeguard the validity of their study. Moreover, they should scrutinize how these concepts are understood and used in cited sources to make sure that—what are often implicit—assumptions are not carelessly reproduced.

Analysts should take the utmost care to present their research as transparently as possible, so that others can understand, evaluate, and replicate the study. Tying in with the previous point, they should explicate how they define concepts and coding rules against which cases are assessed. Analysts should more often consider keeping and making available descriptive data notes, in which they justify per case how the available information is weighed and how coding decisions are made, to allow the interested reader to better appreciate the study and to aid analysts in maintaining coding consistency across cases.[88] Moreover, it allows the analyst to reflect on uncertainties about what is known and what can be known, and discuss alternative coding specifications.

The empirical study of NBC-weapons programs also requires the researcher to take all possible measures to ensure the quality, validity, and veracity of the documentary evidence used in the analysis—especially since information is often scarce and such programs are shrouded in secrecy. The fact remains that a significant source of readily available information comes from the U.S. government. This information may come directly from statements by officials or documents that contain intelligence information that cannot be independently verified. At other time it comes from press reports citing unnamed officials or classified documents. Thus, the analyst has to take great care in surveying the available evidence and analysis beyond that which is easily available in order to not simply accept what appear to be consensual truths. Second, bias is introduced when researchers rely exclusively on English-language sources. Training researchers and graduate students in foreign languages opens up a wealth of primary documentation to study.[89] Third, allegations and pessimistic predictions are frequently repeated over and over again by officials, journalists, and scholars alike, until they become conventional wisdom. To prevent falling in a circular referencing trap, the analyst should therefore trace information back to the original sources as much as possible. Fourth, some of the available information on NBC weapons programs comes

88 See e.g. Bleek and Lorber 2014; Monteiro and Debs 2014..

89 Braut-Hegghammer 2019; Pelopidas 2015.

from sources, governmental and non-governmental, that have parochial agendas. Thus, the analyst has to consider whether these sources have an interest in representing information in a particular way or whether there is a history of false or erroneous (intelligence) reporting. Fifth, governmental assessments and intelligence reports are delivered by different agencies and individual officials at different times. As a result, the contents of these reports may vary among each other and over time. Any analysis should carefully consider the consistency across these reports. Sixth, governments usually only present conclusions intended for public consumption, withholding evidence, analyses, and the nuances and qualifications that contextualize the assessment. When using these assessments, analysts have to consider whether intelligence reports can be independently verified and how public conclusions from intelligence assessments weigh up against alternative sources of information. The latter is especially relevant as technological developments such as geo-locating allow non-governmental analysts to perform the kind of research that was usually the preserve of intelligence agencies.

3

Revisiting the Spread of Chemical and Biological Weapons Programs: A New Dataset

SUMMARY

The previous chapter's deep-dive in the extant scholarly and governmental assessments of chemical and biological weapons programs showed that the literature significantly overstates the extent to which CBWs have spread among states. Building on the lessons learned from this undertaking, this chapter introduces a new dataset of state-run chemical and biological weapons programs in the post-World War II era. While the new data is applied in two subsequent chapters to study the drivers of CBW spread and restraint, this chapter already offers important empirical observations about the spread and rollback of CBW programs.

INTRODUCTION

Relatively little is known about the spread of chemical and biological weapons (CBWs). Some studies have examined the (dis)incentives for CBW programs,[1] while a few publications have studied the history of well-known CBW programs.[2] Yet, the volume of works on CBWs is dwarfed by the literature on nuclear weapons.[3] Notably, several scholarly datasets have attempted to describe the spread of nuclear weapons among states,[4] while the first dataset on the spread of CBWs was published just a few years ago.[5] This is part of a larger problem data problem, as much of the publicly available information about CBW programs comes from U.S. government allegations that are vague, inconsistent, and difficult to verify.[6] Nevertheless, these allegations are so frequently repeated in press reports, scholarly studies, and policy-oriented publications, that they often come to be seen as established facts.[7]

The most popular and enduring view of CBWs is that they are a 'poor man's atomic bomb'. This moniker suggests a few things about the nature of CBWs and the way that they spread: 1) that CBWs are 'easier' or cheaper to acquire than nuclear weapons; 2) that states consider CBWs as substitutes for nuclear weapons; 3) that there is a latent desire among many states for nuclear weapons and, by extension, for CBWs; and 4) that 'poor' states are especially disposed towards CBWs.[8] Indeed, in the 1980s and 1990s US officials regularly warned about as many as two dozen states developing or already possessing the 'poor man's atomic bomb', with many more states in the 'Third World' being able to do so shortly.[9]

A prominent recent study of CBWs by Horowitz and Narang also departs from the premise that CBWs are a 'poor man's atomic bomb'.[10] The authors are the first to systematically investigate this thesis using quantitative methods. They present data on CB weapons programs in the period 1945-2000, which they apply in a quantitative

1 E.g. Tucker 2000; Spiers 1994, chap. 3; Koblentz 2013; Cole 1998; Price and Tannenwald 1996.

2 E.g. Balmer 2009; Moon 2009; Gould and Folb 2000.

3 There are plenty studies that attempt to explain nuclear spread and restraint from a variety of theoretical viewpoints. See, among others, Rublee 2009; Solingen 2007; Paul 2000. A few publications usefully summarize and synthesize extant theories of nuclear spread and reversal. See, for instance, Ogilvie-White 1996; Sagan 1996; Sagan 2011. There is also a large body of work that looks into the history of particular state-run nuclear weapons programs. See, among others, Abraham 1998; Holloway 1994; Rhodes 1986; Jonter 2010; Lewis and Xue 1991; Hymans 2001; Cohen 1999.

4 E.g. Singh and Way 2004; Jo and Gartzke 2007; Bleek 2017.

5 Horowitz and Narang 2014.

6 See also previous chapter.

7 Harris 1989b, 39–41. See also previous chapter.

8 See previous chapter.

9 See, for instance, statements by President George H.W. Bush: Bush 1989c; DeFrank and McDaniel 1989. See also remarks by CIA Director Webster: Webster 1988; or testimony by Director of Naval Intelligence Rear Admiral Brooks: U.S. House Committee on Armed Services 1989, 39f.

10 Horowitz and Narang 2014.

investigation of the relationship between states' desire for nuclear weapons and CBWs. They report that states that are pursuing CWs or BWs are more likely to also pursue NWs, and vice versa. They also find that states that acquire NWs are more likely to cease their pursuit of CB weapons, giving some credence to the popular notion that CBWs are indeed a 'poor man's atomic bomb'.

However, close investigation of Horowitz and Narang's study has revealed that their data on CBW programs considerably overstates the number of countries that have actually pursued and possessed these weapons, particularly among 'Third World' countries.[11] Their data include a large group of states that (almost) certainly have not had CBW programs and overlooks a few that very likely have had them. Consequently, Horowitz and Narang find statistical support for a hypothesized relationship between states' demand for nuclear weapons and CB weapons that does not actually exist (see next chapter).

This chapter introduces a new dataset of states' pursuit and possession of chemical and biological weapons in the post-World War II era (1946-2010). The new dataset reveals that the number of states that have actually pursued and possessed CB weapons is considerably smaller than commonly assumed, particularly among 'poor states'. The majority of these historical CBW programs were relatively small in scale and had limited objectives. Only the United States' and USSR's biological weapons programs were large and sophisticated enough, and had the objective of producing casualties in an order of magnitude similar to nuclear weapons. Remarkably, most states that have pursued and/or possessed CBWs have later reversed course. By 2010 (the end date of the new dataset), only a handful of states pursued or possessed them. Taken together, these findings throw major doubt on the popular notion that CBWs are a 'poor man's atomic bomb'.

This chapter is structured in four parts. First, I define the key concepts under investigation and establish coding rules for the data collection process. Second, I expound on the data collection strategy and selection of sources. Third, I briefly introduce the new data on CBW pursuit and possession. Finally, I analyze the global trends with respect to the spread of CBWs over time.

A NEW CHEMICAL AND BIOLOGICAL WEAPONS DATASET

This chapter presents a new dataset of states' efforts to obtain chemical and biological weapons in the post-World War II period (1946-2010).[12] The year 1946 is taken as the starting point due to the scarcity of reliable data for the (pre-)World War II period. This

11 See previous chapter.

12 A recent study also provides an overview of biological weapons programs in the previous century. See Carus 2017. Carus' findings are broadly in line with the research presented here, although he reaches different conclusions for some cases.

left-censoring unfortunately contributes to the obscuring of many early CBW programs.[13] The endpoint of the dataset is 2010.

What Are CBWs and What Constitutes a Program?

This study follows the definitions of the Chemical Weapons Convention (CWC) and Biological Weapons Convention (BWC) of "chemical agent" and "biological agent" as these are the most comprehensive and most widely accepted. A "chemical agent"—referred to in the CWC as a "toxic chemical"—is defined in Article II.2 CWC as "any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans or animals."[14] This definition not only encompasses the 'traditional' classes of warfare agents, such as nerve agents, vesicant (blister) agents, blood agents, and choking agents, but also any other chemicals that are intended to be used for harming humans and animals based on their direct toxic effects. Accordingly, the Treaty does not provide an exhaustive list of prohibited chemicals but rather introduces a set of provisions and definitions known as the 'General Purpose Criterion' which allows "the CWC to prohibit the application of all toxic chemicals for offensive military purposes while permitting their peaceful uses in commercial industry, agriculture, medical therapeutics, scientific research, and the development of defenses."[15] The CWC definition is useful because it also subsumes rudimentary programs such as Rhodesia's, which focused on developing weapons based on readily available toxic industrial and agricultural chemicals.

Like the CWC, the BWC's prohibition relies on a 'General Purpose Criterion' in lieu of an exhaustive list of proscribed agents. Article I(1) BWC bans the development, production, stockpiling, acquisition, or retention of "microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes."[16] Toxins require further specification as they can be considered both chemical as well as biological agents and are therefore banned under the CWC and BWC. Unlike pathogens (infectious microorganisms like bacteria, viruses, and fungi that can cause diseases), toxins are inanimate toxic products of organisms (like plants, fungi, and bacteria) that have an adverse effect on humans and animals akin to man-made toxic chemicals. This study classifies toxins as biological agents, with one exception: if the development of toxins does not take place within the context of a broader BW program (i.e., a program where other,

13 Chemical weapons were widely used during World War I and before World War II many Western countries had chemical weapons (and some biological weapons) research, development, and production programs supported by technology transfers and other forms of assistance from other Western states. See Zanders 1995b, 7–9.

14 Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction 1993.

15 Tucker 2001a, 3.

16 Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction 1972.

non-toxin, BW agents are developed) but the state has an ongoing CW program, then toxin development is considered part of the country's CW program.

In this study, I take a "biological weapon" or "chemical weapon" to mean the combination of a biological or chemical agent with an appropriate means of release, i.e., a dissemination system. Dissemination systems may be intended for strategic delivery of CB weapons, tactical use on the battlefield, or otherwise. This may include munitions for use with artillery, bomber aircraft, and missiles, but also spray tanks for use with aircraft, and insect vectors. However, dissemination of agents does not necessarily require a dedicated weapons system as it can also happen through less sophisticated means, such as the contamination of water supplies, foodstuffs, beverages, and clothing. These latter methods are usually associated with assassinations, (counter)insurgency, sabotage, and other small-scale operations. This definition is useful because it subsumes the full spectrum of CBW programs, from the large-scale sophisticated programs of the United States and Soviet Union that aimed to developing strategic weapons capabilities to the small and rudimentary programs of Rhodesia and South Africa that were aimed at assassinating political opponents and the sabotage of armed resistance.

For reasons of comparability, this dataset follows the convention of the proliferation studies literature by distinguishing between different steps in the process of acquiring weapons, namely: no interest, launch of a program to pursue weapons, and possession of weapons.[17] A state is coded as possessing when a decision is taken to produce and stockpile chemical or biological weapons, or when there is evidence that the state is performing such activities if there is no information on authorization by leaders or in spite of a decision by leaders not to commence. A state is considered to have ended possession either when it has unilaterally destroyed its stockpile of weapons or when it has declared its stockpile and facilities and put them under verifiable international supervision for destruction. A state is coded as pursuing when a decision is taken to start a program aimed at producing chemical or biological weapons, or when there is evidence that the state is performing such activities if there is no information available of authorization by leaders or in spite of a decision by leaders not to commence. A state is coded as ending pursuit when the decision is taken to end an ongoing program aimed at producing chemical or biological weapons, or when there is evidence that the program has effectively ended if there is no information available of authorization by leaders or in spite of a decision by leaders to continue. A chemical or biological weapons program refers to offensive military activities, although it can sometimes be difficult to distinguish between offensive programs and defensive programs or legitimate civilian and industrial applications as much of the CB weapons research has dual-use applications.[18]

17 Jo and Gartzke 2007.
18 Stockholm International Peace Research Institute 1973, vol. II, 276ff.

The pursuit/possession categorization is certainly not exempt from critique and other categorizations can plausibly be applied. The most obvious point of criticism is that this framework was developed for categorizing nuclear weapons activities and therefore may not be ideal for CBWs, as the latter do not require the same technological capacity and step-by-step infrastructure improvements. Indeed, the step from chemical or biological weapons pursuit to possession poses less of a challenge than in the case of nuclear weapons, particularly if a state sets its eyes on a rudimentary capability to use CBWs. Nevertheless, the distinction between pursuit and possession is relevant.[19] The British in the 1950s, for instance, could have progressed from their research into biological weapons to possession of strategic weapons, yet they chose not to do so. This distinction between research/development and possession is almost always excluded in the earlier CBW literature.[20] The case notes on CBW programs (see *CBW Chronicles* in Chapters 6 and 7) allow the interested reader to (re)consider the evidence presented for coding decisions in this study and even recode cases according to another preferred categorization framework.

Methodology and Sources

The data collection process was done in two parts. In the first step, the list of countries identified by Horowitz and Narang was taken as the starting point as it is the least restrictive published list of countries alleged to have pursued or possessed CBWs.[21] Focusing on one country at a time, the materials cited by them were consulted and claims contained within them were traced back to the original source as much as possible. This initial inquiry revealed that 1) many publications—including Horowitz and Narang's—rely on the same limited set of original sources (often of governmental origin), and 2) allegations are often repeated—with one publication citing another one—until they come to be treated as an established fact or common knowledge.[22]

In the second step, the information collected from this initial set of sources was supplemented with a wealth of new source materials to further explore and corroborate allegations. Sources were identified through repositories of scholarly literature and search engines such as Google Scholar. Each consulted source was reviewed for citations as a means of identifying useful additional materials, but also to assess reliability and prevent circular citations. This process also led to the discovery of several new cases.

19 Robinson 1990, 61.

20 Harris, for example, categorizes states as either known, probable, possible, or doubtful *possessors*. Harris 1989b, 41. These labels indicate the certainty with which allegations of possession can be made. However, this framework either neglects activities that do not rise to the threshold of possession or conflates possession and prior activities into one category. Recently, Carus has employed Harris' framework in his overview of biological weapons programs in the previous century, see Carus 2017.

21 Horowitz and Narang 2014.

22 See Chapter 2.

Extensive use was made of, among others, monographs and edited volumes,[23] journal articles,[24] studies conducted by non-governmental organizations,[25] governmental reports (among which reports on the activities of other states but also self-reporting such as the voluntary confidence building measures (CBM) submissions related to the Biological Weapons Convention),[26] reports from news media,[27] and reports by intergovernmental organizations such as the Organisation for the Prohibition of Chemical Weapons (OPCW) and United Nations (UN).[28] Open source information was privileged when it conflicted with government data that could not be independently validated.

Identifying CBW activities is challenging as the amount and reliability of available information varies significantly between cases. For some countries documentary evidence or officially sanctioned histories exist, while for other countries information is limited to a handful of uncorroborated allegations. Yet, even the best-known programs are often incompletely documented. Data collection is further complicated by the difficulties of distinguishing between legitimate scientific, commercial/industrial, and defensive military activities on the one hand, and activities of an offensive military nature on the other. Therefore, the researcher's judgment of the credibility and reliability of sources, coupled with finding a balance between the available evidence plays a key part. Naturally, different people may come to different conclusions when presented with the same sources. As a matter of transparency, I present a discussion of the available allegations, evidence, uncertainties, judgments, and possible alternative codings for each case in the *CBW Chronicles* (see Chapters 6 and 7). This is of particular importance for countries for which there is *insufficient* evidence available to establish that they have pursued or possessed, rather than clear evidence that they have not, since absence of evidence does not translate to evidence of absence. The same goes for countries for which it is difficult to establish the timeframe during which pursuit and/or possession took place. Naturally, the status of cases should be reconsidered in the future when new evidence comes to light.

Description of Data

The new dataset contains 17 countries that pursued and 18 that possessed chemical weapons in the period 1946-2010 (see **Table 3.1**).[29] In contrast, Horowitz and Narang found that 33

23 E.g. Burck and Flowerree 1991; Croddy and Wirtz 2005, vol. 1; Wheelis, Rózsa, and Dando 2009; Balmer 2001.

24 E.g. Cohen 2001; Gould and Folb 2000.

25 E.g. Nuclear Threat Initiative n.d.; Human Rights Watch 1997; International Crisis Group 2009.

26 E.g. Deutscher Bundestag 1989; Director of Central Intelligence 2001a; U.S. Department of State 2003; Government of Canada 2011.

27 E.g. Knip 1999; Lewis 1987.

28 E.g. OPCW 2003a; UNMOVIC 2007.

29 For three out of 18 pursuit cases (China, India, and South Korea) it was not possible to record the period during which pursuit took place. For India it is even unclear whether pursuit of chemical weapons took place after 1946 or that it had acquired chemical weapons before 1946. For all three cases no date for the start of acquisition could be determined either.

countries pursued and 31 possessed chemical weapons during the period 1945-2000 (see **Table 3.2**).[30] As can be seen in **Table 3.3**, the new dataset contains 10 countries that have pursued biological weapons and 6 countries that have possessed biological weapons in the period 1946-2010.[31] On the other hand, Horowitz and Narang recorded 16 countries as pursuing and 11 countries as possessing biological weapons in the period 1945-2000 (see **Table 3.4**).[32] For a few cases, a lack of available information made it difficult to settle on particular dates for pursuit/acquisition or even to determine whether pursuit/acquisition had taken place. These cases are identified by a question mark or hash sign in **Table 3.1** and **Table 3.3**, while the difficulties involved in making such assessments are described for each case in the *CBW Chronicles* in Chapters 6 and 7.

A few new cases of pursuit and possession were identified. First, South Africa and France were judged by Horowitz and Narang to have possessed chemical weapons from 1945-1993. However, South Africa got rid of its chemical weapons in 1946, started pursuing them again in the early 1980s and possessed them from 1987 until 1993. France, on the other hand, ended its possession in 1988 but continued offensive research aimed at maintaining a capability to produce CWs until a chemical weapons convention would come into effect—this episode is coded as CW pursuit—and finally ended all CW activity in 1993. The authors, furthermore, coded Myanmar (Burma) as pursuing CWs from 1988 up to and through 2000, even though it is most likely that Myanmar had a CW program in the 1980s (with minimal agent and munition production) that ended around 1990. Horowitz and Narang also overlook Canada's pursuit of chemical weapons from the end of World War II until 1969.

On the biological weapons side, the new dataset reveals that Canada similarly pursued from World War II until 1969. Second, France and the United Kingdom are coded as only pursuing biological weapons, while Horowitz and Narang erroneously judged them to have possessed BWs. Finally, Israel is identified as a new case of pursuit and possession of biological weapons.

30 Seven possessor countries (Czechoslovakia, Germany, Greece, Hungary, Japan, Poland, and Spain) are coded by Horowitz and Narang as ending possession in 1945. However, some of these countries were occupied by Germany during World War II and it is possible that CW stocks that were identified on their territory, if present at all, were of German origin.

31 For one country (China) it was impossible to determine whether it had or had not pursued or possessed biological weapons in this period.

32 Horowitz and Narang code one country (Germany) as ending pursuit and one country (Japan) as ending possession in 1945.

Table 3.1: New data on pursuit and possession of chemical weapons, 1946-2010

	Pursuit	Possession
Afghanistan	-	
Algeria	-	
Angola	-	
Argentina	-	
Australia	1939-1946	
Brazil	-	
Canada	1946-1969	1941-1946
Chad	-	
Chile	1975-1976	
China	?	?-1997
Egypt	1958-1962; 1974-9999	1963-1974
Ethiopia	-	
France	1988-1993	0000-1988
German Democratic Republic	-	-
India	?	?-1997
Iran	1985-1986	1987-1991
Iraq	1971-1982	1983-1991
Israel	1955-1956	1956-9999
Kazakhstan		-
Laos	-	
Libya	1984-1988	1989-2004
Mozambique	-	
Myanmar (Burma)	?	?-1990
North Korea	1961-1988	1989-9999
Pakistan	-	-
Peru	-	
Philippines	-	
Rhodesia	1976	1977-1979
Saudi Arabia	-	-
Somalia	-	
South Africa	1981-1986	0000-1946; 1987-1993
South Korea	?	?-1997
Soviet Union/Russia		0000-9999
Sudan	-	
Sweden	-	
Syria	1979-1984	1985-9999
Taiwan	-	-
Thailand	-	
United Kingdom		0000-1957
United States		0000-1997
Vietnam	-	-
Yugoslavia	1976-1987	1988-1991

- No activity
? Unknown date
0000 Date before 1946
9999 Continued after 2010

Table 3.2: Pursuit and possession of chemical weapons (Horowitz and Narang, 2014)

	Pursuit	Possession
Afghanistan	1982-1994	
Algeria	1999-2000	
Angola	1984-1993	
Argentina	1971-1993	
Australia	1945-1973	
Brazil	1988-1993	
Burma	1988-2000	
Canada		1945-1946
Chad	1988-1993	
Chile	1988-1993	
China		1945-2000
Czechoslovakia		1945
Egypt	1945-1962	1963-2000
Ethiopia	1980-1993	
France		1945-1993
German Democratic Republic	1980-1982	1983-1989
Germany		1945
Greece		1945
Hungary		1945
India		1947-2000
Iran	1983	1984-2000
Iraq	1971-1979	1980-2000
Israel	1952-1955	1956-2000
Japan		1945
Kazakhstan		1991-2000
Laos	1988-1993	
Libya	1976-1980	1981-2000
Mozambique	1988-1993	
North Korea	1965-1987	1988-2000
Pakistan	1982-1986	1987-2000
Peru	1988-1993	
Philippines	1988-1993	
Poland		1945
Rhodesia	1975	1976-1980
Saudi Arabia	1988-1989	1990-1993
Somalia	1988-2000	
South Africa		1945-1993
South Korea	1967-1988	1988-2000
Soviet Union/Russia		1945-2000
Spain		1945
Sudan	1990-2000	
Sweden	1945-1973	
Syria	1971-1972	1973-2000
Taiwan	1970-1982	1983-2000
Thailand	1988-1993	
United Kingdom		1938-1957
United States		1945-2000
Vietnam	1975-1989	1990-2000
Yugoslavia	1958-1968	1969-2000

Table 3.3: New data on pursuit and possession of biological weapons, 1946-2010

	Pursuit	Possession
Algeria	-	
Bulgaria	-	
Canada	1942-1969	
China	#	#
Cuba	-	
Egypt	1958-9999	-
France	1948-1967	-
Iran	-	
Iraq	1974-1978; 1985-1989	1990-1991
Israel		1948-9999
Laos	-	
Libya	-	
North Korea	1964-9999	-
Rhodesia/Zimbabwe	1976-1979	-
South Africa	1981-1983	1984-1993
Soviet Union/Russia	0000-0000	1935-9999
Syria	-	
Taiwan	-	
United Kingdom	1945-1956	0000-0000
United States	0000-0000	1944-1972
Vietnam	-	

- No activity
\# Unknown status
0000 Date before 1946
9999 Continued after 2010

Table 3.4: Pursuit and possession of biological weapons (Horowitz and Narang, 2014)

	Pursuit	Possession
Algeria	1999-2000	
Bulgaria	1988-1993	
China	1950-1961	1962-2000
Cuba	1988-1993	
Egypt	1945-1971	1972-2000
France		1945-1973
Germany	1945	
Iran	1981-2000	
Iraq	1974-1986; 1992-2000	1987-1991
Japan		1945
Laos	1988-1993	
Libya	1988-2000	
North Korea	1965-1987	1988-2000
Rhodesia/Zimbabwe	1975	1976-1980
South Africa	1945-1975	1976-1993
Soviet Union/Russia		1945-2000
Syria	1990-2000	
Taiwan	1975-1993	
United Kingdom		1945-1956
United States		1940-1972
Vietnam	1988-1993	

REFLECTIONS ON THE SPREAD AND REVERSAL OF CBW PROGRAMS

The new dataset throws new light on the way that chemical and biological weapons have spread in the post-World War II period. Several noteworthy observations can be gleaned from the data.

The Spread of CBWs is Less Prevalent Than Often Assumed

The number of states that have pursued or possessed CBWs is considerably smaller than in previously published assessments by governments and experts. Horowitz and Narang, for instance, claim that roughly twice as many countries have pursued or possessed compared to the present study. **Table 3.5** illustrates the key differences between Horowitz and Narang's study and the new dataset. Horowitz and Narang erroneously include 21 states as pursuing and 7 states as possessing chemical weapons. On the biological weapons side, the authors judge 9 states as pursuing and 5 states as possessing chemical weapons that have not done so. Moreover, almost two dozen states have pursued or possessed CBWs for a shorter period of time than Horowitz and Narang indicate. Notably, no new states have started pursuing or have acquired chemical weapons since the 1980s, while the last state to acquire biological weapons—albeit it for a very short time—was Iraq in 1990 (see **Figure 3.1** and **Figure 3.2**).

CBWs Are Not Restricted to 'Poor' States

Contrary to the popular notion that chemical and biological weapons are a 'poor man's atomic bomb', there seems to be no discernible disposition towards these weapons by so-called 'developing' or 'Third World' states. On the contrary, plenty industrialized states—with and without nuclear weapons—have pursued or possessed CBWs. At the same time, many 'developing countries' have incorrectly been accused of pursuing or possessing CBWs. Indeed, the majority of cases judged by Horowitz and Narang to have pursued or possessed CBWs that were removed in the new dataset (see the row 'Cases Removed' in **Table 3.5**) are developing countries in the Middle East, South (East) Asia, and Africa.

Most CBW Programs Have Been Small and Have Had Limited Objectives

The notion of a 'poor man's atomic bomb' suggests that states desire chemical and biological weapons when they cannot afford or are not capable of acquiring nuclear weapons. This obscures the differing strategic and tactical functions of nuclear, chemical, and biological weapons. The military objectives of state-run chemical and biological weapons programs have varied considerably. CBWs may be intended for general strategic deterrence, deterrence against nuclear weapons, or in-kind deterrence against opposing CBWs. But, they could also be used as a force multiplier against more powerful conventional rivals, to assassinate political opponents, for terrorism or sabotage operations, for counterinsurgency operations, or on the battlefield.

Table 3.5: Differences between new CBW dataset and Horowitz and Narang's data

	Chemical		Biological	
	Pursuit	**Possession**	**Pursuit**	**Possession**
Cases Removed	**20:** Afghanistan, Algeria, Angola, Argentina, Brazil, Chad, Ethiopia, East Germany, Laos, Mozambique, Pakistan, Peru, Philippines, Saudi Arabia, Somalia, Sudan, Sweden, Taiwan, Thailand, Vietnam	**6:** East-Germany, Kazakhstan, Pakistan, Saudi Arabia, Taiwan, Vietnam	**9:** Algeria, Bulgaria, Cuba, Iran, Laos, Libya, Syria, Taiwan, Vietnam	**5:** Egypt, France*, North Korea, Rhodesia, United Kingdom*
New Cases	**3:** Canada, France, South Africa	**1:** Myanmar (Burma)	**3:** Canada, France‡, United Kingdom‡	**1:** Israel
Shorter period	**3:** Australia, Chile, Israel	**14:** China, Egypt, France, India, Iran, Iraq, Libya, North Korea, South Korea, Rhodesia, South Africa, Syria, United States, Yugoslavia	**2:** Iraq, South Africa	**3:** Iraq, South Africa, United States
Longer period	**4:** Egypt, Iraq, North Korea, Syria		**3:** Egypt, North Korea, Rhodesia	

* Downgraded to pursuit
‡ Downgraded from possession

Most CBW programs—with exception of the American and Soviet programs—have been small (employing anywhere from a dozen to a few hundred staff), have had limited objectives, and have often made use of improvised dissemination methods. These programs have been too limited to develop a functional deterrent and the secrecy surrounding them would make deterrence difficult anyway.[33] The South African and Rhodesian CBW efforts illustrate this well as these countries set out to develop specialty weapons for assassination,

33 Koblentz 2003.

sabotage, and counterinsurgency operations.[34] Their programs focused on the use of toxic industrial and agricultural chemicals in lieu of traditional warfare agents, which were disseminated, among others, by contaminating foodstuffs and clothing that was to be delivered to African nationalist guerillas. While the two main South African chemical and biological research and production laboratories had around 160 technical employees, only few of them were involved with and knew about the offensive military component of the program.[35]

Iraq's chemical weapons in the 1980s, on the other hand, initially provided a force multiplier on the battlefield against Iran's numerically superior forces and human-wave tactics during the Iran-Iraq War, but were also later used against non-combatants and civilians in Iranian cities and villages as well as against Iraq's Kurdish and Shi'a Arab populations.[36] Despite its primarily tactical objectives, Iraq's CW program was among the larger ones in size, although still not close to the magnitude of the American and Soviet programs. According to estimates by UN weapons inspectors, the Iraqi CW effort employed a total of around 1,500-2,000 individuals between 1981 and 1991.[37] During this time, Iraq produced circa 130,000 chemical munitions of which over 101,000 were used.[38] Iraq's BW program began in the mid-1980s under auspices of the existing CW project. Iraqi officials have stated that the BW effort was intended to develop a deterrent as a "stopgap measure because of the long lead-time involved in the development of a nuclear programme."[39] The BW effort was considerably smaller than the Iraqi CW, missile, and nuclear weapons programs, employing around a 100 people with only a quarter of them involved in research, production, field-testing or weaponization in the 1980s.[40] The BW program yielded little effect as only 200 aerial bombs and 25 warheads were filled with BW agent right around Iraq's invasion of Kuwait. Not only did this barely constitute a military significant stockpile, but the selected systems were ill-suited for the dissemination of biological agents.[41]

Few CBW Programs Have Attempted to Mimic Nuclear Weapons

Although chemical and biological weapons are often lumped together under the 'poor man's atomic bombs' moniker, only biological weapons have the potential to produce mass casualties like nuclear weapons. In spite of what the 'poor man's atomic bomb' label might suggest, creating an effective and dependable military biological warfare capability with

34 Gould and Folb 2000; Cross 2017.

35 Gould and Folb 2000, 17; Leitenberg 2001, 274, Table 1.

36 Ali 2001.

37 UNMOVIC 2007, 1053. Among the 1,500-2,000 staff were 60 specialists with a doctorate, circa 200 engineers, and around 600 equipment operators. In contrast, Iraq's unsuccessful nuclear weapons program was significantly larger, employing several thousand staff. Ibid., 1056.

38 UNMOVIC 2007, 180.

39 Ibid., 775.

40 Ibid., 1055.

41 Ibid., 790.

Figure 3.1 : Timeline of chemical weapons pursuit and possession

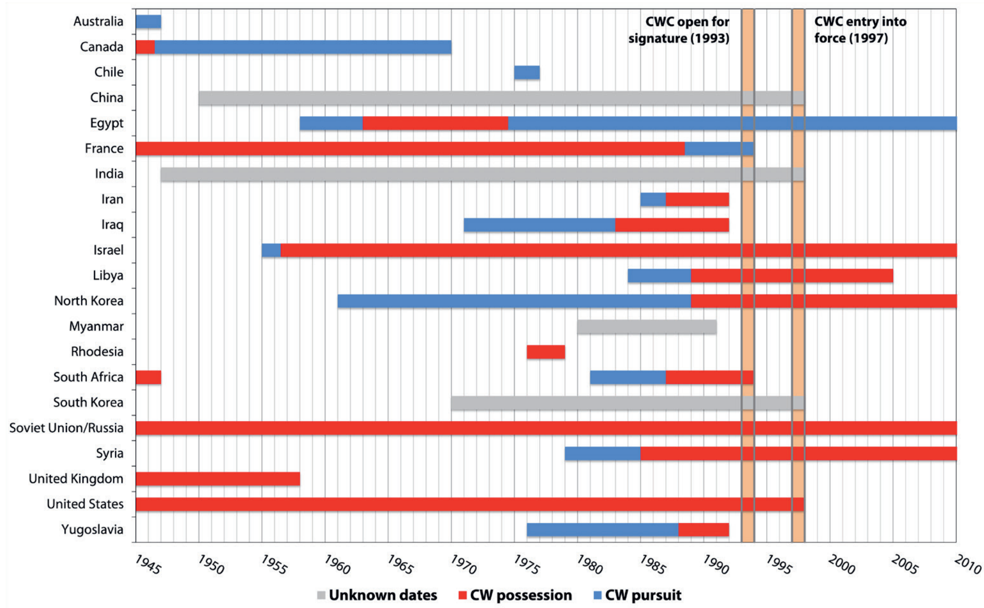
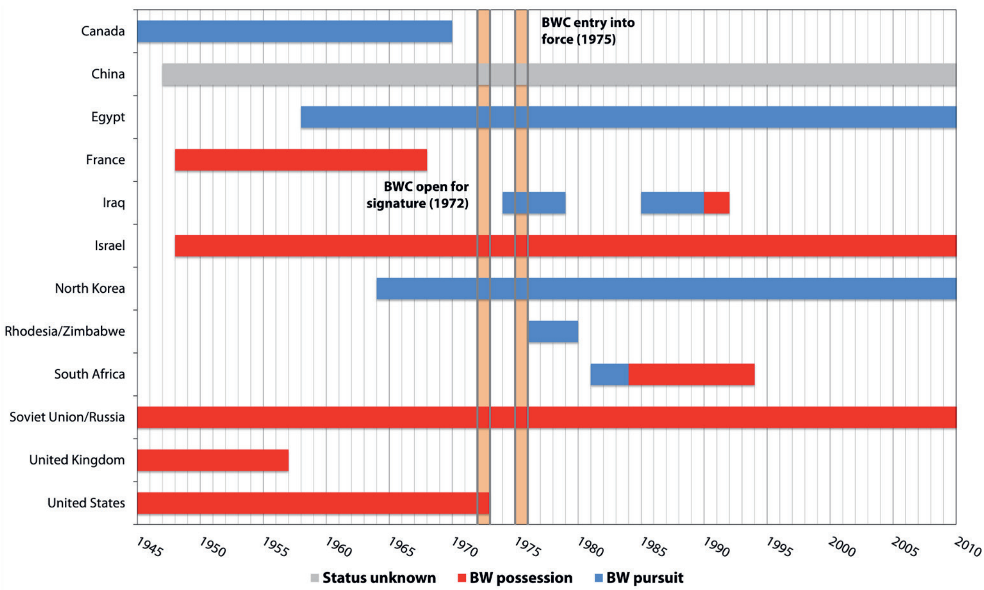


Figure 3.2: Timeline of biological weapons pursuit and possession



an eye to mass casualties is difficult and costly.[42] Even the production of chemical weapons beyond laboratory quantities requires significant knowhow, raw chemicals, technologies, and machinery that is not readily available even in advanced industrial countries.[43] Among all historical CBW programs, only the United States and Soviet Union have had BW undertakings that had the express objective of producing casualties in an order of magnitude similar to nuclear weapons (or even exceeding that), as well as the size and sophistication to do so.

The American BW program was significantly larger than other BW programs, employing around 3,400 staff during the Cold War.[44] By the late 1950s, the Americans were focusing their efforts on the potential of covering large areas with BW.[45] To that end, the BW program developed, tested, and stockpiled a variety of BW agents and fielded them through various systems, such as aerial (cluster) bombs, spray tanks, insect vectors, and missiles.[46] In turn, the American BW effort was dwarfed by the massive Soviet undertaking. The USSR's BW program was the largest ever organized, at its peak employing 65,000 people at dozens of research, development, production, and testing facilities.[47] Although less information is available in the literature about the delivery systems employed by the Soviet program, several options were developed for strategic use.[48] They included aerial (cluster) bombs and spray systems for medium-range bomber aircraft, while cruise missiles may have been under development in the late 1980s.[49]

States Have Ended CBW Programs for a Plethora of Reasons

As of 2010, only a handful of states continued the pursuit or possession of CBWs (see **Figure 3.1** and **Figure 3.2**). Most states that have had CBW program ceased their efforts to acquire them or gave up the weapons they possessed. Termination of CBW programs (but also the launch of such programs) is rarely explained by one neat variable. Instead, such decisions are shaped by a complex constellation of pressures and constraints. A variety of reasons for termination of CBW programs can be found in the empirical material.

In the cases of South Africa, Rhodesia, and Yugoslavia, changing domestic political and security circumstances played an important role in the end of their respective CBW programs. In South Africa and Rhodesia, the shift towards majority rule led the outgoing

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42 Leitenberg, Zilinskas, and Kuhn 2012, 282. At the same time, the deterrent value of BW is diminished because of their delayed and unpredictable effects, and the necessity of the element of surprise. See Koblentz 2003, 104–107.

43 Flowerree 1991, 11.

44 Leitenberg 2001, 274. The American CW program was of similar size, employing 3,700 people in the 1950s. Tucker 2006, 127.

45 Moon 2009, 28–30; Kirby 2007.

46 Smart 1997, 51–59.

47 Koblentz 2009, 113.

48 Leitenberg, Zilinskas, and Kuhn 2012, 303f.

49 Ibid., 303, Table 10.3.

white minority government to wind down the programs, among others, to prevent the public becoming aware of them and the new government getting their hands on them.[50] In Yugoslavia, the Serb-dominated military brass hastily shut down the CW program as the breakup of Yugoslavia and civil war was looming.[51] CBW programs, however, may also be terminated due to external pressures. The Iraqi CBW and nuclear programs were dismantled under UN supervision after Iraq's military defeat in the Gulf War,[52] while Libya offered to shut down its nuclear and chemical weapons programs in order to receive sanctions relief and improved relations with the West.[53]

International norms and legal rules against the spread and use of CBWs have also played a role in changing preferences. A significant number of states—e.g. United States, China, South Korea, India, South Africa, and France—ended their pursuit or possession of CW when they signed and ratified the CWC in the mid-1990s, while some states even ended their programs as the negotiations were ongoing.[54] Public opinion, domestic and international, of the U.S. BW program coupled with the prospects of a global BW ban being negotiated played a part in the American decision to forgo biological weapons in 1969.[55] While the adoption and coming into force of the BWC in 1972 and 1975, respectively, did not directly lead to any state forgoing BW pursuit or possession, it is plausible that it codified a norm against possession that may have aided in preventing other states from embarking on a BW program.

Changing priorities and insufficient progress have played a role in decisions to end CBW efforts. While BW research had demonstrated the immense destructive potential of biological warfare—particularly, in its ability to produce mass casualties in large areas—the United States decided that reliance on nuclear weapons was sufficient for strategic deterrence and for deterring BW use by other states.[56] Changes in budget and defense posture priorities played a role in decisions by the United Kingdom in the 1950s and Canada in 1969 to end their CBW pursuit, and in the French decision in 1967 to end pursuit of biological weapons.[57] In at least one case, Iraq's first BW pursuit attempt in

50 Purkitt and Burgess 2005, 176; Cross 2017.

51 Nuclear Threat Initiative 2014a.

52 UNMOVIC 2007.

53 Tucker 2009.

54 France, for instance, ended possession of chemical weapons in the late 1980s because it intended to become party to the CWC, which was nearing completion, but continued a research program (pursuit) until the convention was adopted in 1993. Tucker 2006, 269.

55 Moon 2009, 36; Avery 2013, 137–146. The American renunciation greatly influenced Canada in ending its own offensive BW research, which was highly intertwined with the United States' program. However, worries about being implicated in the American CBW effort and mounting international support for a ban also played a part in Canadian deliberations in the late 1960s. Ibid., chap. 4.

56 Avery 2013, 137–146; *Report to the National Security Council, 'US Policy on Chemical and Biological Warfare and Agents,' submitted by the Interdepartmental Political-Military Group in response to 'National Security Study Memorandum 59'* 1969, 24f.

57 Balmer 2009; Avery 2009; Lepick 2009.

the 1970s, insufficient progress was even the primary reason to shut down an offensive biological weapons effort.[58]

CONCLUSION

The new CBW program data presented in this chapter casts considerable doubt on the popular notion that chemical and biological weapons are a 'poor man's atomic bomb' (PMAB). The data reveals that far fewer states—especially from the 'Third World'—have pursued and possessed chemical and biological weapons than is commonly assumed. Besides, very few of these programs were large and sophisticated enough to produce casualties on a scale similar to nuclear weapons or even intended to mimic the military and political effects of nuclear weapons. I will examine the PMAB thesis further in the next chapter by applying the new CBW data in a series of quantitative tests.

58 UNSCOM 1995, 22.

4

Do States Treat Chemical and Biological Weapons as a 'Poor Man's Atomic Bomb'? A Quantitative Test

SUMMARY

The previous chapter introduced a new dataset of chemical and biological weapons programs in the post-World War II period. This chapter subjects the new data to several quantitative tests to investigate whether states treat CBWs like a replacement for nuclear weapons as the popular 'poor man's atomic bomb' thesis suggests.

INTRODUCTION

As described in the first chapter, the ‘poor man’s atomic bomb’ thesis is the most popular explanation of the spread of chemical and biological weapons. In short, the thesis proposes that states—particularly, ‘poor’ or ‘developing’ ones—desire chemical and biological weapons because they are a cheap and easy to acquire alternative to nuclear weapons. In the 1980s and 1990s US officials regularly warned about as many as two dozen states developing or already possessing the ‘poor man’s atomic bomb’, with many more states in the ‘Third World’ being able to do so shortly.[1] However, assessments of CBW spread, both official as well as scholarly ones, have systematically overstated prevalence of the phenomenon.[2] To address this gap, I presented a new dataset of state-run CBW programs (indicating when states have pursued and when they have possessed chemical weapons and BWs) in the period 1946-2010 in Chapter 3.

Despite its popularity, the ‘poor man’s atomic bomb’ thesis has rarely been systematically tested. The single exception is a study by Horowitz and Narang (hereinafter H&N), that examines whether CBWs and nuclear weapons serve as complements or substitutes.[3] In brief, H&N find that CBWs do not, in fact, serve as substitutes for nuclear weapons; casting doubt on the “poor man’s atomic bomb’ thesis. However, as I describe in Chapter 2, their data on CBW programs is a prime example of the overestimation of the spread of CBWs. This raises questions about the validity of H&N’s findings. The introduction of the new CBW dataset in Chapter 3 allows me to re-approach this test with the most reliable CBW data to date. In this chapter I will replicate H&N’s research design, with one crucial difference: I use the CBW dataset that is presented in Chapter 3 of this dissertation. Swapping in the key CBW data while keeping the rest of the research design constant allows me to perform a clean comparison of the results with H&N’s findings. As a brief preview, this analysis shows that CBWs do not, in fact, serve as substitutes for nuclear weapons; casting doubt on the “poor man’s atomic bomb’ thesis.

This chapter is structured as follows. First, I describe H&N’s research design and summarize their core findings. Second, I discuss the results of reanalysis with the new CBW data that was introduced in Chapter 3. Finally, I conclude by discussing some implications for the study of unconventional weapons spread.

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1 See, for instance, statements by President George H.W. Bush: Bush 1989c; DeFrank and McDaniel 1989. See also remarks by CIA Director Webster: Webster 1988; or testimony by Director of Naval Intelligence Rear Admiral Brooks: U.S. House Committee on Armed Services 1989, 39f.

2 See Chapter 2.

3 Horowitz and Narang 2014.

PRIOR TEST OF THE 'POOR MAN'S ATOMIC BOMB' THESIS

H&N's study of the 'poor man's atomic bomb' thesis employs a standard cross-sectional time series dataset covering the period 1945-2000, with the country-year as the unit of analysis. They perform hazard models to estimate the probability that a country will pursue nuclear, chemical, or biological weapons (the dependent variable) given that has not yet done so, conditional on a set of covariates.[4] This probability is given by the hazard rate, which indicates the 'risk' that a country will initiate pursuit in a given period. Following previous work on the causes of nuclear weapons spread, H&N estimate parametric discrete-time hazard models using a Weibull distribution.[5] This approach is well-suited to rare events (i.e., initiating pursuit of nuclear, chemical, or biological weapons) and enables the inclusion of both time-invariant and time-variant variables.[6]

From the outset, the reliability of H&N's findings is debatable. The authors present three different versions of their CBW data throughout the published article and its supplemental materials. One version of this data is presented in two tables in the body of the published article (reproduced in Chapter 2 as Tables 2.1 and 2.2).[7] The second version of their CBW data is displayed in two tables in the article's online supplement, alongside citations of the sources the authors consulted.[8] The third version can be found in the *Stata* data file that the authors used to perform the statistical analysis.[9] The tables in the published article and those in the article's online appendix are nearly identical, with only a few cases differing by a few years. However, the data in the *Stata* replication file deviates substantially, with seven countries having different periods of pursuit or possession. The pursuit or possession of another seven countries are even completely left out of the statistical analysis. H&N's replication file may inadvertently contain the wrong CBW data as it is so different from the published tables of CBW programs and the appendix tables that contains the consulted sources. Nevertheless, I was able to replicate the statistical results that H&N report in their published article and have reproduced them below in **Table 4.1**.[10] I also performed additional analyses with the CBW data taken from the tables of H&N's published article,

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4 Ibid., 521. The CBW data was collected by H&N. The data for pursuit and possession of nuclear weapons was obtained from Gartzke and Kroenig 2009.

5 See, for instance, Singh and Way 2004; Sasikumar and Way 2009; Kroenig 2010, chap. 5; Bleek and Lorber 2014.

6 Singh and Way 2004, 871; Box-Steffensmeier and Jones 1997, 1434.

7 The data is taken from Horowitz and Narang 2014, 518–520, Table 1 and Table 2.

8 See Table 11 and Table 12 of the study's online appendix: http://journals.sagepub.com/doi/suppl/10.1177/0022002713509049.

9 See H&N's supplemental materials. The CBW data is included in the Stata data file as the following four variables: *CWpursuit*, *CWknown*, *BWpursuit*, and *BWknown*.

10 H&N's statistical results are reported in Horowitz and Narang 2014, 523, Table 3. I replicated the results with the use of the replication dataset (in Stata's .dta file format) contained in the online supplemental materials of H&N's study, which can be downloaded from: http://journals.sagepub.com/doi/suppl/10.1177/0022002713509049. The commands to perform the analysis in Stata (in .do file format) were obtained from the authors.

the result of which are reported below in **Table 4.3**.[11] Descriptive statistics for the data from these two analyses are reported in **Table 4.2** and **Table 4.4**, respectively. These tables show that the mean and standard deviations for pursuit and possession of CWs and BWs differ between the two datasets. Consequently, the results of the additional analysis (in **Table 4.3**) differ noticeably from H&N's reported findings (in **Table 4.1**) and weaken their conclusions about the 'poor man's atomic bomb' thesis. In the ensuing discussion I will point out when the results of the additional analysis are different from H&N's published findings.

Table 4.1 reproduces H&N's published statistical results. For ease of interpretation, hazard ratios are reported instead of traditional regression coefficients. Hazard ratios are interpreted relative to 1, where hazard ratios greater than 1 indicate that variables increase the risk of weapons pursuit, while hazard ratios smaller than 1 indicate that variables decrease the risk of weapons pursuit. Models 1 and 2 in **Table 4.1** estimate the impact of chemical weapons and biological weapons pursuit and possession on the risk that a state will pursue nuclear weapons over time. Models 3 and 4 estimate the impact of nuclear weapons and biological weapons pursuit and possession on the risk that a state will pursue chemical weapons over time. Finally, models 5 and 6 estimate the impact of nuclear weapons and chemical weapons pursuit and possession on the risk that a state will pursue biological weapons over time. The odd-numbered core models (models 1, 3, and 5) estimate only the relationship between the three weapons types. The even-numbered expanded models (models 2, 4, and 6) include a set of eleven control variables that might influence the probability that a state pursues such weapons. Two variables (total number of shared land borders and presence of a nuclear-armed ally) account for a state's security environment.[12] Gross domestic product per capita (GDPpc) and gross domestic product per capita squared (GDPpc^2) control for a country's relative wealth. A country's membership of the relevant treaties that govern the spread of unconventional weapons (Biological Weapons Convention, Chemical Weapons Convention, and Nuclear Non-Proliferation Treaty) control for the impact of international legal instruments. For each treaty, H&N also generate a system variable that measures the proportion of states in the international system that have signed the treaty. Finally, a domestic unrest variable is included that measures how many riots, strikes, or antigovernment demonstrations a country has faced relative to the size of its population.[13]

Starting with nuclear weapons, H&N find in both the core model (model 1) and the expanded model (model 2) that chemical weapons possession and pursuit increase the risk of nuclear pursuit, as illustrated by the positive and statistically significant hazard ratios. The positive and significant hazard ratios for biological weapons pursuit in models 1 and 2 indicate that biological pursuit is also associated with an increased likelihood of nuclear pursuit. However, biological weapons pursuit becomes insignificant when the analysis is

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11 The CBW data was taken from Ibid., 518–520, Table 1 and Table 2.

12 The data on shared land borders are taken from Stinnett et al. 2002. The data on nuclear-armed allies come from Singh and Way 2004.

13 This data is taken from Banks 2005.

Table 4.1: Horowitz and Narang's (2014) hazard analysis of the interaction between pursuit of chemical, biological, and nuclear weapons

Independent Variables	Dependent Variables					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
	DV: Nuclear Pursuit	**DV: Nuclear Pursuit**	**DV: Chemical Pursuit**	**DV: Chemical Pursuit**	**DV: Biological Pursuit**	**DV: Biological Pursuit**
CBN Weapons						
Nuclear weapon possession			1.37e-07*** (1.03e-07)	3.20e-08*** (2.64e-08)	3.68e-09*** (2.19e-09)	1.44e-07*** (1.28e-07)
Nuclear weapon pursuit			8.033*** (4.202)	4.817*** (2.625)	2.255** (0.826)	1.986 (1.070)
Chemical weapon possession	38.18*** (24.72)	22.85*** (15.99)			24.13*** (17.06)	35.45*** (35.92)
Chemical weapon pursuit	19.90*** (10.32)	13.19*** (7.659)			14.69*** (11.07)	19.95*** (13.08)
Biological weapon possession	2.611 (1.927)	2.629 (2.328)	1.23e-07*** (1.11e-07)	4.33e-08*** (4.39e-08)		
Biological weapon pursuit	2.521** (1.091)	2.507** (1.127)	7.330*** (3.257)	8.311*** (3.306)		
Control Variables						
GDP per capita		1.001* (0.000300)		1.000 (8.87e-05)		1.001* (0.000391)
GDP squared		1.000** (2.33e-08)		1.000* (2.37e-09)		1.000* (4.06e-08)
Alliance		1.243 (0.514)		1.589 (0.545)		0.580 (0.395)
NPT membership		0.208*** (0.0967)				
NPT system effect		1.004 (0.0103)				
CWC membership				0.761 (0.550)		
CWC system effect				0.592 (0.444)		
BWC membership						0.939 (0.497)
BWC system effect						0.199** (0.164)
Number of land borders (security environment)		1.138* (0.0847)		1.028 (0.0805)		0.876 (0.0999)
Domestic unrest		1.054** (0.0258)		1.058 (0.0385)		0.890 (0.135)
Number of countries	187	165	184	162	187	165
Observations	7,263	5,802	7,059	5,635	7,376	5,921

Note: BWC = Biological Weapons Convention; CBN = Chemical, Biological, and Nuclear; CWC = Chemical Weapons Convention; DV = dependent variable GDP = gross domestic product; NPT = Non-Proliferation Treaty. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4.2: Descriptive statistics for data from Horowitz and Narang (2014)

Variables	Mean	Std. dev.	Min.	Max.
CBN Weapons				
Nuclear weapon possession	0.041	0.198	0	1
Nuclear weapon pursuit	0.026	0.158	0	1
Chemical weapon possession	0.058	0.233	0	1
Chemical weapon pursuit	0.034	0.18	0	1
Biological weapon possession	0.022	0.147	0	1
Biological weapon pursuit	0.02	0.141	0	1
Control Variables				
GDP per capita	5784.28	5982.85	281	44048
GDP squared	69244755	1.47E+8	78961	1.94E+9
Alliance	0.442	0.497	0	1
NPT membership	0.435	0.496	0	1
NPT system effect	43.484	39.334	0	96.859
CWC membership	0.135	0.342	0	1
CWC system effect	0.135	0.303	0	0.859
BWC membership	0.42	0.494	0	1
BWC system effect	0.42	0.375	0	0.849
Number of land borders	5.398	3.209	0	29
Domestic unrest	0.854	2.628	0	56.667

Note: BWC = Biological Weapons Convention; CBN = Chemical, Biological, and Nuclear; CWC = Chemical Weapons Convention; GDP = gross domestic product; NPT = Non-Proliferation Treaty

conducted with the ‘correct’ version of H&N’s data (see **Table 4.3**). The hazard ratios for biological weapons possession, while positive, are statistically insignificant. According to the authors, this indicates that states do not view possession of CBWs as a substitute for having nuclear weapons.[14]

Turning to chemical weapons, H&N find that nuclear weapons possession and biological weapons possession decrease the likelihood of chemical weapons pursuit in model 3 to virtually zero. The direction and significance of these effects remain even after inclusion of the control variables in model 4. The authors conclude that these results provide support for the ‘poor man’s atomic bomb’ thesis, “since nuclear weapons appear to systematically satisfy demand for chemical weapons almost entirely.”[15] Yet, there is a simpler explanation for this finding that has nothing to do with the ‘poor man’s atomic bomb’ thesis: survivorship bias. A closer look at H&N’s data reveals that all NW possessors already possessed chemical weapons at the time of acquiring nuclear weapons and most

14 Horowitz and Narang 2014, 524.
15 Ibid., 527.

Table 4.3: Horowitz and Narang's (2014) hazard analysis with CBW data taken from Tables 1 and 2 in their *JCR* article

	Dependent Variables					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Independent Variables	**DV: Nuclear Pursuit**	**DV: Nuclear Pursuit**	**DV: Chemical Pursuit**	**DV: Chemical Pursuit**	**DV: Biological Pursuit**	**DV: Biological Pursuit**
CBN Weapons						
Nuclear weapon possession			2.64e-07*** (1.99e-07)	5.25e-08*** (4.22e-08)	7.56e-08*** (4.40e-08)	3.18e-07*** (1.98e-07)
Nuclear weapon pursuit			5.661*** (3.463)	4.954*** (2.769)	1.557 (0.468)	1.423 (0.463)
Chemical weapon possession	37.40*** (25.33)	24.95*** (16.36)			164.7*** (112.7)	287.4*** (263.7)
Chemical weapon pursuit	20.11*** (11.02)	14.47*** (8.806)			81.89*** (62.50)	117.7*** (102.0)
Biological weapon possession	2.872 (2.221)	2.197 (1.803)	2.77e-07*** (3.27e-07)	5.54e-08*** (7.23e-08)		
Biological weapon pursuit	1.985 (0.877)	1.636 (0.682)	13.25*** (4.994)	12.79*** (3.665)		
Control Variables						
GDP per capita		1.001 (0.000323)		1.000 (9.77e-05)		1.000 (0.000223)
GDP squared		1.000* (2.64e-08)		1.000 (2.78e-09)		1.000 (2.40e-08)
Alliance		1.627 (0.721)		0.890 (0.356)		0.965 (0.382)
NPT membership		0.234*** (0.100)				
NPT system effect		1.008 (0.00918)				
CWC membership				0.302** (0.175)		
CWC system effect				2.104 (1.263)		
BWC membership						0.790 (0.470)
BWC system effect						0.577 (0.404)
Number of land borders (security environment)		1.176** (0.0789)		1.033 (0.0600)		0.979 (0.0748)
Domestic unrest		1.041** (0.0210)		1.074** (0.0361)		0.853 (0.0831)
Number of countries	187	165	183	161	187	165
Observations	7,263	5,802	6,975	5,556	7,338	5,883

Note: BWC = Biological Weapons Convention; CBN = Chemical, Biological, and Nuclear; CWC = Chemical Weapons Convention; DV = dependent variable GDP = gross domestic product; NPT = Non-Proliferation Treaty. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4.4: Descriptive statistics for alternative data from Horowitz and Narang (2014)

Variables	Mean	Std. dev.	Min.	Max.
CBN Weapons				
Nuclear weapon possession	0.041	0.198	0	1
Nuclear weapon pursuit	0.026	0.158	0	1
Chemical weapon possession	0.067	0.25	0	1
Chemical weapon pursuit	0.039	0.195	0	1
Biological weapon possession	0.026	0.16	0	1
Biological weapon pursuit	0.023	0.15	0	1

Note: Descriptive statistics for the control variables are ommitted as they are the same as those in Table 4.2.

of them continued CW possession for a long time after nuclear acquisition.[16], [17] For the purposes of H&N's analysis, these states had already exited the risk pool for CW pursuit before acquiring NWs. As a result, the countries that have not possessed nuclear weapons are the only subjects that contribute to the algorithm. H&N also find that the ratios for NW and BW pursuit are positive and significant in models 3 and 4, indicating that pursuit of NWs and the pursuit of BWs increases the risk of CW pursuit. The sparsity of the data is concerning in both the core and expanded model. Even though the number of countries in models 3 and 4 is 184 and 162, respectively, only 6 countries pursued NWs and CWs at the same time and only 8 countries pursued BWs and chemical weapons at the same time.

H&N also claim to find support for the 'poor man's atomic bomb' thesis when taking biological weapons pursuit as the dependent variable. They report that nuclear weapons possession has a significant and strong negative effect on the likelihood of biological weapons pursuit in the core and expanded model (see models 5 and 6 in **Table 4.3**). Yet again, a closer look at the data reveals survivorship bias. The majority of nuclear possessors already possessed biological weapons when they acquired nuclear weapons in H&N's dataset. Hence, these states are not actually at risk of initiating biological weapons pursuit again and are, therefore, not included in the analysis.[18] The authors also find that nuclear weapons pursuit and chemical weapons pursuit and possession increase the risk of biological weapons pursuit. However, when the analysis is conducted with the correct version of H&N's CBW data, nuclear weapons pursuit becomes insignificant, contradicting the authors' claims about the 'poor man's atomic bomb' thesis (see **Table 4.3**). Finally, data sparsity is an issue here too, as only five countries pursued NWs and BWs at the same time in the period 1945-2000 according to H&N's analysis.

16 H&N's Stata data file, however, inadvertently excludes France's and South Africa's chemical weapons possession.

17 The same holds for biological weapons: all biological weapons possessors already possessed chemical weapons at the time of acquiring biological weapons and most of them continued chemical weapons possession for a long time after biological weapons acquisition.

18 Five out of nine nuclear possessors (the United States, the United Kingdom, France, the Soviet Union, and South Africa) did so. H&N inadvertently excluded their coding of China's possession in their Stata data file. India and Pakistan are the only two nuclear states not judged by H&N to have ever possessed biological weapons.

H&N conclude that these statistical results are "remarkably consistent with the popular notion that CBWs are essentially a poor man's atomic bomb".[19] The opposite is actually true. That nuclear possessors are less likely to pursue CBWs is the result of nuclear states already having acquired them before acquiring NWs. Moreover, the authors seem to have inadvertently used an incomplete version of their CBW dataset for the statistical analysis. When these errors are corrected a number of their key findings already turn out insignificant. As we will see below, when my new CBW dataset is employed H&N's core findings are completely upended.

TESTING THE 'POOR MAN'S ATOMIC BOMB' THESIS WITH NEW DATA ON CHEMICAL AND BIOLOGICAL WEAPONS PROGRAMS

The results of the quantitative tests with the new CBW data are reported in **Table 4.5**.[20] I follow H&N's research design but swap in the new CBW data. Descriptive statistics for this data are reported in **Table 4.6** and illustrate that the means and standard deviations for CBW pursuit and possession differ substantially between the new CBW dataset and H&N's data (see **Table 4.2** and **Table 4.4**). Substituting the CBW data while keeping the rest of the research design constant allows me to directly compare results with H&N's findings. For this reason, I restrict the analysis to the period 1945-2000 even though the new CBW data covers the period 1946-2010.[21] Right censoring the data at the year 2000 only cuts off a few countries that continued pursuing or possessing CBWs. These countries were by and large nuclear weapons possessors. Their exclusion should bias the results against my expectation that states do not treat CBWs as replacements for nuclear weapons and in favor of H&N's finding that states do. Finally, as noted in the previous chapter, the CBW status of a handful of countries could not be determined due to information unavailability. For these cases, H&N's coding was used for the purposes of this analysis.[22] This again biases the results of the subsequent analysis in favor of H&N, which should strengthen my conclusions.

Starting with nuclear pursuit in **Table 4.5**, the core and expanded models (models 1 and 2) indicate that chemical weapons pursuit and chemical weapons possession are positively and significantly associated with nuclear weapons pursuit, although the magnitude of the effects decreases considerably compared to H&N's findings. Biological weapons pursuit is also positively associated with pursuit of NWs, but the effect decreases in magnitude and

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19 Horowitz and Narang 2014, 530.

20 H&N's full dataset (in Stata's .dta file format) was downloaded from: http://journals.sagepub.com/doi/suppl/10.1177/0022002713509049. All the independent variables were retained. The commands to perform the analysis in Stata (in .do file format) were obtained from the authors.

21 As the new dataset does not cover the year 1945, I swap in the H&N's data for that year.

22 One chemical weapons case (Myanmar) was excluded from the analysis because only a date for the end of possession could be determined. This exclusion has a negligible impact on the result, especially as Myanmar never pursued or possessed biological or nuclear weapons.

becomes insignificant. A notable change in findings is that biological weapons possession becomes highly significant, meaning that states possessing them present a higher risk of pursuing NWs. This is unsurprising, however, as there were only six biological weapons-armed states in the period 1945-2000 and four of them—China, USSR, Iraq, and Israel—possessed BWs at least some years whilst pursuing NWs.[23]

Turning to chemical weapons pursuit in models 3 and 4, we see that H&N's core findings completely disappear. While H&N report that nuclear pursuit substantively and significantly increases the risk of chemical weapons pursuit, these findings both decline in magnitude and become insignificant. Hazard ratios flip direction for nuclear possession, meaning that nuclear possessors are actually *more* likely to pursue chemical weapons, although these findings are insignificant. For biological weapons possession directions of effect also flip and even remain significant, indicating that biological weapons possession actually *increases* risk of chemical weapons pursuit. The effect of biological pursuit on chemical pursuit remains positive, but the magnitude of the effect increases considerably. This is unsurprising as chemical and biological weapons programs often go hand in hand, with the latter usually trailing the former.

Finally, we turn to biological weapons pursuit in models 5 and 6. In core model 5, the hazard ratio for nuclear weapons possession increases considerably in magnitude and loses all statistical significance. In the expanded model, it even flips direction and becomes insignificant. These findings indicate that there is no statistically significant relationship between nuclear weapons possession and biological weapons pursuit, which again contradicts H&N's published results. The hazard ratios for chemical weapons pursuit and possession increase considerably in magnitude in both the core and expanded model, indicating, yet again, that chemical weapons and biological weapons programs often go hand in hand.

A look at the control variables included in the expanded models (models 2, 4, and 6 in **Table 4.5**) yields interesting results. One would expect that lower economic development would increase risk of CBW pursuit if the poor man's atomic bomb thesis were true. However, both my analysis as well as H&N's study show that *GDPpc* and $GDPpc^2$ have no substantive effect on the pursuit of any of the three weapons types. The international security variables have a weaker effect on demand for unconventional weapons than often thought. H&N report that an increase in the number of land borders, a proxy for a state's security environment, has a positive and significant effect on the pursuit of nuclear weapons, while the effect on chemical weapons and biological weapons pursuit is insignificant. My analysis yields only slightly different results, with more land borders having a small positive and significant effect (at the 5% level) on both nuclear weapons pursuit and chemical

23 China was already pursuing nuclear weapons prior to acquiring biological weapons, while Iraq was already pursuing nuclear weapons before it even started *pursuing* biological weapons. The Soviet Union and Israel, on the other hand, already possessed biological weapons several years prior to initiating nuclear weapons pursuit.

Table 4.5: Hazard analysis of the interaction between pursuit of nuclear, chemical, and biological weapons with Poor Toulabi's new CBW data

	Dependent Variables					
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Independent Variables	**DV: Nuclear Pursuit**	**DV: Nuclear Pursuit**	**DV: Chemical Pursuit**	**DV: Chemical Pursuit**	**DV: Biological Pursuit**	**DV: Biological Pursuit**
CBN Weapons						
Nuclear weapon possession			2.433 (1.665)	1.360 (1.423)	0.836 (0.482)	1.986 (0.926)
Nuclear weapon pursuit			3.074 (2.327)	3.007 (2.185)	2.599** (0.981)	1.649 (0.647)
Chemical weapon possession	27.65*** (10.80)	14.22*** (4.521)			28.56*** (10.46)	1.649 (0.647)
Chemical weapon pursuit	6.031*** (2.541)	3.824** (2.380)			67.02*** (25.16)	232.5*** (115.7)
Biological weapon possession	3.578*** (1.377)	5.013** (3.878)	20.54*** (19.57)	9.181 (19.20)		
Biological weapon pursuit	1.636 (0.805)	1.928 (1.426)	87.46*** (44.71)	61.68*** (29.20)		
Control Variables						
GDP per capita		1.001** (0.000248)		1.000 (0.000217)		1.000** (0.000180)
GDP squared		1.000** (1.94e-08)		1.000 (1.35e-08)		1.000** (1.25e-08)
Alliance		1.479 (0.758)		1.215 (0.594)		0.411*** (0.113)
NPT membership		0.221*** (0.113)				
NPT system effect		1.018* (0.00965)				
CWC membership				0.0928*** (0.0710)		
CWC system effect				0.522 (0.259)		
BWC membership						0.209*** (0.0892)
BWC system effect						0.485 (0.228)
Number of land borders (security environment)		1.194** (0.0826)		1.109** (0.0552)		0.984 (0.0917)
Domestic unrest		1.026 (0.0200)		1.058 (0.0693)		0.831** (0.0683)
Number of countries	187	165	187	165	186	164
Observations	7,263	5,802	7,157	5,723	7,384	5,931

Note: BWC = Biological Weapons Convention; CBN = Chemical, Biological, and Nuclear; CWC = Chemical Weapons Convention; DV = dependent variable GDP = gross domestic product; NPT = Non-Proliferation Treaty. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 4.6: Descriptive statistics for Poor Toulabi's CBW data

Variables	Mean	Std. dev.	Min.	Max.
CBN Weapons				
Nuclear weapon possession	0.041	0.198	0	1
Nuclear weapon pursuit	0.026	0.158	0	1
Chemical weapon possession	0.046	0.211	0	1
Chemical weapon pursuit	0.018	0.133	0	1
Biological weapon possession	0.021	0.144	0	1
Biological weapon pursuit	0.018	0.135	0	1

Note: Descriptive statistics for the control variables are ommitted as they are the same as those in Table 2.

weapons pursuit, and a negative but insignificant effect on biological weapons pursuit. This finding could be the result of using an indirect proxy instead of more direct measures of conflict. Bell, however, found that most indicators of external threat perform poorly in quantitative studies of proliferation.[24] This may be because threats are filtered through elite perceptions prior to affecting weapons decisions.[25] Turning to alliance, H&N find that the effect of having a nuclear-armed ally is insignificant across all three technologies. I find similar results for nuclear weapons pursuit and chemical weapons pursuit; however, nuclear alliance has a substantial and highly significant dampening effect on the risk of biological weapons pursuit with my new CBW data. If the external security variables are less salient for CBW pursuit than expected, then internal security factors may play a role. H&N oddly report that an increase in domestic unrest has a positive and significant effect on nuclear weapons pursuit, while the effect on chemical weapons and biological weapons pursuit is insignificant. My analysis, however, shows that there actually is no statistically significant relationship between domestic unrest and pursuit of NWs. Domestic unrest is equally insignificant for chemical weapons pursuit, but actually decreases the likelihood of biological weapons pursuit. As with external security threats, the influence of domestic unrest on CBW decisions may be obscured in these models as threats must be filtered through elite perceptions. Finally, the reanalysis shows that being party to the CWC and BWC substantively and significantly reduces the risk of CBW pursuit, while H&N found these effects to be insignificant.

IMPLICATIONS FOR THE STUDY OF WEAPONS PROGRAMS

A new dataset of CBW programs in the post-World War II reveals that the pursuit and possession of CBWs has been less common than is often assumed and predicted.[26] Quantitative tests with this new CBW data present strong evidence that these weapons do

24 Bell 2016, 525.
25 Ibid.
26 See Chapter 3.

not function as 'poor man's atomic bombs'. If the thesis were true, the possession of nuclear weapons should lower the likelihood of CBW pursuit, whereas nuclear pursuit should increase it. Yet, neither pursuit nor possession of nuclear weapons have a statistically significant effect on pursuit of CBWs. This directly contradicts findings reported in a recent study of 'poor man's atomic bomb' thesis.[27]

Contrary to popular belief, 'poor' states have no special disposition towards CB weapons and many developing countries that were thought to have CBW programs never actually did. The CBW programs that did exist often were small and had limited objectives. Most of them were never capable of replicating the destructive effects of nuclear weapons, nor ever intended to. The drivers of CBW spread and reversal have been complex and have differed between states. Case studies have shown that states' CBW decisions have been influenced by, among others, both external and domestic security and political considerations, normative and legal pressures, changing institutional priorities, and technical (in)capability.

This chapter raises a few issues that are relevant for future research on the causes and consequences of the spread of unconventional weapons. First, the accuracy and reliability of data on unconventional weapons programs is an important, but underexposed, constraint on the robustness of proliferation scholarship. As previous research has shown, popular datasets of nuclear weapons programs contain substantial inaccuracies and biases.[28] When these problems are corrected, statistical analyses yield very different results.[29] The present study confirms these earlier findings. As Chapter 2 shows, the technological determinist and security structuralist assumptions underlying the 'poor man's atomic bomb' thesis have biased analysts in favor of concluding that states have CBW programs even when there was no credible evidence for such a conclusion. Chapter 3 presents the most detailed and accurate overview of states' pursuit and possession of CBWs to date, showing that that the pursuit and possession of CBWs has been less common than is often assumed and predicted. This chapter in turn finds that when the 'poor man's atomic bomb' thesis does not stand up to scrutiny when it is subjected to a rigorous quantitative test with the new CBW data.

Second, interpreting statistical results can be quite tricky. Merely reading hazard ratios, regression coefficients, and p-values from a table can lead to erroneous conclusions about causality. For example, H&N report that nuclear weapons possession lowers the risk of a state initiating either chemical weapons or biological weapons pursuit. This leads them to conclude that states treat CBWs as 'poor man's atomic bombs' since NWs satisfy demand for these weapons almost entirely.[30] However, most nuclear weapons-armed states already possessed CWs and BWs, many of them for a long time, prior to acquiring NWs. Moreover, many of these states retained CW and BW arsenals for a long time even after acquiring

27 Horowitz and Narang 2014.

28 Montgomery and Sagan 2009; Montgomery and Sagan 2011; Braut-Hegghammer 2019; Colgan 2019.

29 Montgomery and Sagan 2011; Colgan 2019.

30 Horowitz and Narang 2014, 527–528.

nuclear weapons. In other words, nuclear weapons acquisition did not lower the risk of these states pursuing CBWs since they were never *at risk* of doing so for much of the 1945-2000 period. This interpretation also fits well with case-specific knowledge, since many of these states maintained the three systems for different tactical and strategic purposes. As this example illustrates, intimate familiarity with the underlying data and theory—in addition to the aforementioned need for reliable data in the first place—can guide the researcher to different conclusions than what numbers may suggest at first glance.[31]

Third, more attention is needed to ensure that methodological choices make substantive sense. The relative rarity of 'proliferation events' presents some challenges for the use of quantitative methods in studying unconventional weapons spread. Depending on the weapon system, we essentially study anywhere from a handful to a couple dozen instances of states starting and terminating pursuit or possession. Given the steep data requirements of most quantitative methods, the number of observations can be maximized by employing the country-year as the unit of analysis. While this usually satisfies the technical requirements for the use of quantitative methods, some previous studies of nuclear weapons spread have reported that sparsity of data proved too restrictive for statistical analysis.[32] Even when data requirements are met, the underlying sparsity of the data may still have ramifications for our ability to draw conclusions from established correlations. H&N, for instance, report that nuclear weapons pursuit increases the risk of biological weapons pursuit. However, only five countries ever pursued NWs and BWs at the same time for a total of just 60 country-years in a dataset with over 7,000 observations. In my own reanalysis with the new CBW data I found that BW possession increased the likelihood of NW pursuit. Yet, this was based on just four subjects that simultaneously possessed BWs and pursued NWs in just 17 country-years in a dataset with over 7,000 observations.

Fourth, the use of quantitative methods may be appropriate for answering some questions but has limitations for others. The quantitative analysis in this chapter has raised an important challenge to the popularity of the 'poor man's atomic bomb' thesis, but other variables hypothesized to be determinants of proliferation behavior—like external security threats, alliance, and domestic unrest—do not provide robust explanations.[33] This issue has been described before in evaluations of the quantitative proliferation literature. Sagan, for instance, notes that there is a worrying lack of common findings among quantitative studies that have assessed states' motivations for nuclear weapons.[34] And, Bell's quantitative meta-analysis of the extant statistical literature shows that most variables considered to be determinants of weapons spread actually fail to offer strong

31 Similar issues occur in other quantitative studies of proliferation, see Montgomery and Sagan 2009, 315.

32 Bleek and Lorber 2014, 441; Montgomery and Sagan 2009.

33 Neither do they in H&N's study, see Horowitz and Narang 2014.

34 Sagan 2011, 233.

explanations.[35] There are several factors that likely contribute to these issues, such as the use of inaccurate proxies and the use of variables that are causally proximate to pursuit and acquisition.[36] More fundamentally, though, there are no silver bullet explanations of unconventional weapons spread and reversal.[37] Pressures and constraints combine in different ways in different constellations of cases to shape different weapons decisions. We know from the empirical record that states' CBW decisions have been influenced by, among others, both external and domestic security and political considerations, normative and legal pressures, changing institutional priorities, and technical (in)capability. Modelling such complex interactions is not a strong suit of quantitative methods. Regressional methods excel in determining the net effects—that is, the non-overlapping contribution—of each independent variable on the explained variation in the dependent variable. This is useful when they, for instance, tells us that CBWs are not 'poor man's atomic bombs', but less apt for understanding, more generally, the complex drivers of unconventional weapons spread. As I demonstrate in the next chapter, it is more suitable to make use of methods such as Qualitative Comparative Analysis (QCA), which can unravel complex dependencies in small, medium, and large-N data, to understand the drivers of CBW spread.[38]

35 Bell 2016.

36 Montgomery and Sagan 2009, 311–313; Sagan 2011, 229–230; Bell 2016, 525.

37 Sagan 1996, 85.

38 This point was made before by Montgomery and Sagan 2009, 313. For a useful text-book length primer on QCA, see Schneider and Wagemann 2012.

5

The Drivers of Chemical and Biological Weapons Spread and Reversal: Unravelling Complexity with a Configurational Approach

SUMMARY

Surprisingly, no empirical studies exist that systematically address the drivers of CBW spread and restraint among the universe of cases. The previous chapter began to address this gap through a series of quantitative tests that showed that there is no evidence to support the popular 'poor man's atomic bomb' thesis of CBW spread. This chapter continues this investigation by applying Qualitative Comparative Analysis (QCA), a configurational comparative method of data analysis that is well-suited to deal with causal complexity, to the new CBW data introduced in Chapter 3 in order to investigate the conditions under which states embark on and terminate CBW programs.

INTRODUCTION

Why do states commence and abandon chemical and biological weapons (CBW) programs? While the study of the causes and consequences of nuclear spread has received much scholarly attention, similar work on CBWs is limited. The extant literature on causes of CBW spread and reversal is still dominated by national security-related explanations associated with the structural realist school of International Relations. An especially popular and enduring sub-strand of this realist security model imagines CBWs as a 'poor man's atomic bombs', because they supposedly are a cheap and easy to acquire alternative to possessing nuclear weapons. Other strands of literature focus, among others, on how CBWs may be useful as a means for governments to repress challenges to their rule and on the role of international treaties and norms in stigmatizing development and possession of CBWs.

Although extant theories of CBW spread and reversal highlight important pieces of the puzzle, none provides a sufficient explanation on its own. Scholars have noted that the spread and rollback of weapons of mass destruction (WMD) have occurred for various reasons, suggesting that multi-causality lies at the heart of the puzzle.[1] Attempts to resolve this issue have produced numerous quantitative studies focused on the causes of nuclear weapons spread and reversal.[2] However, these studies have by and large failed to provide strong explanations for proliferation and have barely improved our ability to predict it.[3]

This chapter fills a gap in the academic literature by presenting a cross-case inquiry into the causes of CBW spread and reversal. Making use of a new CBW program dataset introduced in Chapter 3, this chapter applies Qualitative Comparative Analysis (QCA) to investigate why states embark on or terminate the pursuit and possession of chemical and biological weapons. QCA is a comparative method based on Boolean logic that considers how the presence and absence of conditions, either individually or in particular combinations, are sufficient or necessary for an outcome to occur.[4] QCA has already found a plethora of applications by scholars of international relations, foreign policy analysis, and conflict studies, but has yet to be applied to the study of unconventional weapons.[5]

This chapter makes several theoretical, empirical, and methodological contributions. First, it demonstrates that conditions rarely work in isolation to produce CBW decisions and that each outcome can be reached by different pathways that correspond to different

1 For instance, Sagan 1996, 85; Bell 2016, 521.

2 See, among others, Singh and Way 2004; Jo and Gartzke 2007; Kroenig 2009; Fuhrmann 2009; Montgomery 2013; Way and Weeks 2014.

3 Bell 2016, 521.

4 The seminal texts on QCA are Ragin 1987; Ragin 2000. For a recent primer on the method see Schneider and Wagemann 2012.

5 See, among others, Kiser, Drass, and Brustein 1995; Harvey 1999; Chan 2003; van der Maat 2011; Pinfari 2011; Thiem 2011; Mello 2014; Grynaviski and Hsieh 2015; Haesebrouck and Thiem 2018; Bobić 2019; Mello 2019.

(groups of) cases. Substantively, the findings do a good job of approximating empirical insights from extant case study work. The analyses, for instance, show that when external security considerations play a role in initiation of CBW pursuit and possession, it rarely concerns nuclear-armed adversaries. Rather, states that initiate CBW pursuit or possession for national security reasons often do so when they face CBW-armed or conventionally stronger rivals. Moreover, the pursuit of nuclear weapons barely ever determines whether states embark on CBW pursuit or possession. Taken together, these findings cast doubt on the veracity of the popular 'poor man's atomic bomb' thesis. States also initiate CBW pursuit and possession when they experience high domestic unrest coupled with a lack of external threats. Conversely, the resolution of domestic conflict or the occurrence of regime transition creates the circumstances for states to end the pursuit and possession of CBWs. Notably, the beginning of CW pursuit and possession almost always takes place in the context of the absence of a legal prohibition on CW programs, whereas membership of the Chemical Weapons Convention (CWC) is sufficient by itself to produce the end of CW possession. Methodologically, this study demonstrates that configurational methods like QCA are well-suited for unravelling the complex causes of the spread and rollback of unconventional weapons programs, while generating richer and more detailed explanations.

This chapter proceeds as follows. First, I discuss the extant theoretical literature on the causes of CBW spread and reversal. The second section introduces the notion of complex causes and QCA as a novel approach to study CBW programs. Third, I elaborate on the selection of conditions for the QCA analysis, while the research design is explained in the fourth section. Fifth, I describe the results and in the sixth section I discuss their implications for method, theory, and empirics. Finally, the conclusion synthesizes the study's central insights.

STATE OF THE ART

The published literature theorizing the causes of CBW spread and reversal is limited, particularly in comparison to the amount of work that has been dedicated to understanding the causes of nuclear weapons spread. The most popular and enduring view of why CBWs spread among states is that they are merely a cheap and easy to acquire alternative for states that cannot obtain nuclear weapons: a 'poor man's atomic bomb'.[6] This is an overly simplistic and flawed perspective. The 'poor man's atomic bomb' (PMAB) thesis ignores the pre-history of CBWs, as many states had CBW programs before nuclear weapons were invented.[7] It also presumes that 'poor' and non-Western states are especially inclined towards CBWs. Yet, many non-Western and less wealthy states that were alleged of having

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6 Central Intelligence Agency 1988; Carus 1991; Harris 1992; Venter 1999; Horowitz and Narang 2014. See also Chapter 3.

7 Zanders 2000. Also, Chapter 2.

them never actually did, while numerous industrialized and Western states have had them.[8] Similarly, there is no clear distinction between democracies' and non-democracies' demand for CBWs, although the way they run their programs may be different.[9] PMAB thesis also ignores the differing functions of chemical, biological, and nuclear weapons.[10] Only the U.S. and Soviet biological weapons programs had the objective of creating casualties in an order of magnitude similar to nuclear weapons combined with the size and sophistication to create biological weapons capable of doing so.[11] The majority of CBW programs have actually been small in scale and have had limited aims.[12] Finally, the notion advanced by the PMAB thesis that CBWs are easy and cheap to produce is wrong. While it may be possible for a fairly large group of states to produce rudimentary CB weapons on a small scale for foul play purposes, developing mass-casualty biological weapons presents tremendous scientific, financial, and organizational barriers not unlike those associated with nuclear weapons.[13]

Much of the remaining literature on causes of CBW spread focuses on the external security benefits that these weapons are thought to provide to states. This point of view, associated with the (structural) realist school of International Relations (IR), rests on the assumption that an anarchic international system, characterized by a logic of self-help, leads rational states to seek to maximize their security in a competitive environment with limited resources.[14] From this perspective, the main reason for seeking CBWs is their ability to deter an attack by a more powerful neighbor or rival in the same way that nuclear weapons are thought to do.[15] However, CBWs are unsuitable or unreliable strategic deterrents for several reasons. Neither chemical nor biological weapons can destroy physical edifices, unlike nuclear weapons or conventional explosives. Chemical weapons also have to be delivered in large quantities to approach the fatal effects of a nuclear weapon, while they are less fatal against well-protected troops and populations than even conventional explosives.[16] Biological weapons, on the other hand, can potentially cause widespread fatalities if delivered under the right conditions against unprotected populations.[17] Yet, their delayed and unpredictable effects combined with the secrecy required for a successful large-scale attack make them an unreliable deterrent.[18]

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8 Chapters 2 and 3.
9 Zanders 2000, 170f.
10 The functional differences between nuclear, chemical, and biological weapons are discussed further below.
11 See Chapter 3.
12 See Chapter 3.
13 Ben Ouagrham-Gormley 2014.
14 Waltz 1979.
15 Tucker 2000; Martin 2002; Zanders 2000, 175.
16 Office of Technology Assessment 1993b, 52–54.
17 Martin 2002; Office of Technology Assessment 1993b, 52–55.
18 Koblentz 2003.

The international security-related incentives for acquiring CWs or BWs are more nuanced than merely desiring a replacement for nuclear weapons. Some states may seek CBWs as an in-kind retaliatory capacity to restrain adversaries from using their chemical or biological weapons.[19] Indeed, the threat of in-kind retaliation is an important reason that the principal belligerents during World War II did not resort to the use of chemical weapons.[20] CBWs can also serve tactical purposes as battle-field weapons or as force-multipliers against a conventionally stronger rival. When Iraq was thrown on the defensive after its invasion of Iran, it employed massive amounts of chemical weapons to turn back Iran's human wave tactics.[21] Similarly, biological agents could be used to kill, injure, or incapacitate enemy forces whilst posing little risk to one's own forces if properly inoculated.[22]

Conversely, the realist security model explains the absence of CBW spread or the reversal of CBW ambitions by pointing towards an absence of threat, the presence of alternative means to provide for one's security, or the security disadvantages of CBWs. As for the first, a state's threat environment can change over time or its leaders' perceptions of that environment may experience change, leading to a reversal of demand for CBWs. Second, a security guarantee from a stronger—particularly, an unconventionally armed—ally may satisfy a state's security needs without it having to resort to unconventional weapons, [23] even though this violates the realist assertion that an anarchic system is necessarily a self-help system. Third, states may calculate that the pursuit of unconventional weapons could exacerbate the security dilemma leading to countermeasures by neighboring or rival states. Thus, the pursuit of CBWs by one state could lead other states to seek similar capabilities—i.e., precipitate an arms race—or even to resort to preventive military attacks to avoid having to face a CBW armed-rival.[24]

A second, albeit smaller, strand of literature emphasizes how states may resort to CBWs to address domestic security challenges. Governments may view these weapons as a useful means of repressing challenges to their rule. The concept of regime security explains how threats of insurgencies, domestic rivals, popular uprisings, and military coups may drive both the pursuit and acquisition as well as the use of CBWs by regimes, particularly authoritarian ones.[25] CBWs may be viewed by some as cost-effective in domestic settings as they pose little risk of retaliation in-kind by non-state actors, reduce the need for manpower (particularly against fighters in remote and inaccessible locations as well as fighters ensconced in heavily populated urban locations), can inflict heavy casualties on unprotected fighters and civilians, terrorize besieged civilian populations, and can be used

19 Tucker 2000, 29; Spiers 1994, 42–43.

20 Spiers 1994, 43.

21 Ibid., 42.

22 Ibid., 160; Tucker 2000, 31–32; Koblentz 2003, 99–100.

23 Tucker 2000, 33; Zanders 2000, 175.

24 Booth and Wheeler 2008; Tucker 2001a, 34; Koblentz 2003, 117f. For a similar argument regarding nuclear weapons, see Paul 2000.

25 Koblentz 2013.

covertly to reduce the risk of international condemnation.[26] Rhodesia's and South Africa's white minority governments, for example, set up CBW programs to develop specialty weapons for assassinations, sabotage, and counterinsurgency operations against African nationalist fighters.[27] In turn, the cessation of hostilities can lead to the reversal of a state's CBW program. Moreover, a regime transition may spur changes in CBW programs as an outgoing regime may wish to prevent its successors from possessing CBWs, whereas an incoming government may wish to distance itself from its predecessor's controversial weapons programs. Both factors came together in the case of Rhodesia and South Africa, where the outgoing white minority governments wound down CBW programs as the two countries were transitioning towards majority rule, among others, because the negotiated end of the respective conflicts took away the primary motivator of said programs but also to prevent the successive governments from getting their hands on these weapons.[28]

A third strand of the literature focuses on the way that behavioral and legal norms shape states' demand for CBWs. Chemical and biological weapons have long been considered abhorrent and their use in war has been regulated since the 1925 Geneva Protocol.[29] This norm against the use of CBWs has been reinforced over time and even extended to prohibit development and possession by the 1972 Biological Weapons Convention (BWC) and 1993 Chemical Weapons Convention (CWC). Indeed, a considerable number of countries have ended their CBW programs either in anticipation of or after the adoption of the BWC or CWC. Unlike nuclear weapons, which have served as public symbols of legitimacy, modernity, and prestige,[30] the stigma surrounding CBWs has also meant that they have not provided their possessors with prestige.[31] One clear reflections of this is that states have typically treated their CBW programs with the utmost secrecy, whereas states that have acquired nuclear weapons have usually declared this publicly.[32] In the 1960s, for instance, the Canadian government was concerned about the public relations fallout if it were to become known that it was involved in offensive CW and BW research.[33] South Korea even has a confidentiality agreement with the Organisation for the Prohibition of Chemical Weapons (OPCW) that forbids the watchdog from acknowledging South Korea's declaration about a past CW program, requiring instead to be referred to as "an unnamed state party" in all OPCW communications.[34]

26 Spiers 1994, 43–44; Tucker 2000, 33.
27 Gould and Folb 2000; Cross 2017.
28 Purkitt and Burgess 2005, 176; Cross 2017.
29 Tucker 2000, 35; Cole 1998; Price 1995.
30 Sagan 1996, 73–85.
31 Harris 1990, 71–72; Tucker 2000, 28; Roberts 1996, 121.
32 Koblentz 2013, 504; Zanders 2000, 171; Sloss 1997, 99.
33 Avery 2013, 98, 102.
34 International Crisis Group 2009, 4; Nuclear Threat Initiative 2017.

ADDRESSING CAUSAL COMPLEXITY WITH QUALITATIVE COMPARATIVE ANALYSIS

The majority of the extant literature on chemical, biological, and nuclear weapons spread and reversal is of a theoretical/conceptual nature or has focused on individual detailed case studies or small-N between-case variation. While extant theories of the spread and non-spread of unconventional weapons emphasize important aspects of the puzzle, none provides a satisfactory explanation for such an inherently complex process on its own. Indeed, several authors have noted that cases of spread and reversal have occurred for varying reasons, suggesting that multi-causality lies at the heart of the puzzle.[35] The scholarship's attempts to deal with this issue have resulted in a veritable proliferation of quantitative studies since the early 2000s, a phenomenon described by Montgomery and Sagan as a "second wave" of proliferation studies.[36] Instrumental as these studies have been in renewing the scholarly interest in the spread of unconventional weapons, they fail to provide strong explanations for proliferation and barely improve our ability to predict it.[37] Moreover, these studies have almost exclusively examined the factors that increase or decrease the risk of proliferation while neglecting to study the drivers of program reversal. Despite the resurgence of interest in the causes and consequences of nuclear spread, little attention has been given to the study of chemical and biological weapons. Compared to the ubiquity of quantitative nuclear weapons scholarship, only one published article has attempted to systematically study different theoretical accounts of CBW spread among the universe of cases.[38]

In this chapter, I address the lack of systematic inquiries into the causes of CBW spread and reversal among states, making use of a new dataset of CBW programs in the post-WWII era. I do so by applying a mix of multi-value QCA (mvQCA) and crisp-set QCA to investigate which pathways lead states to embark on or give up the pursuit and possession of CBWs.[39] Succinctly, QCA is a configurational comparative data analysis method grounded in set theory that has already found a plethora of applications by scholars of international relations, foreign policy analysis, and conflict studies.[40] As social theory is largely verbal in

35 For instance, Sagan 1996, 85; Singh and Way 2004, 861; Jo and Gartzke 2007, 167; Bell 2016, 521.

36 The second wave distinguishes studies published since the mid-2000s, such as Singh and Way 2004; Jo and Gartzke 2007; Gartzke and Kroenig 2009; Kroenig 2009; Fuhrmann 2009; Bleek and Lorber 2014, from two early quantitative works by Kegley 1980 and Meyer 1984.

37 Bell 2016.

38 Horowitz and Narang 2014. But see Chapter 2 and Chapter 4 for critiques of the validity and reliability of the study's findings.

39 A useful introduction into the essentials of QCA and its three most popular variants—crisp-set QCA (csQCA), fuzzy-set QCA (fsQCA), and multi-value QCA (mvQCA)—can be found in Schneider and Wagemann 2012. For more on mvQCA see Thiem 2013; Thiem 2014a; Thiem 2015; Haesebrouck 2015.

40 See, among others, Kiser, Drass, and Brustein 1995; Harvey 1999; Chan 2003; van der Maat 2011; Pinfari 2011; Thiem 2011; Mello 2014; Grynaviski and Hsieh 2015; Haesebrouck and Thiem 2018; Bobić 2019; Mello 2019.

nature, it often makes set-related claims. Consider, for instance, the well-known democratic peace thesis. In its most basic form it claims that democracies do not go to war with one another. Formulated in set-theoretic terms, we can say that democratic dyads are a (near-) perfect subset of the set of non-warring dyads. Naturally, many other paths can be taken towards peaceful relations between states, and the correlation between democracy and non-warring may therefore be low. We can, however, still state that relations between democracies may be *sufficient* for the absence of war.[41] Essentially, QCA considers how the presence and absence of conditions, either individually or in particular combinations, are sufficient or necessary for an outcome to occur.

QCA is particularly suited for unravelling complex social phenomena, such as the spread of CBWs, due to three underlying methodological assumptions: *conjunctural causation*, *equifinality*, and *causal asymmetry*.[42] These three concepts mean that QCA accounts for the possibility that combinations of conditions can jointly cause an outcome to occur (*conjunctural causation*);[43] different pathways to an outcome exist (*equifinality*),[44] and that any insights about the causal role of a condition or an explanation for the presence of an outcome say nothing about their absence (*causal asymmetry*).[45] This understanding of causality (and complexity) runs counter to the core tenets of conventional regressional approaches, since they assume additivity (that each explanatory variable has an independent effect on the variation in the dependent variable), unifinality (that only one formula explains the outcome), and causal symmetry (that symmetric relations exist between correlated variables). As a result, regressional approaches have difficulty dealing with causal complexity in the way that Boolean methods like QCA do.[46] Yet, paradoxically,

41 Ragin 2008, 16.

42 Schneider and Wagemann 2012, 78–79.

43 Conjunctural causation is, for instance, expressed in the following model: **A*B → Y** (with * indicating the Boolean operator AND).

44 Equifinality is, for instance, expressed in the following model: **A + B + C → Y** (with + indicating the Boolean operator OR).

45 For instance, the identification of a given model **A*B → Y** (with uppercase letters indicating presence of a condition and lowercase letters indicating its absence) does not mean that **a*b → y** is automatically true. Moreover, a condition may be linked to an outcome when it is present and when it is absent, as in the following model: **A*B + a*C → Y**. For more on causal asymmetry in QCA see Schneider and Wagemann 2012, 81–83.

46 There are a few avenues to incorporate a semblance of causal complexity in regression methods. Interaction effects can, for instance, be used to account for the combined effect of variables. Nevertheless, very few have tried so while investigating the causes of weapons spread. The lack of application in the field of proliferation studies may be explained by the steep data requirements for higher-order interaction effects—a significant constraint in the study of weapons spread—and the difficulty of interpreting interactions consisting of more than two variables. Montgomery 2013, for instance, reports difficulties in statistically determining interaction effects due to a limited number of observations. It should, moreover, be noted that Boolean conjunctions and linear-algebraic interactions do not constitute the same concept of causal complexity; see Thiem, Baumgartner, and Bol 2016. Accounting for equifinality, the notion that “many roads lead to Rome” (represented by the logical operator OR) is even more problematic for quantitative methods due to the assumption of linear additivity; see Braumoeller 2003, 211; Ragin 2008, 113.

two pioneering studies of the second wave of quantitative nuclear proliferation literature cite causal complexity as a reason to use statistics even though the quantitative methods they employ are actually not equipped to deal with it.[47]

To progress towards a comprehensive understanding of the way that CBWs spread, it is not just useful to examine the net effects of independent variables but also to systematically investigate the different ways that combinations of causal conditions combine to produce instances of spread and reversal across cases. As Montgomery and Sagan noted in their review of extant quantitative nuclear scholarship, QCA's exploration of "complex interactions between different variables in data sets with a low number of observations might be more appropriate than traditional statistical analysis" for the study of weapons spread.[48] Besides the obvious scholarly benefits such research also has societal relevance. Simply put, for policy-making it is more pertinent to understand which conditions are meaningful in which contexts rather than knowing which single independent variable best succeeds in explaining variation in the outcome.[49]

SELECTION OF CONDITIONS

In this study I apply multi-value QCA (mvQCA) to determine which pathways lead states to embark on or abandon the pursuit and possession of chemical and biological weapons.[50] MvQCA has a distinct advantage over other QCA variants as it can capture the causal role of intermediate categories.[51] The data on CBW programs is taken from the dataset introduced in Chapter 3, which includes all instances of a state beginning or ending the pursuit or possession of chemical or biological weapons in the period 1946-2010.[52] From this data I generate four crisp-set (bivalent) outcome conditions: the pursuit of chemical weapons (*PURS_CW*), the possession of chemical weapons (*POSS_CW*), the pursuit of biological weapons (*PURS_BW*), and the possession of biological weapons (*POSS_BW*). Each outcome condition can take two values: either start or end of pursuit/possession. Each case represents an instance of a country starting or ending pursuit/possession (see **Table 5.1**).

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47 Singh and Way write that "there are multiple determinants and combinations of factors responsible for decisions to pursue nuclear arms"; see Singh and Way 2004, 861. Jo and Gartzke similarly refer to the "complex contingent nature of the topic"; see Jo and Gartzke 2007, 167.

48 Montgomery and Sagan 2009, 313.

49 Ragin 2008, 182.

50 A useful introduction into the essentials of QCA and its three most popular variants—crisp-set QCA (csQCA), fuzzy-set QCA (fsQCA), and multi-value QCA (mvQCA)—can be found in Schneider and Wagemann 2012. For more on mvQCA see Thiem 2013; Thiem 2014a; Thiem 2015; Haesebrouck 2015.

51 Haesebrouck 2015.

52 As noted in Chapter 3, it was not possible to determine for a handful of cases during which years the start or end of pursuit or possession took place. Therefore, those instances of start/end of pursuit/possession are not included in the analysis below.

I also create ten causal (explanatory) conditions based on the three strands of literature on the drivers of spread and reversal discussed earlier: international security, domestic security and politics, and international law and norms.[53]

Table 5.1: Cases of start and end of CW and BW pursuit and possession

	Start Pursuit		End Pursuit		Start Possession		End Possession	
	Country	**Year**	**Country**	**Year**	**Country**	**Year**	**Country**	**Year**
Chemical	Canada	1946	Australia	1946	Egypt 1	1963	China	1997
	Chile	1975	Canada	1969	Iran	1987	Egypt 1	1974
	Egypt 1	1958	Chile	1976	Iraq	1983	France	1988
	Egypt 2	1974	France	1993	Israel	1956	India	1997
	France	1988			Libya	1989	Iran	1991
	Iran	1985			North Korea	1989	Libya	2004
	Iraq	1971			Rhodesia	1977	Myanmar	1990
	Israel	1955			South Africa 2	1987	Rhodesia	1979
	Libya	1984			Syria	1985	South Africa 1	1946
	North Korea	1961			Yugoslavia	1987	South Africa 2	1993
	Rhodesia	1976					South Korea	1997
	South Africa 2	1981					United Kingdom	1957
	Syria	1979					United States	1997
	Yugoslavia	1976					Yugoslavia	1991
Biological	Egypt	1958	Canada	1969	Iraq 2	1990	South Africa	1993
	France	1948	France	1967	Israel	1948	United States	1972
	Iraq 1	1974	Iraq 1	1978	South Africa	1987		
	Iraq 2	1985	Rhodesia	1979				
	North Korea	1964	United Kingdom	1957				
	Rhodesia	1976						
	South Africa	1981						

Nuclear-Armed Rival (RIVAL_NW)

States may seek CBWs as a means of improving their security environment. In this way, CBW may particularly be envisioned as a deterrent against military threats from nuclear-armed, CBW-armed, and conventionally stronger adversaries. A state's security environment—and especially leaders' perception thereof—can be measured in more than one way. Nevertheless, militarized disputes and wars predominantly occur in the context of enduring rivalries rather than isolated interactions.[54] Thus, the crisp condition *RIVAL_NW* indicates whether a country faced one or more enduring rivals that possessed nuclear weapons during the year that it started or ended pursuit/possession of CBWs. A value of 0 indicates that a country had no nuclear-armed rivals, whereas a value of 1 means that it did.

53 Detailed descriptions of the operationalization and calibration of conditions are provided in the appendix.

54 Bennett 1998.

Chemical-Armed Rival (RIVAL_CW)

The crisp condition *RIVAL_CW* indicates whether a country faced one or more enduring rivals that possessed chemical weapons during the year that it started or ended pursuit/possession of CBWs. A value of 0 indicates that a country had no chemical-armed rivals, whereas a value of 1 means that it had.

Biological-Armed Rival (RIVAL_BW)

The crisp condition *RIVAL_BW* indicates whether a country faced one or more enduring rivals that possessed biological weapons during the year that it started or ended pursuit/possession of CBWs. A value of 0 indicates that a country had no biological-armed rivals, whereas a value of 1 means that it had.

Conventionally Stronger Rival (RIVAL_STR)

The crisp condition *RIVAL_STR* indicates whether a country's enduring rivals were conventionally stronger during the year it started or ended pursuit/possession of CBWs. A country's conventional strength is operationalized as the aggregate of its material capabilities. A value of 0 indicates that the combined material capabilities of a country's enduring rivals did not outweigh the capabilities of the country itself, while a value of 1 indicates that the enduring rivals had combined capabilities that outweighed those of the country itself.

Nuclear Weapons Defense (NW_DEF)

States may feel that they have no need for CBWs if they benefit from a nuclear deterrent. A nuclear deterrent may come in the form of a state's own nuclear weapons arsenal or when it has a defensive pact with a nuclear-armed state. The multivalent condition *NW_DEF* can take three values: no nuclear weapons defense (0), having a nuclear ally but not possessing nuclear weapons (1), and possessing nuclear weapons (2).

Nuclear Weapons Pursuit (NW_PURS)

The pursuit of CBWs may be due to an underlying demand for unconventional weapons that may be satisfied by either chemical, biological, or nuclear weapons. Alternatively, states may pursue CBWs as a replacement when they cannot acquire nuclear weapons. To better understand the relationship between states' desire for CBWs and nuclear weapons, the condition *NW_PURS* indicates whether a state was pursuing nuclear weapons during the year it started or ended pursuit/possession of CBWs. This crisp condition can take two values: not pursuing nuclear weapons (0) and pursuing nuclear weapons (1).

Chemical Weapons Convention (CWC)

This condition is based on the expectation that states that have joined the 1993 Chemical Weapons Convention (CWC) will refrain from pursuing and acquiring chemical weapons or will end their ongoing CW programs. Secondly, the conclusion of the CWC may also indicate the arrival of a global norm against the development and acquisition of chemical weapons that may impact even the behavior of states that are not party to the Convention. The multivalent condition *CWC* can take four values: pre-conclusion of the CWC in 1993 (0), not having signed or ratified the CWC (1), having signed the CWC (2), having ratified the CWC (3).

Biological Weapons Convention (BWC)

This condition is based on the expectation that states that have joined the 1972 Biological Weapons Convention (BWC) will refrain from pursuing and acquiring biological weapons or will end their ongoing BW programs. Secondly, the conclusion of the BWC may also indicate the arrival of a global norm against the development and acquisition of biological weapons that may impact even the behavior of states that are not party to the Convention. The multivalent condition *BWC* can take four values: pre-conclusion of the BWC in 1972 (0), not having signed or ratified the BWC (1), having signed the BWC (2), having ratified the BWC (3).

Domestic Unrest (UNR)

Governments may resort to CBWs to repress domestic challenges to their rule. The crisp condition *UNR* indicates whether a country was facing high domestic unrest in the three years preceding the year it started or ended pursuit/possession of CBWs. This condition can take two values: low domestic unrest (0 and high domestic unrest (1).

Regime Transition (REGTRANS)

When a forced or peaceful regime transition takes place, the outgoing regime may opt to end ongoing CBW programs to prevent them from falling in the hands of their successors, whereas an incoming regime might do so because it, for instance, sees no security imperative to retain them or because it is opposed to CBWs out of normative considerations. Conversely, a new regime, particularly in newly established or independent states, may embark on a CBW program as a means of securing itself against either domestic or external adversaries. The crisp condition *REG* indicates whether a country was experiencing a regime transition during the year it started or ended the pursuit or possession of CBWs. The condition can take two values: no regime transition (0) and regime transition (1).

RESEARCH DESIGN

I use the *QCApro* package for the *R* environment to perform a generalization of multi-value QCA (mvQCA).[55] Separate analyses are conducted for the two values (*start* and *end*) on each of the four outcome conditions. Different causal conditions are theoretically relevant for different values of an outcome. Therefore, at most eight conditions are shortlisted for each analysis (see **Table 5.2**).[56] However, this number of conditions introduces a problem that is common to comparative methods: "many variables, small number of cases".[57] As the number of possible combinations of conditions grows, the empirically observed cases only occupy a fraction of the potential 'logical space', leading to very few or even no cases for each path—this is called the limited diversity problem. Carrying on may yield individual explanations for cases and needlessly complex results.[58] While QCA's ability to investigate complex causation is an advantage for studying CBW spread and reversal, the generation of overly complex results makes meaningful theoretical interpretation challenging. Moreover, if the proportion of conditions to cases is too high there is a risk that QCA might generate invalid explanatory models.[59] Besides choosing an appropriate number of conditions, problems of internal validity can be identified and mitigated to some extent when using case knowledge to interpret QCA results.[60]

The number of conditions listed for each analysis in **Table 5.2** present an unreasonably large property space in relation to the modest number of cases under consideration and the limited diversity between those cases. Therefore, I limit the size of the analyzed frame to five conditions for the analyses of CW pursuit and possession, four conditions for the analysis of BW pursuit, and three conditions for the analysis of BW possession. The number of cases for BW possession (two cases of start of possession and three cases of termination of possession) is still quite low relative to the inclusion of three causal conditions. This presents some risk that the analysis might generate invalid explanatory models.[61] As I show below, the results mesh well with existing case knowledge, which should mitigate this concern. Nevertheless, the findings for start and end of BW possession should be approached with some caution.

To select the conditions, I apply a procedure introduced by Haesebrouck and Thiem.[62] First, all possible combination frames are drawn from the full array of available

55 Thiem 2018.

56 Regime transition (REG) is excluded from the analyses of start and end of CW pursuit because none of the cases experienced regime transition. Nuclear weapons pursuit (NW_PURS) is excluded from the analysis of end of BW possession because all the cases already possessed nuclear weapons.

57 Lijphart 1971, 685.

58 Berg-Schlosser and De Meur 2009, 27.

59 Marx and Dușa 2011; Marx 2010.

60 Thomann and Maggetti 2020, 370.

61 Marx and Dușa 2011; Marx 2010.

62 Haesebrouck and Thiem 2018.

Table 5.2: Shortlist of conditions

	CW Pursuit	CW Possession	BW Pursuit	BW Possession
Start	riv_nw riv_cw riv_str nw_purs nw_def cwc unrest	riv_nw riv_cw riv_str nw_purs nw_def cwc unrest regtrans	riv_nw riv_bw riv_str nw_purs nw_def bwc unrest regtrans	riv_nw riv_bw riv_str nw_purs nw_def bwc unrest regtrans
End	riv_nw riv_cw riv_str nw_purs nw_def cwc unrest	riv_nw riv_cw riv_str nw_purs nw_def cwc unrest regtrans	riv_nw riv_bw riv_str nw_purs nw_def bwc unrest regtrans	riv_nw riv_bw riv_str nw_def bwc unrest regtrans

conditions. For instance, for start of CW possession all possible combinations of five conditions are drawn from the set of eight conditions listed in **Table 5.2**. This yields a total of $\binom{8}{5} = 56$ possible combination frames. After Boolean minimization of these 56 frames with the *QCApro* package, the best-fitting models are selected as long as they meet reasonable inclusion and coverage scores, show low model ambiguities, and hold up to further within-case analysis.[63] Consistency and coverage are the two parameters of fit that QCA researchers use to describe the strength of empirical support for argued set-theoretic connections. Set-theoretic *consistency* indicates to which degree the empirical evidence is consistent with the sub-set relation in question. Set-theoretic *coverage* indicates the proportion of cases that display a certain condition or combination of conditions.[64] Model ambiguity refers to the phenomenon where multiple causal models manage equally well in accounting for configurational data.[65] I only use parsimonious solutions, since the conservative and intermediate solution types do not reflect underlying causal structures.[66] Moreover, no separate analyses of necessary conditions are conducted, as these conditions cannot be interpreted causally.[67]

63 Ibid., 757.
64 See Schneider and Wagemann 2012, 123–139.
65 Baumgartner and Thiem 2017.
66 Baumgartner and Thiem 2020; Thiem 2019; Baumgartner 2015.
67 Thiem 2016.

RESULTS AND INITIAL INTERPRETATION

As Schneider and Wagemann note, solution formulas and parameters of fit should not be considered the ultimate purpose of QCA.[68] Rather, findings need to be related back to the individual cases and theoretical expectations. **Table 5.3** and **Table 5.4** display the QCA results for, respectively, CW and BW pursuit and possession. Each sufficient combination of conditions is accompanied by its raw and unique coverage values, as well as the cases covered.[69] A black circle ("●") indicates the presence of a crisp condition (value of 1) and a circle with a cross-out ("⊗") indicate its absence (value of 0). Furthermore, the value of a multivalent condition is represented by a number between curly brackets ("{...}").

The analysis of chemical weapons in **Table 5.3** reveals multiple paths to start and end of both CW pursuit and CW possession. Three distinct paths are associated with the start of CW pursuit that cover twelve out of fourteen cases under consideration. The first path indicates that facing a CW-armed enduring rival is sufficient for the start of CW pursuit, which corresponds with the theoretical expectation that CWs are primarily useful as an in-kind deterrent. This path covers more than half of CW pursuit cases (eight out of fourteen). The second path covers four cases (of which three uniquely) that experienced high domestic unrest during a time that the CWC did not exist yet. This is consistent with the historical record as the South African, Rhodesian, and Chilean regimes pursued chemical weapons as a means of dealing with domestic opponents.[70] The third path indicates that the pursuit of nuclear weapons is associated with CW pursuit. This path covers two cases (Israel and Libya). While the Libyan case is also covered by the first path, Israel indeed established a crash CW program to acquire "a cheap non-conventional capability" in case of war against its neighbors while it was awaiting the development of nuclear weapons.[71]

The analysis of the end of CW pursuit reveals two paths (covering three out of four cases) that accord well with the existing case literature as well as theoretical expectations. The first path, covering France, indicates that having signed the CWC is sufficient for the end of CW pursuit. After France ended its possession of CWs in 1988 in anticipation of the conclusion of a CW convention, it opted to continue research to maintain the capability to acquire them again. This final episode of pursuit was ended when France signed the CWC in 1993.[72] The second path combines the absence of a CW-rival and low domestic unrest with having a nuclear-armed ally. This accords with theoretical expectations, as either a lack

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68 Schneider and Wagemann 2012, 280–81.

69 Raw coverage indicates the proportion of cases covered by the outcome that is covered by a single path, whereas unique coverage expresses which proportion of cases a path *uniquely* covers.

70 For South Africa and Rhodesia, see Gould and Folb 2000; Cross 2017. Chile's Pinochet regime may have initially desired a "secret weapon" to be used in event of war with Chile's neighbors, but the instated CW project was small in scale and may have only produced lab quantities of agent to be used for the assassination of a dissident; see Kornbluh 2013, 178–79; Burck and Flowerree 1991, 491–92.

71 Cohen 2001, 40.

72 See CW entry on France in Chapter 6.

Table 5.3: Configuration chart for chemical weapons

Outcome	Start CW Pursuit			End CW Pursuit		Start CW Possession				End CW Possession						
	Model / Path			Model / Path		Model / Path				Model / Path			Model / Path			
Condition	***1a***	***1b***	***1c***	***1a***	***1b***	***1a***	***1b***	***2a***	***2b***	***1a***	***1b***	***1c***	***2a***	***2b***	***2c***	***2d***
International Security																
RIV_NW						●	⊗	●							⊗	●
RIV_CW	●				⊗				⊗			●			●	
RIV_STR												⊗				⊗
NW_DEF					{1}											
NW_PURS			●													
Law / Norms																
CWC		{0}		{2}		{0}	{0}	{0}		{3}			{3}			
Domestic																
UNR		●			⊗	⊗	●	⊗	●							
REG							⊗		⊗		●			●		
Cases	8	4	2	1	2	6	2	6	2	5	3	5	5	3	3	3
Non-cases						2		2								
Inclusion	1.000	1.000	1.000	1.000	1.000	0.750	1.000	0.750	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Raw Coverage	0.571	0.286	0.143	0.250	0.500	0.600	0.300	0.600	0.300	0.357	0.286	0.357	0.357	0.286	0.214	0.214
Unique Coverage	0.429	0.214	0.071	0.250	0.500	0.600	0.300	0.600	0.300	0.071	0.286	0.000	0.071	0.286	0.000	0.000
Unique Coverage Model 1										0.143	0.286	0.143				
Unique Coverage Model 2													0.071	0.286	0.071	0.071
Inclusion Total		1.000		1.000		0.8		0.8			1.000		1.000			
Coverage Total		0.857		0.750		0.9		0.9			0.786		0.786			
Cases	FR, EG1, EG2, IR, IQ, KP, SY, LY	CL, EG2, RH, ZA2	IL, LY	FR	CA, CL	EG1, IR, IQ, IL, LY, SY	RH, ZA2, YU	EG1, IR, IQ, IL, LY, SY	RH, ZA2, YU	CN, IN, KR, LY, US	MM, RH, ZA2, YU	CN, FR, EG1, KR, US	CN, IN, KR, LY, US	MM, RH, ZA2, YU	FR, KR, US	CN, IN, EG1
Non-cases						IR (EPN), UK (EPN)		IR (EPN), UK (EPN)								

Note: ●/⊗ indicate presence/absence of crisp conditions. Numbers between curly brackets indicate the value of multivalent conditions.

Table 5.4: Configuration chart for biological weapons

Outcome	**Start BW Pursuit**		**End BW Pursuit**				**Start BW Possession**				**End BW Possession**			
	Model / Path		**Model / Path**				**Model / Path**				**Model**			
Condition	***1a***	***1b***	***1a***	***1b***	***1c***	***1d***	***1a***	***1b***	***2a***	***2b***	***1a***	***1b***	***2a***	***2b***
International Security														
RIV_NW					⊗	⊗								
RIV_BW	●	⊗												
RIV_STR							●	⊗	●					
NW_DEF				{2}	{1}		{0}	{2}	{0}		{2}		{2}	{0}
NW_PURS														
Law / Norms														
BWC											{2}	{3}	{2}	{3}
Domestic														
UNR	⊗	●		⊗		●				●				
REG		⊗	●									●		
Cases	5	2	1	2	1	1	2	1	2	2	1	1	1	1
Non-cases	1													
Inclusion	0.833	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Raw Coverage	0.714	0.286	0.200	0.400	0.200	0.200	0.667	0.333	0.667	0.667	0.500	0.500	0.500	0.500
Unique Coverage	0.714	0.286	0.200	0.400	0.200	0.200	0.333	0.000	0.333	0.000	0.500	0.000	0.500	0.000
Unique Coverage Model 1							0.667	0.333			0.500	0.500		
Unique Coverage Model 2									0.333	0.333			0.500	0.500
Inclusion Total	0.875		1.000				1.000		1.000		1.000		1.000	
Coverage Total	1.000		1.000				1.000		1.000		1.000		1.000	
Cases	EG, FR, IQ1, IQ2, KP	RH, ZA	RH	FR, UK	CA	IQ1	IL, IQ2	ZA	IL. IQ2	ZA, IQ2	US	ZA	US	ZA
Non-cases	UK (EPT)													

Note: ●/⊗ indicate presence/absence of crisp conditions. Numbers between curly brackets indicate the value of multivalent conditions.

of internal or external security threats or a decline of existing threats, particularly when coupled with a credible nuclear deterrent provided by the United States, could improve the perceived security to make possible the end of a CBW program.

The analyses of start and end of CW possession introduce slight model ambiguity. Model ambiguity is the phenomenon where multiple causal models account equally well for the same configurational data in a particular analysis.[73] The most popular software tools for performing QCA usually do not display all data-fitting models and many published applications of QCA have not reported model ambiguities or their authors have been unaware of their existence.[74] The *QCApro* package, however, does report all possible models and for the sake of transparency all models found are described here. As displayed in **Table 5.3**, two models, containing two paths each, account equally well for the start of CW possession. Both models indicate the importance of external and internal security threats for the acquisition of chemical weapons. Both models share the first path (path *1a* and *2a*). This path associates having a nuclear-armed rival combined with low domestic unrest during the pre-CWC period with the start of CW possession. While this path covers eight cases, two are actually instances where a state ended CW possession.[75] The second path for model 1 (path *1b*) draws attention to the importance of regime security considerations, covering the acquisition of CWs by the minority-white regimes of South Africa and Rhodesia and Yugoslavia's acquisition. This path combines high domestic unrest and the absence of regime transition with the absence of a NW-armed rival during the pre-CWC period. The second path for model 2 (path *2b*) merely drops the condition CWC{0} (pre-CWC) from the causal recipe for these two cases. However, all known instances of CW acquisition took place before the existence of a global CW ban. The inclusion of the pre-CWC period in almost all of the paths towards start of CW possession confirms the salience of the absence of a CW convention on state behavior.

The analysis of the end of CW possession reveals two models. Both models share the first two paths. The first path (path *1a* and *2a*) indicates that having signed and ratified the Chemical Weapons Convention is sufficient for end of CW possession. The second path (path *1b* and *2b*), covering four cases, associates regime transition with the end of CW possession. This accords well with the extant case-knowledge, as both South Africa and Rhodesia gave up their chemical weapons when the countries transitioned towards majority rule, whereas the Serb-dominated Yugoslav leadership hastily dismantled its CW program in anticipation of the impending breakup of the state and the sectarian violence that would ensue.[76]

Similar to the analyses of CW programs, the QCA models reveal multiple paths to the start and end of both BW pursuit and BW possession as can be seen in **Table 5.4**. Two

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73 Baumgartner and Thiem 2017, 2.

74 Baumgartner and Thiem 2017; Thiem 2014b.

75 Namely, the United Kingdom's renunciation of CWs in 1957 and Iran's in 1991.

76 See the entries on the CW programs of South Africa, Rhodesia, and Yugoslavia in Chapter 6.

distinct paths are associated with the start of BW pursuit that, taken together, cover all cases under consideration. These paths confirm theoretical expectations that both external security considerations and domestic challenges to regime security play a role in demand for biological weapons. The first path combines the presence of a BW-armed rival with low domestic unrest. This recipe covers five out of seven cases of the start of BW pursuit and one case of a state ending BW pursuit.[77] This finding corresponds with the theoretical expectation that states often envision BWs as an in-kind deterrent. The second path indicates that the absence of a BW-armed enduring rival coupled with the absence of regime transition and high domestic unrest is sufficient for the start of BW pursuit. Indeed, the two cases covered by this path, South Africa and Rhodesia, set out to develop rudimentary biological weapons to be used as tools for assassinations, dirty tricks, and counterinsurgency operations against African nationalist opponents.[78]

The analysis of the end of BW pursuit introduces four paths that cover all five countries that have ended BW pursuit. While this implies a significant degree of equifinality, taken together the paths confirm the importance of having an advantageous external security conditions and domestic security considerations for the rollback of BW programs. The first path, covering Rhodesia, indicates that the occurrence of regime transition is sufficient for the end of BW pursuit. The second path combines low domestic unrest with the possession of nuclear weapons. The two countries covered by this path, France and the United Kingdom, indeed abandoned offensive BW research as strategic priorities shifted towards nuclear weapons.[79] While the first two paths conform closely to both theoretical expectations and extant case knowledge, the final two paths leave something to be desired. The third path, covering Canada, namely combines the absence of a nuclear-armed rival with having a nuclear-armed ally as a recipe towards the end of BW pursuit. While the absence of direct security threats and having a close alliance with nuclear-armed United States shaped the context in which the Canadian government ended its involvement with BWs (and CWs) in the late 1960s, at least three other factors were at play: public opposition to CB warfare and the concern over damage to Canada's image if its involvement with CBW research became public, its public commitment to outlawing biological weapons and ongoing negotiations over a BW convention, and the United States' surprise BW renunciation in 1969.[80] Finally, the fourth path, covering Iraq, combines the absence of a NW-armed rival with high domestic unrest. On its own this makes little sense, but it is important to note that Iraq's first episode of BW pursuit actually ended in 1978 due to poor project management and a lack of progress.[81]

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77 This path covers the end of the United Kingdom's BW pursuit. However, that case is also correctly covered by one of the paths in the analysis of the end of BW pursuit as discussed below.

78 Gould and Folb 2000.

79 Lepick 2009; Balmer 2001.

80 Avery 2013, chap. 4.

81 UNSCOM 1995, 22.

Now, I turn to the analysis of the start and termination of BW possession. The analysis of start and end of BW possession again introduces a slight degree of model ambiguity. Two models that cover all three cases under consideration account equally well for the underlying data for start of BW possession. Both models share the first path (paths *1a* and *2a*), which covers Israel and Iraq. This path indicates that the presence of stronger rivals combined with the absence of a nuclear-armed rival leads to BW acquisition. This corresponds well with what we know about the genesis of Israel's BW program, which was founded during the 1948 Arab-Israeli War.[82] Meanwhile, Iraq's move towards acquisition of BWs took place whilst Iraq was preparing the invasion of Kuwait and a dash was made to prepare rudimentary BW-filled aerial bombs and warheads right before the start of Operation Desert Storm.[83] Model 1's second path (path *1b*), covering South Africa combines the absence of a conventionally stronger rival with the possession of NWs. While South Africa in the 1980s was indeed in a stronger military position than its neighbors and possessed nuclear weapons, its BW program was spurred by the internal conflict between the Apartheid government and its opponents. This rationale is reflected in the final path for model 2 (path *2b*), covering South Africa and Iraq, which indicates that the presence of domestic unrest is sufficient for BW possession. While the Saddam regime routinely used CWs against Iraqi Kurds and Shi'ites in the latter half of the 1980s, the move towards acquisition of BWs is better explained by its deteriorating external environment as reflected path *1a* and *2a*.

Finally, the analysis of the end of BW possession introduces two models. Each model contains two distinct paths that cover both cases that ended BW possession. The first path of each model (paths *1a* and *2a*), covering the United States, combine the possession of nuclear weapons with having signed the BWC. This path requires a reservation as President Nixon had already decided by early 1970 (two years before the conclusion of the BWC) to renounce all BWs, in part because of mounting domestic and international public opposition to BWs coupled with the prospects of a BW ban being negotiated.[84] The actual end of the United States' BW possession, however, only took place in 1972 when it completed destruction of its BW stocks. The second path of model 1 (path *1a*), covering South Africa, indicates that the occurrence of regime transition combined with having ratified the BWC is sufficient for end of BW possession. This makes theoretical sense and fits remarkably well with what we know about the South African case. An important motivator for the outgoing Apartheid regime was to prevent a future government led by the African National Congress (ANC) from having access to CBWs.[85] At the same time, the gradual process of regime transition from the late 1980s until 1993/1994 enabled increased civilian control

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82 Cohen 2001, 31.

83 Duelfer 2005a, 45.

84 Moon 2009, 36.

85 Purkitt and Burgess 2005, 176. Similar motivations played a role in South Africa's renunciation of nuclear weapons; see Sagan 1996.

and parliamentary oversight over the chemical, biological, and nuclear (CBN) weapons projects that had previously flourished under the control of military agencies. Notably, South Africa's ratification of the BWC long predated its decision to end BW activities.[86] However, the establishment of civilian control over the CBW program coupled with sustained diplomatic pressure from the United States and its allies over fears that South Africa's CBW secrets might be passed on to other countries enabled President De Klerk's office and the foreign ministry to ensure compliance with the BWC and initiate accession to the CWC and the Nuclear Non-Proliferation Treaty (NPT).[87] Finally, the second path of model 2 (path *2b*), covering South Africa, combines the absence of conventionally stronger rivals with having ratified the BWC to produce the end of BW possession. As with the start of its BW possession, however, South Africa's BW renunciation was tied to its domestic rather than external security situation, which is correctly modelled in path *1b*.

IMPLICATIONS FOR METHOD, THEORY, AND EMPIRICS

The results of the QCA models confirm that the causes of CBW spread and reversal are complex. First of all, the analyses reveal that each distinct outcome is explained by more than one pathway. Second, most paths consist of combinations of conditions rather than a single condition. Third, for several outcomes both the presence and absence of a condition were present in different configurations of conditions. Moreover, the inverse of a pathway towards an outcome was not sufficient for the inverse of that outcome in any of the analyzed models. The identification of these three characteristics—equifinality, conjunctural causation, and causal asymmetry—provides support for the application of QCA and other configurational comparative methods in the study of chemical, biological, and nuclear weapons programs.

The QCA results yield several important insights for empirics and theory. Unsurprisingly, external security factors play a noteworthy role in the process of CBW spread and reversal, but they rarely do so in isolation. For the start of CW possession and BW pursuit and possession, having a rival combines with other conditions. Only in the first path towards start of CW pursuit is having a CW-armed rival sufficient by itself. This may merely reflect that the barriers to starting pursuit are lower than actually committing to acquisition of weapons, hence only causally remote external threat-related considerations playing a role in this initial stage. Notably, the finding that external threats do not affect proliferation decisions in isolation may explain why many measures of threat perform poorly in quantitative studies of proliferation.[88]

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86 It ratified the BWC in 1975.

87 Purkitt and Burgess 2005, 176.

88 See Bell 2016.

As discussed in the state of the art section, the external security-related incentives for desiring CBWs are more nuanced than CBWs merely serving as general strategic deterrents in lieu of nuclear weapons. The QCA results also reflect this. In-kind deterrence and deterrence of conventionally stronger rivals play an important role in explaining start of CW pursuit and start of BW pursuit and possession. As a matter of fact, having a NW-armed rival only occurs in path *1a/2a* for start of CW possession. However, we know from the case literature that for most countries covered by this path (e.g., Egypt, Iran, Iraq, and Israel) having CW-armed or conventionally stronger rivals, rather than facing nuclear adversaries, played a role in their decision to acquire CWs. In this case the underlying data structure generates a causal recipe that, while algorithmically correct, does not stand up to case-based knowledge.[89] The strength of configurational methods like QCA is that its case-level findings can directly be compared to theoretical and empirical expectations.

Notably, the pursuit of nuclear weapons plays a very limited role in CBW pursuit or possession. The pursuit of nuclear weapons only occurs in one path towards start of CW pursuit (uniquely covering Israel). These results are remarkably accurate as Israel represents one of only two cases where officials have explicitly stated that a CBW program was intended to develop temporary alternatives to nuclear weapons.[90] Taken together, these findings cast severe doubt on the accuracy of the 'poor man's atomic bomb' thesis. The possession of nuclear weapons or having a NW-armed ally, similarly, only occur in a few paths that only cover a handful of countries. Still, these findings conform to theoretical expectations as the QCA models indicate that possessing nuclear weapons is a component of one causal recipe for end of BW pursuit (path *1b*) and one recipe for end of BW possession (paths *1a* and *2a*), while having a NW-armed ally is part of a path towards end of CW pursuit (path *1b*) and BW pursuit (path *1c*).

Even though the security model provides a parsimonious and intuitive explanation of CBW decisions, its singular importance is often overstated as shown by the QCA results. It is, in fact, often difficult to pinpoint exactly whether and which security threats precipitated a weapons program. As Sagan noted, analysts often observe a decision to initiate or rollback a weapons program and then work back in time, trying to find the national security threat that "must" have caused that decision.[91] This retrospective quest to find evidence of international security considerations tends to overstate the salience of realist security explanations of weapons spread and rollback in two ways. First, analysts often rely on statements by key decision makers even though they have a vested interest in portraying their choices as serving national security interests.[92] This represents the 'national interest'

89 The underlying data shows that all cases of CW acquisition that faced nuclear-armed rivals also faced CW-armed and conventionally stronger rivals.

90 The other case concerns Iraq's BW program. In the 1990s, Iraqi officials stated that Iraq's 1980s BW program was "a stopgap measure because of the long lead-time involved in the development of a nuclear programme." See UNMOVIC 2007, 775.

91 Sagan 1996, 63.

92 Ibid.

as shared *faits accomplis*—an expression of a Rousseauian general will—rather than the parochial concerns of elites or even the shared interests of a ruling class.[93] Second, the intuitiveness and simplicity of the security model sometimes leads analysts to establish a causal link between differences in military capabilities or even the occurrence of conflict and a weapons decisions even though these factors did not actually play a role in the decision or were temporally distant from it. Yet, threats have to be filtered through elite perceptions, rather than dispassionate analysts, before they affect proliferation decisions.[94] These challenges are addressed, at least in part, as QCA allows one to explore alternative and even complex explanations, and makes it possible to check the accuracy of explanations by relating them back to individual cases.

Turning to domestic explanations, the QCA results confirm expectations from theory and empirics that conditions related to internal conflict and regime security play an important role in explaining the advent and termination of CBW programs. High domestic unrest namely combines with other conditions to lead to the start of CW pursuit (path *1b*), CW possession (path *1b* and *2b*), BW pursuit (path *1b*), and BW possession (path *2b*). These paths cover, among others, the well-known cases of South Africa and Rhodesia. Domestic unrest and regime transition are equally salient in the analysis of termination of pursuit and possession. Low domestic unrest namely combines with the absence of CW rivals and the presence of a NW-armed rival to create a favorable (internal and external) security environment leading to the end of CW pursuit (path *1b*). Meanwhile, the occurrence of regime transition was sufficient by itself to lead to the end of CW possession (path *1b*/*2b*) and end of BW pursuit (path *1a*), while it combined with BWC ratification to produce the end of BW possession (path *1b)*. Notably, domestic conflict and regime security conditions gained salience in a number of cases after a CW program had already been initiated. These countries, like Iraq and more recently Syria, began their programs with external threats in mind but over time their program objectives evolved towards applications for domestic use.[95]

The results of the QCA analysis, furthermore, confirm the importance of legal instruments in stemming and even turning around the spread of unconventional weapons. Looking at the underlying data, all cases of initiation of CW pursuit and CW possession occurred before the CWC even existed. This is reflected in the QCA results as one path towards CW pursuit (path *1b*) and almost all paths towards CW possession (paths *1a*/*1b*/*2a*) combine non-existence of the CWC with other conditions. Conversely, having signed the CWC is

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93 As Marx wrote, 'The ideas of the ruling class are in every epoch the ruling ideas.' See Marx and Engels 1998, 67. Sagan presented a 'domestic politics model', which envisages unconventional weapons as political tools to promote bureaucratic or parochial interests, as an alternative to the 'realist security model'. See Sagan 1996, 63–73.

94 Bell 2016, 525.

95 Koblentz 2013, 508. The Soviet CW program also developed agents for assassination of dissidents during the Cold War and it is likely that Russia continued some of these activities in light of the attempts on the lives of Sergei Skripal and his daughter Yulia.

sufficient for end of CW pursuit (path *1a*) and having ratified the CWC is sufficient for end of CW possession (path *1a*). Likewise, the QCA models for BW pursuit and possession indicate that the BWC played a role in the end of South Africa's and the United States' BW possession.

An appreciation of the complexity of the process that leads states to embark on or roll back CBW programs is fundamental to furthering our understanding of it and to generate sensible policy advice for it. The literature on the causes of spread and rollback of weapons of mass destruction (WMD) programs has in large part not progressed from the paradigmatic debates and grand theories of state behavior of the 1980s and 1990s. Attempts at synthesizing these differing viewpoints by quantitative scholars have not sorted much effect either,[96] which is unsurprising as quantitative methods are more suitable for adjudicating between theories rather than synthesizing them. However, discrete theories are unsuccessful at explaining state behavior across the universe of cases. Take for example the 'poor man's atomic bomb' thesis. Numerous 'developing' states were alleged to have been pursuing or even having acquired CBWs by U.S. government officials and non-governmental experts in the 1980s and 1990s with reference to this theory.[97] Yet, many of these allegations have been proven incorrect or inconclusive at best.[98] Moreover, we know from the historical record that of all the countries that did acquire chemical or biological weapons, only two—Iraq and Israel—explicitly pursued CBWs as a temporary replacement for nuclear weapons. In other words, while the 'poor man's atomic bomb' thesis may explain a couple of cases of CBW demand well it is unsuccessful when applied as a general theory of state behavior.

CONCLUSION

Why do states embark on and abandon chemical and biological weapons programs? International security related explanations of CBW spread and reversal have dominated the literature but alternative theoretical accounts have drawn attention to, among others, regime security considerations and the role of international law and norms on weapons decisions. While extant theories of CBW spread and reversal emphasize important aspects of the puzzle and individual theories may be more successful in explaining particular historical cases, none provides a satisfactory explanation on its own for such an inherently complex process.

Departing from the notion that the drivers of CBW programs are complex, this chapter presented a novel approach to investigate the causes of CBW spread and rollback with the help of Qualitative Comparative Analysis (QCA). The analyses revealed, first, that each outcome under consideration (i.e., the start and end of CW pursuit, CW possession, BW

96 Bell 2016; Sagan 2011, 233.

97 See Chapter 2.

98 See Chapter 2 and Chapter 3.

pursuit, and BW possession) is explained by more than one pathway. Second, most paths consist of combinations of conditions rather than a single explainer. Third, the presence and absence of individual causal conditions were parts of different paths towards the same outcome. Finally, the inverse of a given path towards an outcome was not sufficient for the absence of that outcome in any of the investigated models. Taken together, these findings confirm the expectation that the process of CBW spread and rollback is characterized by causal complexity and provides support for the application of QCA in the further study of chemical, biological, and nuclear weapons dynamics to generate richer and more detailed explanations.

Substantively, the QCA results indicate that international security considerations play a considerable role in CBW decisions, but in more nuanced ways than is often thought. First of all, external security conditions have a causal effect in combination with other conditions in most pathways in which they occur. Second, nuclear-armed adversaries play a relatively limited role in CBW pursuit and possession. In most cases where adversaries play a role in CBW decisions, it concerns the presence or absence of CBW-armed or conventionally stronger rivals rather than NW-armed ones. This indicates that states accord different tactical and strategic functions to CBWs than to nuclear weapons. Third, the findings indicate that prior pursuit of nuclear weapons explains very few instances of CBW pursuit or possession. Taken together, these findings throw further doubt on the popular view that CBWs are essentially a cheaper and easier to acquire alternative to nuclear weapons.

While external security consideration plays a substantial role in CBW decisions, the QCA results indicate that some regimes turn to CBWs as means of dealing with domestic challenges to their rule. High domestic unrest combines with a lack of external security threats to produce the start of CW pursuit, CW possession, and BW pursuit. High domestic unrest even constitutes a path on its own towards BW acquisition. Conversely, low domestic unrest or the occurrence of regime transition combine with the absence of external threats or BWC ratification to produce the end of CW pursuit, end of BW pursuit, and end of BW possession. The occurrence of regime transition was even sufficient by itself to produce the end of CW possession and end of BW pursuit.

Finally, the QCA results highlight the importance of treaties in constraining the spread of CBWs. The majority of paths towards the start of CW pursuit and CW possession included the non-existence of the CWC. It is likely that the lack of a legal prohibition on the development and possession of chemical weapons—even though a prohibition on the use of them existed—was an important contextual condition in the start of many instances of CW pursuit and CW possession. Conversely, being a party to the CWC is sufficient on its own for end of CW pursuit and possession, indicating that it operates as a causally proximate explanation of rollback. Furthermore, having signed or ratified the BWC was part of each path towards the end of BW possession.

6

Chronicle of Chemical Weapons Programs, 1946-2010

SUMMARY

This chapter chronicles all state-run chemical weapons programs after World War II. The entries in this chapter serve, first of all, as the case notes for the dataset on CBW pursuit and possession that was introduced in Chapter 3. Moreover, the entries are valuable reference materials whilst reading the other chapters in this dissertation. This chronicle describes the available information regarding chemical weapons pursuit and possession for each case, analyzes how the available information is weighed, discusses how coding decisions are made, and makes note of possible alternative coding specifications.

Afghanistan

Horowitz and Narang[1] code pursuit from 1982-1994 based on two sources the Office of Technology Assessment (OTA) report and volume by Burck and Flowerree.[2] The OTA report finds Afghanistan mentioned in three out of eleven consulted sources, two of which express doubt.[3] In their discussion of Afghanistan, Burck & Flowerree note that "the primary CW allegation against the government of Afghanistan is of complicity in allowing the USSR to stock and use CW agents against domestic opponents".[4] As Horowitz and Narang do not discuss their coding choices, it is difficult to determine on which grounds specifically they code Afghanistan's pursuit as starting in 1982, particularly since there is nothing to be found in Burck & Flowerree that would lead one to believe that a pursuit effort was underway in that specific year. The only thing coming close to that date concerns the story of an Afghan army colonel, who had defected from the defense ministry, telling a western reporter in August 1982 that a CBW department had been created in 1981.[5] The obvious problem is that the dates do not match. Second, the existence of a CBW department does not imply pursuit, as many armed forces maintain such units for CB defense purposes. Burck & Flowerree only find one report concerning any Afghan chemical corps facility, in which the chief of an Afghan rocket regiment's chemical department said that its activities concerned CW defenses.[6] Based on the lack of credible evidence, Afghanistan is coded as not pursuing chemical weapons.

Algeria

Horowitz and Narang's[7] coding of Algerian pursuit from 1999-2000 is sketchy. Their primary source states the following of Algeria: "Possible development. No evidence of deployed systems," but provides no further evidence.[8] Horowitz and Narang's second source merely refers back to their first source.[9] This provides insufficient basis to code Algeria as pursuing. Moreover, there is no further evidence to believe that Algeria has or has had a CW program.[10] Hence, Algeria is coded as not pursuing chemical weapons.

Angola

Horowitz and Narang[11] code Angola as pursuing from 1984-1993, based on Burck and

1 Horowitz and Narang 2014.
2 Office of Technology Assessment 1993a; Burck and Flowerree 1991.
3 Office of Technology Assessment 1993a, 80.
4 Burck and Flowerree 1991, 333.
5 Ibid., 339.
6 Ibid.
7 Horowitz and Narang 2014.
8 Cordesman 2005, 31.
9 Center for Nonproliferation Studies 2008.
10 Nuclear Threat Initiative 2018.
11 Horowitz and Narang 2014.

Flowerree and the OTA report.[12] The OTA report finds Angola mentioned in only 1 out of 11 consulted sources as a "doubtful chemical weapons state" in connection to alleged uses of CWs during the Angolan Civil War in the second half of the 1980s.[13] Burck and Flowerree note that reports of CW use in Angola during this time could only plausibly be ascribed to Cuban forces making use of Soviet supplies.[14] These sources provide no basis to code Angola as pursuing chemical weapons.[15] Hence, Angola is coded as not pursuing chemical weapons.

Argentina

Horowitz and Narang[16] code Argentina as pursuing from 1971-1991, based on two sources.[17] Burck and Flowerree report that "evidence of any offensive or defensive CW capabilities is weak."[18] They mention that "the few reports suggesting a stockpile of chemical agents and/or munitions do not involve the lethal CW agents," but concern unconfirmed reports of tear agent and smoke shells.[19] Burck and Flowerree conclude that "there is no convincing evidence that the [CW] arms race [between Argentina and its neighbors] has started.[20] Other sources, likewise, determine that there is no evidence that Argentina has ever had an offensive CW program.[21] Hence, Argentina is coded as not pursuing chemical weapons.

Australia

Horowitz and Narang[22] code Australia as pursuing from 1945-1973 based on volume by the Stockholm International Peace Research Institute.[23]

In 1939 the Australian Defence Committee recommended to the Australian government "to investigate the production of mustard gas, the filling of bombs and shells and the fitting of aircraft for use in chemical warfare".[24] On 26 June 1939, the Minister of Defence approved the recommendation. During the first meeting of the Defence Committee's sub-committee

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12 Burck and Flowerree 1991; Office of Technology Assessment 1993a.

13 Office of Technology Assessment 1993a, 80. The OTA report describes Angola as a "doubtful chemical weapons state" based on a chapter by Elisa Harris, see Harris 1989a. According to Harris such doubtful cases concern states that are usually reported by adversaries (domestic or foreign) as seeking, possessing, or using CWs without confirmation by Western officials, often in order to discredit them. See Harris 1989b, 41; Harris 1989a, 74.

14 Burck and Flowerree 1991, 450.

15 It is particularly odd that Horowitz and Narang code Angola as *pursuing* whilst the consulted sources only refer to the alleged *possession* and *use* of chemical weapons.

16 Horowitz and Narang 2014.

17 Burck and Flowerree 1991; Office of Technology Assessment 1993a.

18 Burck and Flowerree 1991, 489.

19 Ibid.

20 Ibid., 490.

21 See, for instance, Nuclear Threat Initiative 2015d; Cirincione, Wolfsthal, and Rajkumar 2011, 383.

22 Horowitz and Narang 2014.

23 Stockholm International Peace Research Institute 1971, vol. I.

24 Plunkett 2013, 12.

on chemical warfare on 22 August 1939, the Controller General of Munitions Supply noted that CW production would take between eighteen months and two years and suggested that "if supplies of gas were required earlier there would be no option but to arrange for their importation from the United Kingdom."[25] On 12 November 1940, the War Cabinet, accepting a Defense Committee recommendation, decided that Australia should, in principle be self-reliant in the production of CW agents.[26] But, after Singapore, an important barrier to the surge of Japanese forces towards Australia, was overrun in February 1942, the Defence Committee concluded that a request should be made to the United Kingdom for the supply of CWs. The formal request was made by the Australian Prime Minister on 10 March 1942 and received a favorable response from London on 24 March 1942.[27] As a result, the CW stocks were imported until the end of the war and indigenous production never took place.[28] Ultimately, the army requested on 13 December 1945 that chemical ammunition held should be disposed of and for the need for replacement to be reviewed annually. The request was agreed to by the Defence Committee on 27 February 1946.[29] Australia's CW program after 1946 has been of a defensive nature.[30] Hence, Australia is coded as pursuing from 1939 (before the start date of this study) until 1946, when it decided to destroy imported stocks and review the need for chemical weapons annually. Due to the lack of indigenous production Australia is coded as not possessing during this time.

Brazil

Horowitz and Narang[31] code Brazil as pursuing from 1988-1993 based on a volume by Burck & Flowerree and the OTA report.[32] Burck & Flowerree only note that "chemical weapons concern […] centers on Brazil's strong chemical industry rather than any specific CW [Chemical Weapons] programs in place."[33] The OTA report finds that Brazil is mentioned only in one of eleven sources investigated and even that source expresses doubt.[34] Hence, Brazil is coded as not pursuing.

Canada

Horowitz and Narang[35] code Canada as possessing from 1941 until 1946 based on two sources.[36]

25 Ibid.
26 Ibid., 14.
27 Ibid., 17.
28 Ibid., 20.
29 Ibid., 307.
30 Stockholm International Peace Research Institute 1971, vol. I, 245–47.
31 Horowitz and Narang 2014.
32 Burck and Flowerree 1991, 490; Office of Technology Assessment 1993a.
33 Burck and Flowerree 1991, 490.
34 Office of Technology Assessment 1993a, 80.
35 Horowitz and Narang 2014.
36 Stockholm International Peace Research Institute 1973, vol. II; Center for Nonproliferation Studies 2008.

Canada's BW and CW research programs can be traced back to World War II (WWII) and are characterized by their close connection with the British and American CBW programs during and after the war. During WWII, Canada produced around 1500 tons of mustard and phosgene and purchased another 3500 tons of mustard (and smaller amounts of lewisite and phosgene) from the U.S. army. This stockpile was destroyed in 1946.[37]

The close links between the American, British, and Canadian CBW programs were formalized right after the war in the Tripartite Military Agreement on Chemical and Biological Warfare. Within the Canadian armed forces, the Army was most enthusiastic about the offensive potential of chemical weapons, desiring to equip its forces with nerve agents[38] While Canadian scientists worked closely with their American and British counterparts to develop and test new agents and munitions, successive governments refused to acknowledge Canadian involvement with offensive dimension of CB warfare.[39] The government's refusal to acknowledge continued involvement with offensive research greatly irked Canadian scientists, particularly since it undermined their standing as full partners within the alliance.[40] Nevertheless, the government's hesitation did not restrain the scientists' involvement in offensive CBW research as contemporary reports from Tripartite meetings in the second half of the 1950s show.[41]

By the 1960s, the Americans were manufacturing chemical and biological weapons on a large scale, with the British and Canadians aiding in research, development, and testing. Around this time, Canada had built up a significant stockpile of blister and nerve agents, some in munitions, provided to it by the United States.[42] However, it still had no official CBW policy and the CBW issue was rarely discussed in the Canadian Cabinet until the late 1960s. The Canadian Chiefs of the General Staff issued the first policy statement on chemical and biological warfare in secret in May 1963, stating as principle that "the Canadian Armed Forces will develop the knowledge and the capacity to ensure that protective measures are adequate, and that a capability for retaliation in kind could be quickly instituted if so directed."(Avery, 2009, p. 96f.) While little was done to implement this directive, Brigadier General Tellier issued an official statement in December 1968 on behalf of the Chiefs of the General Staff about Canada's CBW policies:

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37 Stockholm International Peace Research Institute 1971, vol. I, 63; Stockholm International Peace Research Institute 1973, vol. II, 187, n. 30.

38 Avery 2013, 68.

39 Avery 2013; Paxman and Harris 1982.

40 Avery 2013, 98, 102.

41 During the eleventh Tripartite meeting (1956), Canadian scientists, for instance, reported "active participation in a number of CBW operational projects, including the potential battlefield use of the nerve gas VX." See, ibid., 99. And, during the thirteenth Tripartite meeting (1958), the three countries agreed that "all three countries should concentrate on the search for incapacitating and new type lethal agents." See, U.S. Army Chemical Corps Historical Office 1960, 95.

42 Avery 2013, 154f. Some or all of the blister agents were destroyed in the mid-1970s, whereas it would take until 1988-89 for Canada to destroy the remaining nerve agent. Ibid., 154, n. 30.

> the new policy proposes that agreements should be reached with our Allies whereby suitable weapons can be made available [...] the Canadian Forces have no intention of holding B or CW munitions in Canada or in Europe. Our requirements would be held in British or American stockpiles, to be supplied in the event B or CW is employed against NATO forces.[43]

Following President Nixon's unilateral BW renunciation, Pierre Trudeau's cabinet released a policy statement on 11 December 1969 renouncing all CBW weapons and endorsing a draft convention for the prohibition of biological weapons.[44]

Canada is coded as ending possession of chemical weapons in 1946, starting pursuit in 1946, and ending pursuit again in 1969.

Chad

Horowitz and Narang[45] code Chad as pursuing based on two sources.[46] Burck & Flowerree indicate that Chad appears only in two sources, both of them considering Chad as one of the most doubtful suspects.[47] The OTA report finds that Chad is mentioned only in one of eleven sources investigated and even that source expresses doubt. Hence, Chad is coded as not pursuing.

Chile

Horowitz and Narang[48] code Chile as pursuing from 1988-1993 based on the OTA report.[49] The report, however, only finds Chile mentioned in three out of eleven sources, two of which express doubt.[50]

According to Kornbluh the Pinochet regime desired "to possess a secret weapon that could be used in the event of war against Chile's neighbors, Peru or Argentina".[51] The Chilean secret police (DINA) tasked Michael Townley with creating the nerve agent sarin in a secret project codenamed "Project Andrea". Townley and chemical engineer Eugene Berrios worked throughout 1975 and 1976 to procure the necessary materials and know-how to synthesize sarin. Possession of CW agents has only seriously been alleged in the assassination of dissident politician and academic Orlando Letelier in Washington D.C. in September 1976.[52] In preparation for the assassination, Townley made arrangements for

43 Avery 2009, 99.
44 Avery 2013, 136.
45 Horowitz and Narang 2014.
46 Burck and Flowerree 1991; Office of Technology Assessment 1993a.
47 Burck and Flowerree 1991, 467.
48 Horowitz and Narang 2014.
49 Office of Technology Assessment 1993a.
50 Ibid., 80.
51 Kornbluh 2013, 178.
52 Burck and Flowerree 1991, 491.

a small quantity of the agent to be transported to Washington in a Chanel No. 5 perfume bottle, but eventually opted to carry out the assassination by means of a car bomb.[53]

It is disputed whether efforts were made to further weaponize and stockpile the agent after the production of the amount needed for the Letelier assassination. According to Kornbluh, DINA "had manufactured significant amounts of Sarin and Townley was working on a military delivery system that would allow the gas to be deployed in a wartime setting" by the time of the Letelier mission.[54] However, no evidence is available to corroborate this assessment. Burck and Flowerree, on the contrary, argue that the "Townley story involves only small quantities of the agent" and find no evidence of further production of sarin or other chemical agents.[55] As the episode seems to only involve the incidental synthesis of lab quantities of agent, Chile is coded as pursuing from 1975-1976. However, a short period of possession in 1976 is a possible alternative specification.

China

Horowitz and Narang[56] code China as continuing to possess chemical weapons from at least 1945 up to and through 2000 (the end date of their study), citing a list of alleged proliferators by the Center for Nonproliferation Studies and a SIPRI volume.[57]

China ratified the CWC in 1997 and disclosed two former CW production facilities (CWPFs). Nevertheless, the CNS list cited by Horowitz and Narang finds it "probable" that China has a continuing CW program based on four US government sources that paint an incongruent picture of China's CW status.[58] The first source is a testimony by the Director of Naval Intelligence in 1991, during which he identified China as one of the countries that "probably possess [an] offensive CW capability."[59] The second is a testimony by the Assistant Secretary of State for Intelligence and Research in 2002, in which he stated: "I believe that the Chinese have an advanced chemical warfare program, including research and development, production, and weaponization capabilities." The third, a 2001 US Department of Defense report, referred to China as having "the ability to quickly mobilize the chemical industry to produce a wide variety of chemical agents and delivery means." And, fourth, a 2005 State Department compliance report which judges that China "maintains a CW production mobilization capability, although there is insufficient information available to determine whether it maintains an active offensive CW research and development program." Only one of these sources, the oldest and least detailed one, makes reference to *possession*, although in reference to the vague notion of "offensive CW capability". The two reports

53 Kornbluh 2013, 178–79; 201–205.
54 Ibid., 179.
55 Burck and Flowerree 1991, 491–92.
56 Horowitz and Narang 2014.
57 Center for Nonproliferation Studies 2008; Stockholm International Peace Research Institute 1973, vol. II.
58 Center for Nonproliferation Studies 2008.
59 see also Robinson 1992, 60f.

from 2001 and 2005 refer to the *capability* to mobilize CW production, which is applicable to any country with a significant chemical industry and does not imply the existence of an offensive weapons program. Therefore, it is unclear why the authors chose to code China as continuing to possess chemical weapons.

Over the years, the U.S. government has expressed doubts about whether China had fully disclosed its past and ongoing CW activities.[60] However, in its 2011 Condition 10(C) report, the U.S. State Department noted that "China has made an accurate declaration [in 1997] in relation to its historical CW program, including CW agent production and disposition".[61] No concerns about China have been expressed in subsequent reports. The OPCW, on the other hand, has not challenged the content of China's CWC declaration following inspections of the declared CWPFs[62]—nor has any other State Party—and has indicated the full destruction of China's CWPFs.[63] Hence, there is no reason to assume that China still possesses chemical weapons.

Horowitz and Narang's coding of start of possession in 1945 refers to the presence of World War II U.S. CW stocks left in China.[64] Horowitz and Narang alternatively specify that pursuit could be coded "as beginning in 1950 and acquisition shortly after," citing Mauroni.[65] Mauroni, however, only tersely states that "China is believed to have begun developing a chemical weapons program in the 1950s," without specifying who "believes" that and on the basis of which evidence.[66]

The Chinese government has maintained absolute secrecy surrounding its (past) CBW activities and has frequently denied producing or possessing chemical weapons, for instance in statements delivered at the Conference on Disarmament in 1987 and the 1989 Paris Conference on Chemical Weapons.[67] Due to China's long-standing public denials, many observers were surprised by the inclusion of former CW production facilities in its CWC declaration.[68]

A SIPRI volume from the early 1970s already stated that "virtually nothing is known of Chinese CBW activities" and that still holds true today. It, furthermore, noted that the U.S. intelligence community had been unable to locate "either large-scale field testing or nerve-gas production"[69] The 1983 Special National Intelligence Estimate (SNIE) prepared by the U.S. intelligence community judged that China had a "small, though not militarily

60 Nuclear Threat Initiative 2015i.
61 U.S. Department of State 2011b.
62 OPCW 2003a.
63 OPCW 2003b, 11.
64 Stockholm International Peace Research Institute 1973, vol. II, 243.
65 Mauroni 2003, 64.
66 It is possible that Mauroni repeats the assertion in a 1996 U.S. government report that China "has funded a chemical warfare program since the 1950s". See, U.S. Department of Defense 1996.
67 Burck and Flowerree 1991, 417.
68 Frieman 2004, 76.
69 Stockholm International Peace Research Institute 1973, vol. II, 243.

significant offensive CW capability."[70] Burck and Flowerree conclude from their survey of sources on China's CW activities that there was little evidence (at the time) to conclude that China had any "CW stockpile newer than leftovers from World War II."[71] They add that "allegations are primarily based, not on CW production or storage facilities, but on rumors of use or transfer of CW agents or munitions or on logical leaps from China's conventional forces and strong CW defense efforts."[72] The SIPRI yearbooks from the period 1969-1986 only mention China twice in connection to chemical weapons. The 1983 volume notes that "a US newspaper said that China was capable of waging CBW",[73] while the 1986 volume merely notes that China was included in lists of countries believed to possess chemical weapons by U.S. officials.[74] Lastly, the Nuclear Threat Initiative's entry on Chinese CW activities does not comment on the genesis and substance of China's offensive CW program at all.[75]

It is very likely that China started pursuing and acquired chemical weapons after World War II, and probably only after the establishment of the People's Republic of China. However, due to a lack of details in the available literature it is not yet possible to settle on a definitive—or even approximate—date when China embarked on pursuit and on possession. China disclosed two former CW production facilities in its 1997 CWC declaration. It is not clear when these were dismantled, hence China is coded as ending possession of chemical weapons in 1997.

East Germany (German Democratic Republic)

Horowitz and Narang[76] code the German Democratic Republic (GDR) as pursuing from 1980-1982 and possessing from 1983 until 1989, citing three sources.[77] The coding seems to be based on a single newspaper report.[78] *The Baltimore Sun* reports that "East Germany may have sold Iraq chemical weapons or at least cooperated in providing technical advice on their production in the early 1980s," noting that it helped Iraq build a CW training facility modeled on a site near Berlin.[79] Yet, the report only describes activities that are unrelated to the development and production of chemical weapons, like the training of

70 Director of Central Intelligence 1983, 12.

71 Burck and Flowerree 1991, 423.

72 Ibid.

73 Stockholm International Peace Research Institute 1984, 407.

74 Ibid., 175.

75 Nuclear Threat Initiative 2015i. Notably, the "History" section of the NTI entry on China only discussed Japan's WWII-era abandoned chemical weapons on Chinese territory.

76 Horowitz and Narang 2014.

77 Johnson 1991; Clarke 1988; Stockholm International Peace Research Institute 1973, vol. II. Horowitz and Narang also offer two alternative coding specifications: no pursuit ("since weapons potentially controlled by Soviet Union") and pursuit since 1945 ("due to incomplete destruction of German CW stockpiles by the Soviet Union").

78 Johnson 1991.

79 Ibid.

troops to operate under conditions of chemical warfare. Although the report pertains to dealings with Iraq, it also alleges that the GDR "secretly produced its own biological and chemical weapons during the 1980s," citing an East German chemist.[80] There is, however, no credible evidence in the literature that East Germany ever developed and produced chemical weapons. A few months prior, the German weekly news magazine *Der Spiegel* already reported that officers from the "Chemical Services" division of the East German army had led the construction of a "maneuver field for atomic, chemical and biological weapons in Baghdad" and "instructed Iraqi soldiers on the […] training ground in the professional handling of special equipment for the detection of chemical warfare agents or radioactive radiation."[81] Earlier charges that the GDR had provided CW assistance to other states were either unsubstantiated or involved defensive assistance.[82]

The other two sources cited by Horowitz and Narang indicate that the GDR did not have an offensive CW program. Clarke notes that while the GDR had the technical expertise and industrial base to produce CWs, the Soviets would object to such a program in order to keep CWs under their strict control.[83] The SIPRI volume indicates that the USSR possessed vast CW stocks and had stationed a significant portion of them in East Germany.[84]

There are no indications that East Germany had an offensive CW program. Hence, it is coded as not pursuing or possessing.

Egypt

Horowitz and Narang[85] code Egypt as pursuing from 1945-1962 and acquiring in 1963. It is unclear why they code Egypt as pursuing since 1945 as two of three sources they cite trace the start of Egypt's chemical weapons program back to the early 1960s.[86] The third source merely states that "during the 1950s [Egypt] made efforts to recruit wartime CW workers from Germany, according to one who declined the offers made."[87] It is not specified for which purposes these workers were being recruited, nor does this indicate that Egypt was already pursuing chemical weapons (by means of an indigenous program or attempts to purchase weapons or weapons components abroad) by that time, let alone in 1945. Contemporary Israeli intelligence reports found no evidence of German

80 Ibid.

81 Irak: NVA übte Gaskrieg [Iraq: NPA practiced gas warfare] 1990.

82 The Eritrean People's Liberation Front (EPLF) alleged that an East German nerve agent was shipped to Ethiopia. See, Burck and Flowerree 1991, 445. This charge and other reports that Ethiopia used chemical weapons during its conflicts with Somalia and Eritrea were unsubstantiated (see entry on Ethiopia below). In the early 1960s it was also reported that East Germany had supplied Cuba with "large quantities of materials for chemical warfare," although this most probably concerned defensive clothing and equipment. Ibid., 486f.

83 Clarke 1988, 2.

84 Stockholm International Peace Research Institute 1973, vol. II, 176.

85 Horowitz and Narang 2014.

86 (Center for Nonproliferation Studies, 2008, citing Cohen, 2001; Shoham, 1998)

87 Stockholm International Peace Research Institute 1973, vol. II, 240.

scientists working for an Egyptian CBW program.[88] Horowitz and Narang's acquisition coding seems to be derived from allegations that Egypt used CWs during its intervention in the 1963-1967 Yemeni civil war. However, the CWs used by Egyptian forces in Yemen were most likely not developed indigenously, but were provided by the Soviet Union and possibly also included old CW stocks left behind by the British.[89]

Most available sources agree that Egypt's interest in CWs was spurred by Israel's efforts to obtain a nuclear deterrent in the 1950s and early 1960s. Tucker, for instance, estimates that Egypt "had acquired an indigenous capability to manufacture nerve agents" by 1967.[90] After the 1973 Yom Kippur War, U.S. press reported that the Egyptian leadership was contemplating building a capability to use nerve agent to deter nuclear-armed Israel, while Egyptian scientists expressed concerns about such plans at international conferences.[91] Others estimate that Egypt was producing chemical weapons by the time of the Yom Kippur war, although there is no public evidence to back up these claims.[92] There are also allegations that Egypt provided Syria with complete CW munitions in the run up to the 1973 war.[93] However, there are no reports that substantiate the presence of these weapons in Syria. If any CWs were transferred to Syria they are more likely to have originated from the Soviet Union.[94] Notably, no chemical weapons were used during the 1967 and 1973 wars, despite resounding Israeli victories.

Details about Egyptian CW production facilities are scarce. Claims about CW production mainly revolve around a facility at the Abu Za'abal military industrial complex just outside of Cairo. While the facility was founded in the mid-1960s as a commercial plant named the Company for Chemicals and Insecticides, it is alleged to be run by the Ministry of Defense as the primary CW production factory under the moniker Military Plant No. 801.[95] In the latter half of the 1980s, concerns arose over the purchase of a Swiss-built chemical plant. After delivering the plant, Swiss firm Krebs AG pulled out of the project at the request of the Swiss government because there were concerns that the plant would be used for the productions of CW agents. The charge was denied by the Egyptian government.[96] The U.S. State Department spokesperson stated that the United States "has concerns about the possible uses of this equipment, [but] concerning Egyptian intentions for the equipment, that I could not confirm."[97]

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88 Nuclear Threat Initiative 2010b, 32.

89 Burck and Flowerree 1991, 227; Stockholm International Peace Research Institute 1971, vol. I, 161; Director of Central Intelligence 1983, 10.

90 Tucker 2006, 193.

91 Burck and Flowerree 1991, 222.

92 See, for instance, Carus 1988, 15.

93 Ibid., 4; Shoham 1998, 49.

94 Burck and Flowerree 1991, 213; Director of Central Intelligence 1983, 11.

95 Shoham 1998; Cohen 2001, 41; Tucker 2006, 193.

96 Burck and Flowerree 1991, 228.

97 Goshko 1989.

Statements regarding Egypt's CW program by governments have varied. A declassified 1963 Special National Intelligence Estimate (SNIE) prepared by the U.S. intelligence community concluded that "despite continuing accusations by both [Egypt] and Israel that the other is developing chemical, biological, and radiological weapons of mass destruction" the intelligence community had "no evidence to confirm these charges." Nevertheless, both countries were believed to be able to "produce small quantities of chemical or biological warfare devices designed for clandestine use."[98] The discussion section of the report was completely redacted, making it impossible to conclude whether the intelligence community believed that a CW or BW program existed.

The Israeli government has repeatedly accused Egypt of developing and producing chemical weapons. In November 1963, American officials met with their Israeli counterparts in Washington for two-day talks. During an intelligence sharing session on the Egyptian military, the Israelis alleged that Egypt was producing chemical weapons, but specific types were not mentioned in the summary memorandum. The Americans, in turn, emphasized that Egypt's CW and BW efforts were "on a very limited scale".[99] An Israeli military publication reported in 1986 that Egypt "expanded and improved its chemical weapons arsenal to include agents of nerve gas" after the 1967 war, and "again" began to develop weapons after the 1973 war without identifying the production or stockpiling of CW agents.[100]

A 1993 Russian intelligence report noted that Egypt possessed the scientific and industrial base to produce certain chemical weapons with local and imported raw materials. The report assessed that Egypt had mastered techniques for producing nerve and blister agents. Finally, it judged that Egypt did not possess a CW stockpile sufficient for large-scale operations, although Egypt's industrial potential afforded it the capacity to produce additional weapons in a short amount of time.[101]

U.S. government pronouncements on CW activity in Egypt, a key American ally in the Middle East since the early 1970s, have been relatively muted. Officials, for instance, refused to publicly confirm or denounce allegations of Egyptian CW use in Yemen, possibly due to concerns that a strong reaction would provoke backlash over continued American use of tear gas and herbicides in Vietnam.[102] During a 1975 hearing before the House Armed Services Committee, Lieutenant General Howard H. Cooksey, the U.S. Army Deputy Chief of Staff, was asked whether there was "any evidence, or any intelligence at all, that the Egyptians were equipped to use chemical warfare in the Yom Kippur War?", answering "no, none".[103] A 1983 SNIE described Soviet training and CW materiel provided to Egypt, but did

98 Director of Central Intelligence 1963, 2.
99 Sirrs 2006, 125f.
100 Burck and Flowerree 1991, 224, 226.
101 Foreign Intelligence Service of the Russian Federation 1993.
102 Tucker 2006, 194.
103 U.S. House Committee on Armed Services 1975, 4203.

not comment on any indigenous development or production of CW.[104] A 1985 CIA research paper on the Egyptian arms industry did not discuss CBW, but indicated that Egyptian "chemical and biological warfare production facilities are operated independently from the defense production sector."[105] During a testimony to a congressional subcommittee in 1991, Rear Admiral Thomas Brooks identified Egypt as "probably possess[ing]" an "offensive CW capability".[106] Finally, periodic reports by U.S. government and intelligence agencies from the 1990s and 2000s made no reference to Egypt in relation to chemical weapons at all.[107]

Egyptian officials have routinely denied developing, producing, possessing, and using chemical weapons. In 1988, the Egyptian ambassador to the Conference of Disarmament made a formal declaration that Egypt did not "produce, develop, or stockpile" any CWs.[108] Responding to allegations that a Swiss-built chemical plant in Egypt was to be used for producing chemical weapons, a U.S. government official said that President Mubarak had "very emphatically made clear that his government was not, repeat not, involved in the production of chemical warfare weapons."[109] An Egyptian Defense Ministry spokesman also denied the charges, adding that Egypt did not have a CW production plant and had no intention to build one.[110] Regionally, Egypt has been an outspoken advocate for a complete prohibition on WMDs, launching a plan for a WMD-free zone in the Middle East (MEWMDFZ) in 1990 and advocating for a decision on a MEWMDFZ as part of the deal to indefinitely extend the Nuclear Non-Proliferation Treaty in 1995.[111] While Egypt was involved in negotiations of a ban on chemical weapons, it has made its accession to the CWC conditional upon Israel joining the NPT. Moreover, as Burck and Flowerree note, Egypt has (unofficially) held the position that although all CWs should be eliminated in the long-term, certain states may have a real need for a CW deterrent in the meanwhile.[112] In Egypt's case, and the Arab-world more broadly, this pertains specifically to Israel's possession of nuclear weapons. Indeed, Egyptian officials have regularly attempted to deter Israeli nuclear weapons use by raising the possibility of resorting to chemical and biological weapons.[113] In 1990, Egypt performed a National Trial Inspection on one of its civilian chemical plants in preparation for the upcoming CWC. The report Egypt subsequently submitted to the

104 Director of Central Intelligence 1983.

105 Directorate of Intelligence 1985, 1, fn. 1.

106 U.S. House Committee on Armed Services 1991, 107.

107 See, for instance, Deputy Director of National Intelligence for Analysis 2006a; Deputy Director of National Intelligence for Analysis 2008; Director of Central Intelligence 2001a; Director of Central Intelligence 2001b; Director of Central Intelligence 2003b; Director of Central Intelligence 2004; Director of National Intelligence 2012; U.S. Department of Defense 1997; U.S. Department of Defense 2001; U.S. Department of Defense 2000; U.S. Department of Defense 2002.

108 Henckaerts and Doswald-Beck 2005, vol. II, 1690.

109 Ottaway 1989.

110 Cowell 1989.

111 Harris 1992, 88.

112 Burck and Flowerree 1991, 231.

113 Shoham 1998.

Conference on Disarmament stated that while Egypt does not produce or possess CWs, the unidentified plant "is fully capable of producing chemical weapons of all kinds."[114] The first acknowledgement of involvement with CWs came in 1990, when an unnamed senior official admitted that Egypt had used chemical weapons against Royalist forces during the war in Yemen.[115] The closest thing to an inside look into Egypt's CW program can be found in a book by influential Egyptian journalist, and Nasser confidante, Mohammed Heikal. Relying on information from the CW program's unnamed former project manager, Heikal describes how a group of scientists began working out of an insecticide factory on the outskirts of Cairo—possibly, the aforementioned Abu Za'abal Company for Chemicals and Insecticides.[116] A breakthrough in 1962-1963 led to the production of mustard agent.[117] Although work was carried out in preparation for the 1973 war, a political decision was taken not to use CWs even though, by that time, Egypt was already producing Sarin and VX armed artillery shells and bombs, and was reportedly working on binary weapons.[118] According to the former manager, the entire CW program was terminated after the 1973 war.[119] The pesticide factory's CW branch supposedly restarted its work in 1981 after Iraq offered it a US$12 million contract, but was later ordered to stop by President Sadat.[120]

While there have been allegations that Egypt has pursued and produced chemical weapons since the 1960s, it is difficult to verify these claims and to settle on definitive dates for milestones. As Burck and Flowerree note, "the public record contains only a few, contradictory allegations that Egypt has produced warfare-related chemicals, and few details that support the allegations of a current stockpile."[121] Hence, allegations about an offensive CW program stem primarily from Egypt's CW use in Yemen, Egypt's technical-scientific and industrial base, and ambiguous public pronouncements by its officials about the utility and desirability of a CW deterrent. There is very little information available from those in the know, other than the unnamed former manager of the CW project cited by Heikal.[122] Despite the source being anonymous, it is plausible that Heikal had access to such individuals due to his close relationship with the Egyptian political and military establishment. Hence, it is possible, but uncertain, that Egypt had started pursuit towards the end of the 1950s and commenced with production of chemical weapons around 1963. This would leave unanswered whether such weapons were used in Yemen, or that those were of Soviet and/or British origin as widely reported over the years. Accordingly, possession may have lasted until after the Yom Kippur War, when Sadat supposedly ordered the program to

114 Burck and Flowerree 1991, 228; Henckaerts and Doswald-Beck 2005, vol. II, 1690.
115 Claiborne 1990.
116 Heikal 1992, 72–73.
117 Ibid., 72.
118 Ibid., 72–73.
119 Ibid., 73.
120 Ibid.
121 Burck and Flowerree 1991, 226.
122 Heikal 1992.

be stopped, although it is unclear whether this should be taken to mean that existing stocks were retained or destroyed. Moreover, it is also unclear whether offensive research persisted after this time. Going off on Egypt's ambiguous pronouncements on CWs it is possible that the CW R&D program continued without the actual production of weapons—but with the ability to quickly produce and stockpile if a political decision were taken—constituting the resumption of pursuit in 1974 until the present.

Based on the foregoing, Egypt is coded as starting pursuit in 1958. Egypt is coded as possessing from 1963 until somewhere in 1974. From 1974 onwards, it is coded as pursuing. However, it bears repeating that these dates are uncertain and the available information could be interpreted in such a way that different conclusions are reached.

Ethiopia

Horowitz and Narang[123] code Ethiopia as pursuing from 1980-1993, citing three sources[124] and providing no further explanation. The OTA report only indicates that five out of eleven consulted sources suspected Ethiopia of having a chemical weapons program.[125] Kerr, on the other hand, makes no mention at all of Ethiopia in relation to CW activity.[126] Finally, Burck & Flowerree discuss reports of alleged Ethiopian use of chemical weapons during conflicts it was involved in from the end of the 1970s through the early 1990s (for which they find no substantiated press reports), but make no mention of Ethiopia pursuing chemical weapons.[127] Therefore, it is unclear on which grounds Horowitz and Narang code Ethiopia as pursuing chemical weapons, particularly in the specific period 1980-1993. Other than a testimony delivered by U.S. Rear Admiral Thomas Brooks to a congressional subcommittee in 1991, identifying Ethiopia as "probable" possessor,[128] little other evidence seems to be available to support the assessment that Ethiopia pursued or possessed chemical weapons.[129] Hence, Ethiopia is coded as not pursuing.

France

Horowitz and Narang[130] code France as possessing chemical weapons from 1945-1993 based on a SIPRI volume.[131] This volume, however, only discusses the state of French activities in the period leading up to its publication in 1973. It is likely that Horowitz and

123 Horowitz and Narang 2014.
124 Burck and Flowerree 1991; Kerr 2008; Office of Technology Assessment 1993a.
125 Office of Technology Assessment 1993a, 80.
126 Kerr 2008.
127 Burck and Flowerree 1991, 443–50.
128 Center for Nonproliferation Studies 2008, n. 16.
129 Burck & Flowerree note that Ethiopia has no ability to produce CW agents and that no reports of use or existence of stockpiles can be substantiated. They conclude by expressing "doubt [about] the existence of any offensive CW capability." See Burck and Flowerree 1991, 450.
130 Horowitz and Narang 2014.
131 Stockholm International Peace Research Institute 1973, vol. II.

Narang settled on the end date because France signed the CWC in 1993.

Although much has been written on France's arms policies, the literature on its chemical weapons program is extremely scant. France developed and used CWs in WWI and at the start of WWII it had a stockpile of mustard and phosgene ready for use.[132] France continued developing, producing, and stockpiling chemical weapons at least until the mid-1980s.[133] A SIPRI volume from mid-1980s noted that France was the only NATO country other than the United States to possess a significant stock of chemical weapons, estimating it at about 435 tons of CW agent (but providing no source for this assessment).[134] In 1987, the French government announced a rearmament plan, focused on the production of binary nerve agents.[135] However, this effort was reportedly suspended later that year by President Mitterrand in anticipation of the conclusion of a global chemical weapons convention.[136] In a September 1988 speech before the UN General Assembly, Mitterrand for the first time officially declared that France did not possess any chemical weapons (anymore).[137] Furthermore, Mitterrand stated that France was ready, "as of this moment to renounce any possibility of producing chemical weapons" as soon as the CWC entered into force.[138] This was reiterated in February 1989 during a session of the CD by Foreign Minister Dumas, who stated that "France possesses no chemical weapons and will not produce any once the convention enters into effect."[139] In April 1989, Dumas wrote in an article for the *NATO Review* that France "was carrying out research aimed at maintaining a capability in [non-binary chemical weapons] but, in view of present circumstances, is not intending to go beyond that."[140]

France signed the CWC in 1993 and ratified it in 1995. As it did not declare any chemical weapons stocks in its initial declaration under the CWC (but did declare former CW production facilities), it is assumed that its stocks were destroyed earlier. This may have indeed happened prior to Mitterrand's statement of non-possession at the UN in 1988. Considering the 1987 plans to develop binary CWs, it is possible that destruction of stocks happened in the first half of 1988. Hence, France is coded as ending possession in 1988. Considering Mitterrand's and Dumas' statements about continued research aimed at maintaining a capability to produce CWs until a convention would come into effect, France is coded as pursuing from 1988 onwards. It is not clear when pursuit ended exactly. Hence, France is coded as ending pursuit in 1993, when it signed the CWC.

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132 Stockholm International Peace Research Institute 1971, vol. I, 291.
133 Tucker 2006, 234, 269.
134 Turner and SIPRI 1985, 53.
135 Lewis 1987.
136 Tucker 2006, 269.
137 Utgoff 1991, 123f.
138 News Chronology – September 1988 Through Mid-January 1989 1989, 7.
139 News Chronology – December 1988 Through March 1989 1989, 11.
140 News Chronology – March 1989 Through June 1989 1989, 6.

India

Horowitz and Narang[141] code India as possessing chemical weapons from 1947 up to and through 2000 (the end date of their study). Of the two sources they consulted, only one makes reference to the possible origins of Indian CW possession.[142] It comments that "according to one published report, India's stockpile of chemical weapons consists of mustard gas shells left by the British of World War II vintage." The same report, however, also states that "India is said to have acquired chemical weapons in the 1980s." No sources are provided to support either of these statements.

The details surrounding India's CW program are scarce. Some sources indicate that India may have inherited WWII stocks from the United States[143] or British produced agents from the interbellum.[144] India ratified the CWC in 1996 and in 1997 declared that it possessed 1,044 tons of sulfur mustard and declared some small-scale manufacturing facilities.[145]

India's CWC declaration came as a surprise since it had long maintained publicly that it did not have an offensive CW program. In 1979, the Indian ambassador to the Conference on Disarmament (CD) stated that "India does not have chemical weapons in its stock and … we do not have any intention of going in for such stocks." In 1981, his successor to the CD said that "Soon after gaining independence, India abjured the production and use of chemical weapons." Similar statements were offered in following years.[146] India's policy of denying any involvement with offensive aspects of chemical warfare was formalized in a 1992 agreement with Pakistan, which not only prohibited the development, production, and possession of chemical weapons, but also categorically denied CW possession.[147]

India has maintained a high level of secrecy surrounding its CWC declaration and destruction program.[148] Similarly, very limited information is available about India's offensive CW program. U.S. government agencies and officials have rarely commented publicly on Indian CW activities and the few public statements that are available paint an ambiguous picture. During a 1989 Congressional testimony, Rear Admiral Thomas Brooks counted India among a group of thirteen "Third World states [that] are developing or have achieved CW capabilities".[149] Two years later, Brooks testified that India was one of the countries that "probably possess[es]" an "offensive CW capability," noting that "India […] has a large industrial infrastructure, including fertilizer manufacturing plants, that could be redirected toward the production of chemical agents."[150] Moreover, an unnamed

141 Horowitz and Narang 2014.
142 Namely, Federation of American Scientists 1999a.
143 Burck and Flowerree 1991, 360.
144 Federation of American Scientists 1999a.
145 Ibid.; Nuclear Threat Initiative 2015j.
146 Burck and Flowerree 1991, 359.
147 India-Pakistan Joint Declaration on the Complete Prohibition of Chemical Weapons 1992.
148 Patel 2016, 269, n. 14.
149 U.S. House Committee on Armed Services 1989, 39.
150 U.S. House Committee on Armed Services 1991, 106f.

administration official told a *New York Times* journalist who covered the testimony that "there was no firm proof in the case of India and Pakistan".[151] In other words, it seems that at the time the U.S. intelligence community did not yet judge that India possessed chemical weapons. The Russian Foreign Intelligence Service's 1993 WMD report does not provide any further evidence other than the assessment that "the armed forces of India have chemical weapons".[152]

The open literature is extremely scant on information relating to the genesis and development of India's CW program. Burck and Flowerree comment primarily on India's CW R&D capability and defensive CW work, but conclude that it is "years away from a capability for waging [chemical warfare]".[153] SIPRI's volumes on CB weapons from the early 1970s do not mention any offensive CW work in India.[154] Furthermore, the SIPRI yearbooks make hardly any significant mention of an Indian CW R&D program in the period 1968-1986.[155] Similarly the Nuclear Threat Initiative entry on India contains no information on India's CW program prior to its CWC declaration.[156]

If it is indeed so that India inherited its entire stock from the United Kingdom after WWII, no acquisition decision can be recorded at all. Moreover, any inherited stocks of mustard would have become ineffective after some years. However, it would seem more plausible that if India's case were limited to inherited stocks and facilities that it would have declared them as abandoned to the OPCW the same way that China has declared abandoned stocks of Japanese chemical weapons from WWII. It is likely that if India had an independent offensive CW program, it would have started years later. Due to the lack of information, it is not possible to specify a start date for India's pursuit and possession of chemical weapons. Hence, India is only coded as ending possession in 1997 when it first submitted a declaration to the OPCW.

Iran

Horowitz and Narang[157] code Iran as pursuing in 1983 and possessing from 1984 up to and through 2000. As the Nuclear Threat Initiative notes, it is difficult to evaluate Iran's CW status as all public assessments of Iran's alleged CW program consist of "repackaged information from a limited number of sources," in particular from certain opposition

151 Engelberg and Gordon 1989; see also Engelberg 1989.

152 Foreign Intelligence Service of the Russian Federation 1993.

153 Burck and Flowerree 1991, 361.

154 Stockholm International Peace Research Institute 1971, vol. I; Stockholm International Peace Research Institute 1973, vol. II.

155 Only one significant reference is found in the 1982 edition of the SIPRI yearbook, see Stockholm International Peace Research Institute 1983, 407. This entry mentions a West German newspaper reporting Indian CW weapons as though they are well known to everyone, while they are not. See Burck and Flowerree 1991, 359f.

156 Nuclear Threat Initiative 2015j.

157 Horowitz and Narang 2014.

groups and Western intelligence agencies.[158]

Of the four sources Horowitz and Narang cite, only one[159] mentions particular years that account for the 1983 and 1984 coding decisions. This source notes that a Defense Intelligence Agency (DIA) report[160] alleges that "Iran's offensive chemical warfare program began in 1983 in response to Iraq's use of mustard gas against Iranian troops" and that "Iran has been producing chemical agents at a steadily increasing rate since 1984." However, evidence that Iran possessed or even used chemical weapons at this stage of the war with Iraq—as was routinely alleged at the time—are extremely thin.[161] The first few years of the war Iran was preoccupied with procuring second-hand and black-market equipment and spare parts for the weapons systems it inherited from the Shah-era and little, if any, attention would have been paid to chemical weapons.[162] It is likely that Iran only started considering chemical weapons after Iraq intensified CW use towards the end of 1983. In 1983 and 1984 Iraqi chemical offensives caught Iran unprepared in both equipment and training, as the Iranians lacked protective equipment and received little training in operating under conditions of chemical warfare.[163] Iran scrambled in 1983 and 1984 to procure necessary protective equipment, but these endeavors were mostly unsuccessful and Iran seemed to have only managed to sufficiently protect its troop by 1985 or 1986.[164] It is unlikely that Iran would have exerted any serious efforts to develop its own chemical weapons at a time when it was not even able to adequately protect its own troops against chemical weapons. Around this time Iranian officials began to publicly hint that Iran could develop CWs and could take the decision to retaliate in kind in the future if the international community would not take action against Iraqi CW-use.[165] Hence, it is plausible that Iran's pursuit started in 1985.

In November 1998, Iran formally declared that it had acquired chemical weapons in the latter stages of the Iran-Iraq War. In a statement to the Conference of State Parties to the CWC, Iranian Ambassador Mohammad Alborzi stated that "following the establishment of [the 1988 ceasefire], the decision to develop chemical weapons capabilities was reversed and the process was terminated."[166] A subsequent report by the Organisation for the Prohibition of Chemical Weapons (OPCW) indicated that Iran had declared two CW production facilities by 1999 that were certified as destroyed.[167] Although Iran's CWC declaration is not publicly available, some of its contents can be gleaned from communications between the U.S. government and Iran. A diplomatic cable made public by WikiLeaks, reveals the

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158 Nuclear Threat Initiative 2015h.
159 Namely, Iran Watch 2005.
160 Namely, U.S. Department of Defense 1996, 15.
161 Zanders 2001; Burck and Flowerree 1991, 237–266.
162 Zanders 2001.
163 Burck and Flowerree 1991, 250f.
164 Zanders 2001; Burck and Flowerree 1991, 250–252.
165 Burck and Flowerree 1991, 238f.
166 Alborzi 1998.
167 OPCW 2003a.

Iranian government's answers to questions about Iran's CWC declarations.[168] Iran declared that it had produced 20 MT of sulfur mustard and 4 MT of nitrogen mustard from 1987 until 1988. Iran, furthermore, indicated that it destroyed its stock of nitrogen mustard between September 1990 and February 1991 and its stock of sulfur mustard between September 1991 and February 1992.

From the 1990s until around 2003, a number of unclassified U.S. intelligence reports asserted that Iran had an active offensive CW program. Many of these "described specific military capabilities related to agent stockpiles, delivery systems, and deployments that cannot be independently verified in open sources."[169] From 2003 onward, however, these reports show a decline in certainty regarding Iran's CW status.[170] For instance, a 2000 unclassified Section 721 report to Congress alleged that Iran "has manufactured and stockpiled several thousand tons of chemical weapons, including blister, blood, and choking agents, and the bombs and artillery shells for delivering them."[171] While other Section 721 reports from the 1997-2002 period contain similar assessments, the two reports from 2003 contain more cautiously worded assessments. Instead of asserting that Iran "has" stockpiled CW agents, the first 2003 report noted that Iran "likely has already stockpiled" them.[172] The report over the second half of 2003, takes an even more cautious tone by remarking that Iran "may have already stockpiled" CWs.[173] Certainty was further reduced in the 2004 report, which removed all references to stockpiles and delivery systems, instead noting that Iran "continued to seek production technology, training, and expertise from foreign entities that could further Tehran's efforts to achieve an indigenous capability to produce nerve agents."[174] With the exception of the 2006 report—which details that "Iran maintains a small, covert CW stockpile"[175]—all Section 721 reports in the period 2005-2011 have removed all references to stockpiles.[176]

This change in tone is also evident in other U.S. governmental assessments since 2003, such as State Department compliance reports and Congressional testimonies by intelligence officials.[177] For instance, in February 2003, the Director of the DIA, Vice-Admiral Jacoby, testified that Iran "maintains a stockpile of chemical warfare agents and may have weaponized some of them into artillery shells, mortars, rockets, and aerial

168 U.S. Embassy in The Hague 2004.
169 Nuclear Threat Initiative 2015h.
170 Ibid.; Cordesman and Seitz 2009, 144–45; Binder 2008.
171 Director of Central Intelligence 2001a.
172 Director of Central Intelligence 2003b.
173 Director of Central Intelligence 2004.
174 Deputy Director of National Intelligence for Analysis 2006a.
175 Deputy Director of National Intelligence for Analysis 2008.
176 The charge in the 2006 report relates to the uncertainty of unilateral weapons disposal before the entry into force of the CWC in 1997. Such uncertainty, however, is not expressed in other cases (e.g. France). I thank Jean Pascal Zanders for making this point.
177 Binder 2008; Nuclear Threat Initiative 2015h.

bombs."[178] In 2007, Jacoby's successor, Lieutenant General Maples, merely noted that "Iran has a large and growing commercial chemical industry that could be used to support a chemical agent mobilization capability."[179]

It is evident that the U.S. intelligence community has significantly adjusted its assessments of Iran's chemical weapons status since 2003. In recent years, unclassified reports and testimonies have drawn attention to Iran's capability to produce chemical warfare agents and its acquisition of dual-use technologies that could advance its production capability of such agents. Iran's ability to produce chemical warfare agents is the logical consequence of its large chemical industry and dual-use items by themselves are not evidence of a chemical warfare program due to their legitimate civilian applications. Despite all this, Horowitz and Narang conclude that Iran continued to possess CWs until the end date of their study. Their conclusion is based on two sources,[180] which in turn heavily cite the aforementioned U.S. intelligence/government assessments from the 1990s and early 2000s. This is all the more surprising since another source they consult explicitly stresses that no evidence could "be found to confirm these accusations" and draws attention to the U.S. intelligence community downgrading its assessments of Iran's CW capabilities.[181]

In light of Iran's CWC declarations and its communications about said declarations with the U.S. government, the OPCW's implementation report, and a lack of credible public sources supporting the assessment of Iran continuing to possess CWs after the Iran-Iraq War, possession of chemical weapons is coded as ending late 1991 or early in 1992.[182]

Iraq

Horowitz and Narang[183] code Iraq as pursuing CWs from 1971-1979 and possessing from 1980-2000. In 1981 Iraq decided to produce and deploy chemical weapons, and to that end established Project 922 under auspices of the Ministry of Defense, with production of agents starting that same year and agent weaponization and filling of munitions commencing in 1983.[184] Hence, Iraq is recoded as pursuing from 1971-1982 and acquisition starting in 1983.

It is unclear why Horowitz and Narang code Iraq as continuing to possess chemical weapons up to and through the year 2000.[185, 186] Among their sources is the final report of the Iraq Survey Group (ISG)—known as the Duelfer Report—which was tasked by the

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178 Director of the Defense Intelligence Agency 2003.

179 Director of the Defense Intelligence Agency 2007.

180 Center for Nonproliferation Studies 2008; Iran Watch 2005.

181 Center for Nonproliferation Studies 2006.

182 The choice between the two years is mostly relevant for further empirical analysis. If, for instance, the country-year is taken as the unit of analysis, then (late) 1991 will be the more appropriate choice.

183 Horowitz and Narang 2014.

184 Duelfer 2005b, 6ff.; UNMOVIC 2007, 56ff., 179–80.

185 While the end date of the study is the year 2000, it is likely that the authors assume that Iraq continued to possess CWs until the United States-led coalition invaded Iraq in 2003.

186 The authors do present 1991 as an alternative specification for the end of possession.

United States government after the 2003 invasion to locate the weapons of mass destruction (WMD) allegedly possessed by Iraq. The ISG's final report judged "that Iraq unilaterally destroyed its undeclared chemical weapons stockpile in 1991" and found "no credible indications that Baghdad resumed production of chemical munitions thereafter".[187] Hence, Iraq is coded as possessing chemical weapons until 1991.

Israel

Horowitz and Narang[188] code Israel as pursuing from 1952-1955 and possessing from 1956 up to and through 2000 based on five sources.[189]

As Cohen describes, a unit devoted to biological and chemical warfare (known by its Hebrew acronym HEMED BEIT) was set up in 1948 under the Israel Defense Force's Science Corps (HEMED).[190] In a 1993 interview, Ephraim Katzir, the first former commander of HEMED and later president of Israel, stated the following on the rationale behind the founding of HEMED BEIT: "we planned various activities, to get a sense what CBW is and how could we build a potential [in this area] should there be a need for such a potential."[191] In 1952, HEMED's wartime work was converted into 'Machons,' a group of research centers sponsored by the Ministry of Defense. That year saw the establishment of the Israel Atomic Energy Commission (IAEC; which assumed the work in the nuclear field) and the Israel Institute of Biological Research (IIBR; a merger of HEMED BEIT and another chemistry-oriented Machon) focusing on chemical and biological R&D. As Cohen contends, it is doubtful that a distinction was made between defensive and offensive research at the time.[192] When David Ben-Gurion returned to government in early 1955 as defense minister, he initiated the development of two options of last resort, one for the long term (nuclear weapons) and one for the short term. While the Israeli leadership considered nuclear weapons to be the country's ultimate guarantor in the first half of the 1950s, operational nuclear weapons would take a long time to develop.[193] Therefore, Ben-Gurion ordered a crash project to develop chemical weapons as "a cheap non-conventional capability" to be operationalized as soon as possible and before another war with Egypt would break out.[194] Reportedly, Ben-Gurion held a close eye on the project, which "involved a crushing timetable, procurement of equipment and material from overseas, and the conversion of research facilities—as well as commercial plants—to production."[195]

187 Duelfer 2005b, 1.
188 Horowitz and Narang 2014.
189 Burck and Flowerree 1991; Center for Nonproliferation Studies 2008; Cohen 2001; Kerr 2008; Stockholm International Peace Research Institute 1973, vol. II.
190 Cohen 2001.
191 Ibid., 30.
192 Ibid., 33.
193 Cohen 1999, chap. 3.
194 Cohen 2001, 40f.; Nuclear Threat Initiative 2015f.
195 Cohen 2001, 40f.

Burck & Flowerree have described several sources that indicate that the U.S. government has believed at least since the early 1970s that Israel has an offensive CW program.[196] During a 1974 hearing before Congress, General Almquist testified that Israel had admitted to having an offensive CW capability.[197] The *Washington Times* reported in 1988 that “the existence of chemical test grids [in Israel] has been known since the early 1970s, and possible tests were detected in January 1976,” citing a “secret CIA report”.[198] The “secret CIA report” referred to seems to be the 1983 Special National Intelligence Estimate (SNIE) on “Implications of Soviet Use of Chemical and Toxin Weapons for U.S. Security Interests”, which was approved for release in redacted forms in 2008 and 2009.[199] The discussion of Israeli CW activities was completely removed from the SNIE, but an unredacted version of the page was accidentally discovered at the Ronald Reagan Presidential Library.[200] In addition to the existence of “chemical test grids,” the report noted that “several indicators lead [the CIA] to believe that [the Israelis] have available to them at least persistent and nonpersistent nerve agents, a mustard agent, and several riot-control agents, matched with suitable delivery systems.”[201] Furthermore, “a probable CW nerve agent production facility and a storage facility” were identified in the Negev Desert, while “other CW agent production is believed to exist within a well-developed Israeli chemical industry”.[202] A U.S. defense journal reported in 1989 that, according to unnamed U.S. government officials, Israel’s “recently accelerated [offensive program] *will involve* a major plant located in the Negev,” which will be producing “far more sophisticated nerve agents”.[203] The Russian Foreign Intelligence Service’s 1993 WMD report noted that the “development of chemical weapons in Israel began in the mid-1960s,” adding that it “has a stockpile of its own chemical weapons”.[204]

Details about Israel’s CW program are scarce. As Barak noted, this is due to the overwhelming focus on Israel’s nuclear activities (both within as well as outside Israel) combined with the government’s refusal to publicly confirm or deny CW possession.[205] Israel’s ambiguous CW policy is buttressed by its signing of the CWC but subsequent refusal to ratify it. Notably, a 1998 newspaper reported that crews of Israeli F-16 fighter jets have been trained to load active chemical or biological weapons on their aircraft within minutes of receiving an order to engage. The report also quoted a former biologist who held a senior post in Israeli intelligence as saying that “There is hardly a single known or unknown form

196 Burck and Flowerree 1991, 192–94.
197 Ibid., 192.
198 Ibid., 193.
199 Director of Central Intelligence 1983.
200 Aid 2013.
201 Ibid.; Director of Central Intelligence 1983, 11.
202 Aid 2013; Director of Central Intelligence 1983, 11.
203 Burck and Flowerree 1991, 193.
204 Foreign Intelligence Service of the Russian Federation 1993.
205 Barak 2003, 122f.

of chemical or biological weapon . . . which is not manufactured at the institute."[206]

Clues about Israel's continued interest in offensive chemical warfare can also be found in the dual-use applications of Israeli research into toxic chemicals.[207] A SIPRI volume on CB warfare noted in the 1970s that scientists at the IIBR and other Ministry of Defense-affiliated research centers "have published on topics that relate to CBW problems, and for one such publication it is hard to see much rationale except in connection with V-agent synthesis."[208] Dutch reporter Karel Knip searched digital databases of medical literature for unclassified research conducted by around 140 IIBR-affiliated scientists over a period of nearly 50 years.[209] Knip's analysis revealed that from its early days the institute was "involved in an extensive effort to identify practical methods of synthesis for nerve gases (such as tabun, sarin, and VX) and other organophosphorus and fluorine compounds."[210] In 1996, the Dutch government revealed that the El Al cargo plane that crashed in an Amsterdam suburb in 1992 was carrying 190 liter of DMPP, a precursor material for the nerve agent sarin, intended for the IIBR, which was described merely as "flammable liquid" on the plane's manifest.[211]

It is clear that Israeli leaders have had an interest in the offensive applications of chemical warfare that can be traced back to the days before the founding of the state of Israel, as evidenced by the founding of HEMED BEIT in 1948, its continuation in the form of the IIBR in 1952, and the stated mission of keeping the CBW option open. The period starting in 1948 can be considered as the start of exploration of a CW option. Israel seems to have initiated a crash development effort under orders of Ben-Gurion in 1955, constituting the start of pursuit. It is likely that this yielded an initial offensive warfare capability by the year 1956. It is unclear from the available evidence whether Israel still has an offensive CW program, due to the secrecy in which the program is shrouded and the policy of ambiguity that is maintained by the government. At the same time, there are no indications that Israel ever halted its offensive CW program. Hence, Israel is coded as starting pursuit of chemical weapons in 1955 and start of possession in 1956 (up to and through the end date of this study).

Kazakhstan

Horowitz and Narang[212] code Kazakhstan as possessing chemical weapons from 1991 up to and through 2000. Their coding is based on Kerr, who simply states that Kazakhstan is

206 Mahnaimi 1998.

207 As Cohen notes, bibliographical surveys are a great tool for "reconstructing the institutional research interests at IIBR," but reveal little about unclassified activities such as development and weaponization. See Cohen 2001, 39. In isolation, however, such surveys do not tell us whether Israel has an offensive CW program.

208 Stockholm International Peace Research Institute 1973, vol. II, 242.

209 Knip 1999.

210 Cohen 2001, 38; Knip 1999.

211 Van den Berg and Knip 1998.

212 Horowitz and Narang 2014.

suspected of having a "chemical weapons capability" without any sourcing.[213] Kerr adds in a note that "Kazakhstan reportedly retained some Soviet-era CW stockpiles.[214] However, evidence of Kazakh CW possession is thin or nonexistent. Worries regarding the country's CW status revolve primarily around the Pavlodar chemical plant.[215] Though the plant was intended to produce warfare agents, its construction was halted in 1987 due to Moscow's involvement in negotiating the CWC.[216] Moreover, in a 1997 report the U.S. Department of Defense noted that Kazakhstan has "no chemical warfare program.[217] Hence, Kazakhstan is coded as not possessing (or pursuing) chemical weapons.

Laos

Horowitz and Narang[218] code Laos as pursuing chemical weapons from 1988-1993 based on the OTA report, which finds Laos mentioned as a suspect in 2 out of 11 surveyed sources.[219] The first source, a pair of articles by Thom Shanker in the *Chicago Tribune*, notes that "intelligence sources, diplomats and academic analysts say the roster of those known or suspected to possess and be developing chemical weapons" includes, among others, Laos.[220] The second source includes Laos in a list of "doubtful chemical weapons states."[221] Horowitz and Narang seem to recognize that the OTA report provides very thin evidence to support their pursuit coding and include no pursuit as an alternative specification supported by skepticism expressed by Burck & Flowerree's skepticism.[222] Hence, Laos is coded as not pursuing.

Libya

Horowitz and Narang[223] code Libya as pursuing CWs from 1976-1980 and possessing from 1981 up to and through 2000 based on three sources.[224] However, upon inspection of these sources it is not evident why the authors settle on these dates.

None of Horowitz and Narang's sources contain any references to the year 1976 in connection with the start of Libya's CW program. It similarly remains a mystery why they code Libya as acquiring CWs in 1981. Their first source makes no reference to this

213 Kerr 2008, 20.
214 Ibid., 21. Kerr does not mention where this is reported.
215 Federation of American Scientists n.d.
216 Bozheyeva 2000.
217 U.S. Department of Defense 1997.
218 Horowitz and Narang 2014.
219 Office of Technology Assessment 1993a, 80.
220 Shanker 1989a; Shanker 1989b.
221 Harris 1989a, 74.
222 Burck and Flowerree 1991, 430–31.
223 Horowitz and Narang 2014.
224 Burck and Flowerree 1991; Center for Nonproliferation Studies 2008; Kerr 2008.

specific year in connection with Libyan CW acquisition.[225] The second source, a report by Kerr, merely states that "Libya declared to the OPCW on March 5, 2004 that it had produced 23 tons of mustard gas at Rabat [*sic*] between 1980 and 1990 and stored those materials at 2 sites", which is too broad a timeframe to justify coding acquisition in 1981.[226] Moreover, this statement is doubtful for two reasons. First, Kerr provides no source to back the assertion that CWs were produced at Rabta between 1980 and 1990. A quick online search revealed that the passage was most likely taken from (but not credited to) a report prepared for U.S. Congress by Squassoni, which in turn cites a press release by the OPCW.[227] While the OPCW press release stated that Libya's declared CW stockpile consisted of 23 tons of mustard agent, it did not specify where and when it was produced. In fact, declarations made by states to the OPCW are confidential by virtue of the CWC's Annex on the Protection of Confidential Information and neither the Libyan authorities nor the OPCW have publicly disclosed such details. Second, construction of the Rabta facility only began in the mid-1980s,[228] which would necessarily place any indigenous CW output in the second half of the 1980s at the earliest. Finally, the only reference to the year 1981 in connection to CW acquisition in Horowitz and Narang's last source[229] concerns a 1983 report by the West German Federal Intelligence Service (*Bundesnachrichtendienst*; BND) that described a Libyan plant at Abu Khammash starting the production of mustard agent at the end of 1981.[230] However, the BND reported in 1984 that no such facility existed at Abu Khammash after all.[231]

Information about the genesis of Libya's CW program, particularly from public sources is limited. What we do know is largely derived from U.S. and West-German intelligence reports from the 1980s about the Rabta chemical facility.[232] In February 1989, the West-German government released the 'Schäuble report,' named after its principal author Wolfgang Schäuble, regarding the involvement of West-German firms in the construction of CW facilities in Libya. The report indicated that the West-German intelligence service BND thought that Libya was developing a plant for the manufacture of CW agents with the help of German experts as early as April 1980, however, adding that the BND did not

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225 Center for Nonproliferation Studies 2008.

226 Kerr 2008, 21.

227 Squassoni states the following: "Libya declared to the Organization for the Prohibition of Chemical Weapons (OPCW) on March 5 that it had produced approximately 23 tons of mustard agent in one chemical weapons production facility (Rabta) between 1980 and 1990 and stored those materials in two storage sites. Libya also declared thousands of unfilled munitions." See Squassoni 2004, 4; OPCW 2004b.

228 Burck and Flowerree 1991, 277; Tucker 2009, 372.

229 Burck and Flowerree 1991.

230 Ibid., 274; Deutscher Bundestag 1989, 4.

231 Burck and Flowerree 1991, 275; Deutscher Bundestag 1989, 4–5.

232 The Rabta facility was identified by Libya as the main CW production site in its declaration to the OPCW in 2004.

rule out the possibility that the facility was a "normal chemical factory".[233] No details about the location of the plant were provided but it is likely that it referred to Abu Khammash, as that was the first alleged CW facility to be explicitly named in the Schäuble report's chronology.[234] However, as discussed above, the BND retracted its assessment regarding Abu Khammash in 1984.[235]

A clearer picture emerges around 1984. The Schäuble report revealed that Ihsan Barbouti, an Iraqi-born engineer living in London, was one of the key figures in the Rabta affair. In an interview with Time Magazine a few weeks after the release of the Schäuble report, Barbouti explained that his company Ihsan Barbouti International (IBI) was contracted by the Libyan government in 1984 to act as a middleman with foreign suppliers.[236] A few weeks later, the German authorities arrested Jürgen Hippenstiel-Imhausen on the suspicion that his namesake company Imhausen Chemie GmbH had violated German export laws by assisting Libya in its quest for chemical weapons. During his 1990 trial, Hippenstiel testified that Imhausen Chemie had indeed secretly assisted Libya by designing and building the Rabta chemical facility after signing a contract with Ihsan Barbouti in September 1984 in the presence of a Libyan delegation.[237] Around the same time, citing a journalistic source close to Asian construction workers, the Bangkok Post reported that construction of the Rabta facility had begun in November 1984 and that the first equipment was installed in 1986.[238]

Details of Libya's CW quest prior to 1984 are murky and based on the available evidence it is difficult to establish whether the Qadhafi regime was seriously pursuing a CW capability before 1984. The West-German's suspicion that Libya was building a CW plant in 1980 is the only significant indication of CW activity predating 1984 and even this assessment was couched in uncertain terms and was devoid of any details or an explicit follow-up. As Wiegele argued, "a thorough chronology, if it could be known" would find "decisional activities that preceded the actual search for equipment and knowledge for the Rabta undertaking."[239] Yet, it is uncertain what the nature of these activities was and at which point they may have crossed the threshold of pursuit. Hence, based on currently available evidence, Libya is coded as starting pursuit in 1984.

Reports of the completion of construction and the start of CW agent production at Rabta are conflicting. The Schäuble report indicates that the BND was made aware by an "allied intelligence service" in the summer of 1987 that the Rabta plant would be completed and start production within weeks.[240] On 12 September 1988, the BND reported that Rabta

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233 Deutscher Bundestag 1989, 4.

234 The Schäuble report referred to a 22 July 1983 BND report.

235 Deutscher Bundestag 1989, 4–5.

236 Birnbaum 1989.

237 Wiegele 1992, 118. Hippenstiel, however, insisted that he was not aware that Rabta was to manufacture chemical weapons.

238 Burck and Flowerree 1991; Wiegele 1992, 50.

239 Wiegele 1992, 129.

240 Deutscher Bundestag 1989, 7.

was not operational yet and on 21 September 1988 the US Embassy in Bonn warned the West German Foreign Office that Libya was about to start "mass production" of chemical weapons.[241] In January 1989, unnamed US officials claimed that small amounts of CWs had been produced at Rabta but that full production had not yet commenced.[242] Assessments seem to have found a conclusion in early 1990, when numerous reports based on U.S. government sources appeared, noting that Rabta had begun limited production of chemical weapons somewhere in 1989.[243] Hence, Libya is coded as acquiring in 1989.

Following months of secret talks with the United States and United Kingdom, Libya announced on December 19, 2003, that it would dismantle its nuclear, chemical, and ballistic missile programs. Libya became a party to the CWC on 5 February 2004, and submitted its initial partial declaration to the OPCW on February 20, followed by its complete declaration on March 5. By March 19th, the OPCW had completed their initial inspection of Libya's chemical program and verified the destruction of its declared stockpile of unfilled munitions.[244] The deadline for complete destruction was initially set to April 29, 2007, but was extended by the OPCW Executive Board in December 2006 (to December 2010) and again in December 2009 (to December 2011).[245] By February 2011, Libya had destroyed 51 percent of its sulfur mustard stockpile and 40 percent of precursor chemicals, while dismantling two of three former CW production facilities and converting one to a pharmaceutical plant.[246] The destruction process was halted in February 2011 due to a defect in the disposal facility and was further delayed when OPCW inspectors left the country in anticipation of NATO-led airstrikes that began in March 2011.[247] In November 2011, the Libyan transitional government declared a small "previously undeclared chemical weapons stockpile", consisting of a few hundred munitions filled with sulfur mustard and a few hundred kilograms of sulfur mustard stored in plastic containers.[248] OPCW inspectors dispatched to Libya in January 2012, found that the newly declared materials were stored at the Ruwagha depot in southeastern Libya, alongside previously declared but not yet destroyed materials.[249] Due to the tumultuous end of the Gadhafi regime and the ongoing unrest in Libya it is difficult to establish whether the recently declared materials were willfully withheld by the Gadhafi regime—after all, they hardly qualify as military significant amounts and they were stored alongside declared materials.

Libya voluntarily decided to shut down its CW production program in 2003 and provided its declaration to the OPCW in 2004. Hence, end of possession is coded in 2004.

241 Ibid., 9.
242 Burck and Flowerree 1991, 277.
243 Ibid., 278–79; Gertz 1990; Zanders 1990, 19.
244 OPCW 2004a; Tucker 2009, 370.
245 Trapp and Walker 2014, 127.
246 OPCW n.d.
247 Vishwanathan 2012, 18.
248 OPCW n.d.
249 OPCW 2012.

The OPCW has certified that Libya destroyed the last of its filled munitions in January 2014, with disposal of remaining agent stockpiles having taken place in 2013.[250]

Mozambique

Horowitz and Narang[251] code Mozambique as pursuing from 1988-1993 based on the OTA report.[252] The OTA report finds Mozambique mentioned in only 1 out of 11 consulted sources,[253] based on allegations made by South-African backed RENAMO guerillas against the Mozambican government and reported by the Washington Times on December 31, 1986. As Burck & Flowerree note, these allegations "against the desperately poor government are of exceedingly low reliability" and they have never been corroborated.[254] Similarly, Harris includes Mozambique in the category of "doubtful chemical weapons states".[255] Moreover, the allegations made against the Mozambique government revolved around the *use* of Soviet-supplied chemicals,[256] which makes the *pursuit* coding peculiar. These allegations provide weak basis to code Mozambique as pursuing chemical weapons and, therefore, it is coded as not pursuing.

Myanmar (Burma)

Horowitz and Narang[257] code Myanmar as pursuing based on a 1991 testimony delivered by Rear Admiral Thomas Brooks before the Subcommittee on Seapower, Strategic and Critical Materials of the U.S. House Armed Services Committee, in which he identified Myanmar as a "probable" possessor of an "offensive chemical weapons capability".[258]

For decades, there have also been allegations of the production and use of chemical weapons by Myanmarese dissident groups. While the reports are persistent, it remains unclear whether "the reports refer to agents recognized under international law as chemical weapons or to riot control agents—the latter is most likely."[259] Moreover, no reports of CW use by Burmese forces have ever been independently verified.[260]

Most information regarding Myanmar's chemical weapons comes from U.S. intelligence sources and is often contradictory. In 1989, Myanmar was named by the Director of Naval Intelligence as one of the countries that was "developing or [had] achieved CW capabilities"

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250 OPCW 2014.
251 Horowitz and Narang 2014.
252 Office of Technology Assessment 1993a, 80.
253 Namely, Harris 1989a, 74.
254 Burck and Flowerree 1991, 468–69.
255 Harris 1989a, 74.
256 Burck and Flowerree 1991, 468.
257 Horowitz and Narang 2014.
258 Center for Nonproliferation Studies 2008. Note the vagueness of the term "offensive chemical weapons capability." This is discussed further in Chapter 2.
259 Nuclear Threat Initiative 2015e, n. 26.
260 Koblentz and Roty 2020.

and in 1991 as one of the countries that "probably possess" an "offensive CW capability".[261] The Staff Director of the Subcommittee on Arms Control, International Security and Science, a leading expert on chemical warfare, however, disputed those assessments, stating that the case against Myanmar was based on circumstantial evidence.[262] Moreover, Burck and Flowerree note that "most of the allegations against [Myanmar] are of little use, with very little reporting of details of an offensive capability, any defensive CW capabilities, or any production capability."[263] The most detailed information about Myanmar's activities can be found in a 1991 National Intelligence Estimate that was declassified in 2012. The NIE reported that Myanmar had a "small chemical weapons production facility, built with West German assistance in the early 1980s" that "originally produced laboratory amounts (about 500 liters) of mustard but now probably is not producing any."[264] Myanmar was also mentioned in a 1992 report by the Defense Intelligence Agency (DIA) report as possessing "chemical weapons and artillery for delivering chemical agents", but the same report a year later indicated that it was no longer developing chemical weapons.[265]

A little noticed unclassified compliance report by the U.S. Department of State that was published in November 2019 provides more details about Myanmar's alleged CW activities. The report states that the United States assesses that Myanmar "had a CW program in the 1980s that included a sulfur mustard development program and chemical weapons production at the facility near Tonbo."[266] It is likely that this refers to the same facility described in the 1991 NIE. The compliance report centers on the US government's assessment that Myanmar failed to declare its past CW program and the Tonbo production facility.[267] The report includes an aerial photograph of the alleged location, indicating that the structure is still intact. The location of the facility and its integrity have recently been independently confirmed using geolocation.[268]

While the U.S. government's information about Myanmar's CW activities has been contradictory and circumstantial at times, it is possible that Myanmar had an active CW program in the 1980s with some minor pilot-scale production of sulfur mustard. There is insufficient information to say precisely when Myanmar's CW program began, other than that the U.S. government believes that a small production facility was built in the early 1980s. Burma can therefore be coded as possessing CWs, albeit nominally, in the latter part

261 U.S. House Committee on Armed Services 1989, 39; U.S. House Committee on Armed Services 1991, 107.
262 Burck and Flowerree 1991, 428f.
263 Ibid., 428.
264 Director of Central Intelligence 1991, 14.
265 Hoogendoorn 1997, 38.
266 Department of State 2019, 2.
267 Ibid.
268 Koblentz and Roty 2020.

of the 1980s.[269] Myanmar is coded as ending possession by 1990.

North Korea

Horowitz and Narang[270] code North Korea as pursuing from 1965-1987 and possessing from 1988 up to and through 2000 (the endpoint of their study) based on four sources.[271] It is unclear why Horowitz and Narang code North Korea as starting pursuit in 1965, as none of their sources specifically mention this year in connection to commencing a CW program.

North Korea started building its CW defenses at the end of the Korean War by setting up a chemical department in the defense ministry.[272] With help from the Soviets, North Korea also embarked on the rapid development of its chemical industry as part of its 'First Five Year Plan' (1957-61).[273] It is possible that North Korea embarked on a quest for an offensive CW capability in 1961 when Kim Il-Sung issued a "Declaration of Chemicalization," which among others declared the need for "strengthening of chemical warfare knowledge".[274] Hence, North Korea is coded as starting pursuit in 1961.

Due to the exceptionally closed nature of North Korean society it is difficult to determine when it acquired chemical weapons. According to the US Department of Defense, North Korea first started experimenting with the production of offensive chemical agents at the end of the 1960s.[275] However, this assessment seems to be exaggerated as the US Defense Intelligence Agency (DIA) noted in 1979 that it had "only a defensive CW capability".[276] Some assessments, particularly from South Korean officials, held that Pyongyang had developed a significant stockpile in the 1970s.[277] One of the more forceful estimates came in June 1985 from the South Korean defense minister who stated that North Korea was "producing 14 tons of CW agent per year, and that 250 tons had already been stockpiled, implying that production had begun no later than 1967."[278] But, reports from the U.S. intelligence community are less confident. For instance, a 1983 Special National Intelligence Estimate (SNIE) stated that North Korea "reportedly stores and produces" rudimentary first-generation CW agents, adding that such reports are "unsubstantiated".[279]

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269 Seeing as that only pilot-level quantities of sulfur mustard were produced it is also plausible to code Burma as only pursuing chemical weapons. If the United States' efforts to get Myanmar to amend its CWC declaration are successful, a more accurate picture about the nature of its CW activities may arise.

270 Horowitz and Narang 2014.

271 Namely, Burck and Flowerree 1991; Center for Nonproliferation Studies 2008; Office of Technology Assessment 1993a; Wisconsin Project On Nuclear Arms Control 2005.

272 International Crisis Group 2009, 5; Kim 2004, 81; Waldenström, Norlander, and Puu 2005, 23.

273 International Institute for Strategic Studies 2004, 50–51; Waldenström, Norlander, and Puu 2005, 36.

274 Waldenström, Norlander, and Puu 2005, 23; Nuclear Threat Initiative 2015l; International Institute for Strategic Studies 2004, 51.

275 International Institute for Strategic Studies 2004, 51.

276 Nuclear Threat Initiative 2015l.

277 See, for instance, International Crisis Group 2009, n. 41; Nuclear Threat Initiative 2015l.

278 Burck and Flowerree 1991, 397–98.

279 Director of Central Intelligence 1983, 12.

Headway towards a full offensive CW capability was only made in the 1980s. In a 1980 speech Kim Il-Sung told members of the Korean Worker's Party Central Military Committee: "we succeeded in producing poisonous gas and bacterial weapons through our own efforts supported by the Soviet scientists in this field."[280] While it is difficult to corroborate Kim's claim, it is very likely that it did not refer to North Korea having a full-scale indigenous CW production capability, but rather the ability to produce laboratory quantities of agent. This interpretation is supported by later US government assessments of North Korean capabilities. A U.S. State Department spokesperson stated in 1988 that the United States believed that "North Korea has some limited chemical weapons capabilities",[281] while a 1997 Department of Defense report concluded that "by the late 1980s, Pyongyang was able to produce large quantities of chemical agents and munitions independently."[282] Finally, a number of reports prepared by the Department of Defense's Chemical and Biological Defense Program in the early 2000s stated that North Korea had the capability since 1989 to indigenously produce bulk quantities of several classes of CW agents.[283] Most of this evidence is circumstantial and is based on undisclosed intelligence sources. Nevertheless, it is remarkably consistent over time—particularly, when compared to intelligence reporting in some of the other cases—and represents the best guesstimate of Pyongyang's CW capabilities at this time. Hence, North Korea is coded as acquiring in 1989 and continuing up to and through 2010 (the end date of this study).

Pakistan

Horowitz and Narang[284] code Pakistan as pursuing from 1982-1986 and possessing from 1987 up to and through 2000 (the endpoint of their study) based on four sources.[285] It is unclear why they code pursuit as starting in 1982 as none of the aforementioned sources contain any information that Pakistan may have started pursuit in 1982. The OTA report merely indicates that Pakistan is mentioned in 7 out of 11 consulted sources (of which 4 express doubt). Kerr's report states that Pakistan is "likely" to have a "chemical weapons capability," but does not provide any sources to support this assessment.[286] Burck & Flowerree express skepticism, noting that Pakistan is not "strongly suspected of

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280 Waldenström, Norlander, and Puu 2005, 24.

281 Burck and Flowerree 1991, 396.

282 U.S. Department of Defense 1997.

283 U.S. Department of Defense 2000; U.S. Department of Defense 2002.

284 Horowitz and Narang 2014.

285 Namely, Burck and Flowerree 1991; Federation of American Scientists 1999b; Kerr 2008; Office of Technology Assessment 1993a. Horowitz and Narang refer to "Pike (1999)" as one of their four sources but do not include it in their bibliography. Other references to "Pike (1999)" in their study concern several country reports published on the website of the Federation of American Scientists. I assume that in the Pakistan case, the authors refer to one of these country reports, see Federation of American Scientists 1999b.

286 Kerr 2008.

having either an offensive CW capability or a development program."[287] The Federation of American Scientists profile of Pakistan seems to be the only source consulted by Horowitz and Narang that directly supports some of their assessments.[288] The profile notes that "it is widely believed in India that Pakistan used chemical weapons against Indian soldiers in Siachen in 1987," although no sources are provided.[289] There are no reports that substantiate the claim that Pakistan used chemical weapon and there is no evidence that the Indian government formally charged Pakistan with using chemical weapons.[290]

The Nuclear Threat Initiative profile of Pakistan's CW history notes that "over the past thirty years, several countries and media outlets have periodically raised allegations of a possible Pakistani chemical weapons program" primarily based on the import of dual-use chemicals, adding that "absent clear and independently verifiable evidence, however, the veracity of these claims is unknown."[291] U.S. intelligence assessments from the 1990s, for instance, refer to Pakistan's procurement of dual-use chemicals and its development of a commercial chemical industry capable of producing precursors necessary for a CW stockpile.[292] Other intelligence assessments are equally vague and ambiguous. For instance, the Director of Naval Intelligence included Pakistan in a list of countries believed to be "developing or having achieved CW capabilities" during a 1989 testimony before Congress. But an unnamed government official later added that "there was no firm proof in the case" of Pakistan.[293]

The government of Pakistan has denied allegations that it is pursing offensive chemical weapons and in 1992 signed a joint declaration with India undertaking not to develop, produce, acquire, or use chemical weapons. Pakistan and India both signed the CWC in 1993 and ratified it in 1997. Since ratifying the CWC, the OPCW has inspected a number of facilities producing scheduled chemicals but none of these inspections have resulted in publicized irregularities.[294]

Following Pakistan's 1998 nuclear weapons test, the U.S. government imposed sanctions on a number of Pakistani chemical and biological facilities, but these sanctions were lifted in 2001 and no conclusive evidence has been found that these entities were involved in researching or developing offensive chemical weapons.[295] Since the early 2000s

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287 Burck and Flowerree 1991, 357.

288 Federation of American Scientists 1999b.

289 Ibid.

290 A Google search for the terms [Siachen "chemical weapons" 1987] yielded only a few hits that refer specifically to this event and they either cite the Federation of American Scientists profile or are unsourced themselves. A search using the same terms in LexisNexis yielded no related hits. Burck & Flowerree note that Pakistan has never been formally accused of using chemical weapons, see Burck and Flowerree 1991, 358.

291 Nuclear Threat Initiative 2016a.

292 see e.g. U.S. Department of Defense 1997.

293 Burck and Flowerree 1991, 357.

294 Nuclear Threat Initiative 2016a.

295 Ibid.

U.S. government suspicions of an offensive CW program in Pakistan have disappeared. Moreover, Pakistan has not been included in any unclassified Section 721 report in relation to chemical weapons activities.[296]

Due to the circumstantial nature of the allegations and the change in U.S. intelligence assessments, Pakistan is coded as not pursuing or possessing chemical weapons.

Peru

Horowitz and Narang[297] code Peru as pursuing in the period 1988-1993 merely on the basis of the OTA report, which finds Peru mentioned (with doubts expressed) in only 1 out of 11 consulted sources.[298] Burck & Flowerree note that "Peru has drawn two press nominations of the lowest concern. Evidence is completely lacking."[299] There is no reason to assume that Peru has worked on CWs and therefore it is coded as not pursuing.

Philippines

Horowitz and Narang[300] code the Philippines as pursuing in the period 1988-1993 merely on the basis of the OTA report,[301] which finds the Philippines mentioned (with doubts expressed) in only 1 out of 11 consulted sources.[302] Burck & Flowerree add that "the only report of a stockpile of lethal chemicals seems to be spurious" and "reports of domestic use are doubtful."[303] Based on the lack of evidence, Philippines is coded as not pursuing.

Rhodesia

Horowitz and Narang[304] code Rhodesia as pursuing in 1975 and possessing from 1976-1980 based on Martinez,[305] but present "no pursuit/acquisition" as a potential alternative specification. Martinez' study does not sufficiently disentangle Rhodesia's development and use of industrial chemicals as warfare agents from its involvement with pathogens and toxins.

Research conducted by Gould and a monograph by Cross provide the most detailed insight into Rhodesia's CBW program, making use of documentary evidence and testimonies of Rhodesians involved in the program.[306] During the Rhodesian Bush War (also known

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296 See e.g. Deputy Director of National Intelligence for Analysis 2006a; Deputy Director of National Intelligence for Analysis 2008; Director of Central Intelligence 2001a; Director of Central Intelligence 2004; Director of National Intelligence 2012.

297 Horowitz and Narang 2014.

298 Office of Technology Assessment 1993a, 80.

299 Burck and Flowerree 1991, 496.

300 Horowitz and Narang 2014.

301 Office of Technology Assessment 1993a, 80.

302 Namely, Harris 1989a.

303 Burck and Flowerree 1991, 432.

304 Horowitz and Narang 2014.

305 Martinez 2002.

306 Gould and Folb 2002; Gould 2005; Cross 2017.

as the Zimbabwe War of Liberation) in the second half of the 1970s, the security forces of the increasingly isolated white minority regime resorted to counterinsurgency operations, among which so-called "pseudo-operations," psychological warfare, assassinations, and the use of toxic substances to fight nationalist guerillas.[307] Exact dates about the program are contested. Between mid-1975 and mid-1976, a proposal for a chemical and biological (mostly toxin) weapons program was submitted and the first experiments began in 1976.[308] The program was small and rudimentary and primarily focused on the developments of weapons to be used against African nationalist guerrillas based on readily available toxic industrial and agricultural chemicals rather than the development of 'traditional' chemical warfare agents.[309] The Rhodesians contaminated clothing intended for guerrillas with parathion (an organophosphate insecticide), injected canned foods and beverages with thallium (a highly toxic heavy metal used in rodenticides), and poisoned bulk foods such as mielie (corn) meal with warfarin (an anticoagulant used in rodenticides).[310] According to members of the Rhodesian CBW team, poisoning of clothes began in April 1977 and the contamination of food, beverages and medicines in May/June 1977.[311]

The BW component of the program seems to have been less prevalent and seems to have yielded no significant production of pathogens or toxins. An early document describing the possible directions of the CBW program described mostly chemicals and a few toxins that were deemed of interest, but no other biological warfare agents.[312] While the CBW team experimented with several toxins and possible even considered and experimented with some other biological agents (e.g. *V. cholera* and *B. anthracis*) it is not evident that the Rhodesians ever actually produced and/or used biological weapons. Cross assesses that the production of BW agents and toxins seems to have begun in early 1979 when Victor Noble, one of the members of the CBW team, returned from South Africa bearing a vial of *C. botulinum* and a sample of *B. anthracis*.[313] Yet, on the same page Cross notes that "no evidence exists to suggest that the Rhodesians ever attempted to isolate, culture or cultivate *B. anthracis*." The Rhodesians attempted to produce botulinum toxin "by heating water bowsers filled with water, corn, rotted meat and *C. botulinum*," but Cross notes that this is an ineffective method for cultivating *C. botulinum* and it remains unclear how successful this procedure was.[314] The toxin was allegedly used in attacks on guerrilla camps in Mozambique, but no confirmation exists to substantiate the claim.[315] The only biological weapon to have actually been used was *V. cholera*e. The causative agent for cholera was reportedly used Rhodesian

307 Bale 2006, 30.
308 Cross 2017, 74.
309 Ibid., 249f.
310 Ibid., 106–110; Gould and Folb 2000, 26ff.
311 Cross 2017, 74.
312 Ibid., 80.
313 Ibid., 111.
314 Ibid.
315 Ibid., 113.

troops to contaminate wells and other water sources in Mozambique starting around 1973. This predates the establishment of the CBW program in the second half of the 1970s. There are several published accounts of the use of *V. cholera* by Rhodesian forces.[316] However, it remains unclear how Rhodesia's armed forces obtained the cultures, particularly since its medical laboratories did not possess the capability to produce pathogens in significant quantities, making it most likely that the cultures and possibly 'finished' agents were provided by South Africa.[317]

Rhodesia is coded as starting pursuit of chemical and biological weapons in 1976. Possession of chemical weapons started in early 1977. There are no indications that that the CBW program in the second half of the 1970s led to BW possession. The use of *V. cholerae* starting in the early 1970s indicates the possession of at least some limited amounts of BW. However, questions surrounding the origins of the pathogen and Rhodesia's ability to produce it without South African assistance leads to Rhodesia not being coded as possessing (although possession is a possible alternative coding). Rhodesia is coded as ending possession of CW and pursuit of BW when the war came to a close in 1979.[318]

Saudi Arabia

Horowitz and Narang[319] code Saudi Arabia as pursuing in the period 1988-1989 and possessing from 1990-2000 based on four sources.[320]

Burck & Flowerree note, "with a strong basic chemicals industry, modern delivery systems, and significant chemical defenses, Saudi Arabia is a 'CW-capable' country."[321] Shoham notes that "no solid evidence points to Saudi Arabian acquisition of CBW."[322] Reports of Saudi development or possession of CWs are limited. For instance, the Center for Nonproliferation Studies,[323] Federation of American Scientists,[324] and Office of Technology Assessment[325] make no mention of a Saudi CW program, while the Nuclear Threat Initiative[326] country profile states that "there is no evidence that Saudi Arabia possesses either a chemical or biological weapons program, or that Saudi Arabia intends to develop such weapons." Saudi Arabia was mentioned only a couple of times by U.S. officials at the end of the 1980s and early 1990s, but has been absent in any public statements or reports since the early 1990s. In 1991 the U.S. Director of Naval Intelligence identified Saudi Arabia as one

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316 Ibid., 111–13.
317 Ibid., 111.
318 Ibid., 135.
319 Horowitz and Narang 2014.
320 Namely, Burck and Flowerree 1991; Hoogendoorn 1997; Kerr 2008; Shoham 1999.
321 Burck and Flowerree 1991, 327.
322 Shoham 1999, 122.
323 Center for Nonproliferation Studies 2008.
324 Federation of American Scientists n.d.
325 Office of Technology Assessment 1993b, 80.
326 Nuclear Threat Initiative 2016c.

of the countries that "may possess" an "offensive chemical weapons capability".[327] Two years earlier, President Bush had stated that "there is no credible intelligence reporting indicating that Saudi Arabia possesses nuclear, chemical, or biological weapons."[328] Furthermore, in April 1989 President Bush certified to Congress that Saudi Arabia possessed no nuclear, chemical, or biological weapons for the missiles.[329]

Horowitz and Narang[330] base their acquisition coding on Riyadh's purchase of Chinese Dongfeng-3 (DF-3; NATO designation: CSS-2) intermediate-range ballistic missiles in 1987. The missiles—deployed with nuclear warheads in China—were sold to Saudi Arabia in a heavily modified form and outfitted with a large conventional warhead.[331] The purchase raised suspicion that Saudi Arabia intended to arm them with chemical warheads. Kerr notes that "there are unconfirmed reports that Saudi Arabia may have developed chemical warheads for its CSS-2 missiles."[332] Burck & Flowerree comment that "in the absence of nuclear warheads, the question arises: what could Saudi Arabia be planning to put on a small number of highly inaccurate missiles that could achieve a significant military or political deterrent effect?"[333] There are a number of plausible reasons for purchasing these missiles. Shoham, for instance, notes that the Saudis had been pressured by China into making the purchase.[334] The Nuclear Threat Initiative explains that the purchase came at the heels of the Iran-Iraq War, in which both sides engaged in the infamous 'War of the Cities' using inaccurate ballistic missiles.[335] Moreover, the NTI profile notes the DF-3 may have been obtained for reasons of prestige and diplomatic signaling.[336]

Horowitz and Narang's[337] coding of Saudi Arabia is confusing. The authors state that their coding of "acquisition [is] based on assessment of CSS-2 purchase from China." Yet, they code pursuit as starting in 1987—the year the missiles were purchased—and acquisition of CWs taking place in 1990. Horowitz and Narang provide no further details and the sources they refer to also do not make clear why they settle on these particular dates.[338] Moreover, Saudi Arabia signed the CWC in 1993 and there are no indications that it breached the Treaty's provision.

The charge that the purchase of ballistic missiles indicates the existence of CW-warheads is circumstantial at best. Hence, Saudi Arabia is coded as not pursuing or acquiring CWs.

327 Robinson 1992, 61.

328 Bush 1989b.

329 Bush 1989a.

330 Horowitz and Narang 2014.

331 Shoham 1999, 124.

332 Kerr 2008, 22.

333 Burck and Flowerree 1991, 328.

334 Shoham 1999, 125.

335 Nuclear Threat Initiative 2016c.

336 For a discussion of other political and military reasons to field ballistic missiles, also see Fetter 1991, 9–12.

337 Horowitz and Narang 2014.

338 See the following cited sources: Hoogendoorn 1997; Shoham 1999.

Somalia

Horowitz and Narang[339] code Somalia as pursuing from 1988 up to and through 2000 (the end year of their study) based on Burck & Flowerree[340] and Center for Nonproliferation Studies,[341] even though the latter makes no mention of Somalia at all.

The Somalian case concerns two rounds of reports that it allegedly imported CW stocks from Libya in 1988-1989. As Burck & Flowerree note, western governments were not convinced that any delivery had taken place.[342] There have been no reports of Somali pursuit/possession from government sources of in the open literature since the early 1990s. Besides, allegations of CW imports provide no basis to code Somalia as pursuing or possessing an indigenous offensive chemical warfare capability. Hence, Somalia is coded as not pursuing/possessing.

South Africa

Horowitz and Narang[343] code South Africa as possessing CWs from 1945-1993 based solely on a SIPRI volume that mentions, among others, allegations that West-German firms had constructed CW-agent factories in South Africa and that the West German government had supplied the Apartheid regime with irritant agent bombs.[344]

After the start of World War II, South Africa agreed to assist the British Ministry of Supply with the production of phosgene and mustard agent at two facilities near Pretoria and in the Cape Province. In July 1945 these plants were either closed or redirected to the production of insecticides and large quantities of mustard agent were dumped at sea in 1946.[345] From the end of the war until the early 1980s, South African CBW efforts were limited. South African military officers continued training in CB warfare strategy and tactics in Britain and the United States.[346] And, in 1960 the Medchem company was established under auspices of the Department of Trade and Industry, which was tasked by the South African Defense Forces (SADF) to investigate chemical compounds. However, due to a policy of not working with lethal agents, Medchem's work was restricted to compounds such as teargas and other riot control agents.[347]

During the 1970s South African scientists saw reasons to expand the scope of the country's CBW efforts. In a 1971 paper commissioned by the chief of defense staff, Medchem's director dr. J. P. De Villiers and his colleagues discussed the potential of chemical agents

339 Horowitz and Narang 2014.
340 Burck and Flowerree 1991.
341 Center for Nonproliferation Studies 2008.
342 Burck and Flowerree 1991, 470.
343 Horowitz and Narang 2014.
344 Stockholm International Peace Research Institute 1973, vol. II, 240.
345 Bale 2006, 28; Purkitt and Burgess 2002, 231.
346 Purkitt and Burgess 2002, 231.
347 Bale 2006, 28; Gould 2005, 22.

for poisoning water supplies and noted that they could be used by "terrorists".[348] In a July 1977 report De Villiers wrote that "the treatment of terrorist bases with a non-persistent, non-lethal agent just before a security force attack can affect both the terrorists' ability to defend themselves and their ability to escape."[349] Finally, in a 1977 SADF army manual, De Villiers wrote that while there was no threat of CW agents being used against South African troops, the use of irritating and lethal agents against internal enemies may be to the SADF's advantage.[350]

As the Apartheid regime felt increasingly threatened by internal unrest and the escalation of hostilities in neighboring Angola and Mozambique, a feasibility study for the establishment of a CBW program with the code name 'Project Coast' was commissioned by the chief of defense force in August 1981. Later that year the minister of defense officially approved the establishment of a CBW program.[351] The offensive nature of the program was confirmed in a secret November 1989 military report. The report, prepared by Project Coast's head dr. Wouter Basson, stated that Project Coast was designed with, among others, the following in mind:

- "Research with regards to the basic aspects of chemical warfare (offensive)."
- "Research with regard to the basic aspects of biological warfare (offensive)."
- "Research with regard to offensive systems, both covert and conventional."
- "The creation of an industrial capability with regard to the production of offensive and defensive CBW equipment. In this regard, the project provides access to the basic technology through acting as a middleman between the local and overseas companies."
- "Support to CBW operations (offensive and defensive) through the export of security forces. This is usually divided into two sections: Conventional: this support usually includes distribution of equipment (offensive and defensive) which is not yet authorized for use in terms of standard procedures. This includes the storage of equipment. Covert: This support is provided to the Commanding Officer Special Forces and his organizations, Chief of Staff Intelligence and his organizations, the South African Police and National Intelligence. This service includes the preparation of equipment, training in the use thereof, transport thereof as well as support during use."

348 Gould 2005, 23.
349 Gould and Folb 2002, 32.
350 Ibid., 34.
351 Gould and Folb 2000, 12.

- "The conduct of [our] own CBW operations. This is carried out in a similar way to covert support except that [our] own operators are used as a result of access and other circumstances."[352]

The main chemical research and production facility, Delta G Scientific, was established in 1982.[353] Basson testified, during his 1999-2002 criminal trial, that all research on lethal CBW agents for conventional weapons delivery had been concluded by 1986 or 1987, implicitly acknowledging that South Africa had initially considered deploying CBW agents as conventional battlefield agents.[354] By the second half of the 1980s, the program had only produced large quantities (20 tons) of the lachrymatory agent CR.[355] However, the program also produced small quantities of lethal chemical and biological agents to be used for assassination and sabotage purposes from 1987 onwards.[356] According to a 1989 sales list ("verkope lys") obtained from the trunk of Basson's car, Project Coast had produced cigarettes contaminated with anthrax, and food, beverages, and household items contaminated with various lethal biological and chemical agents (among which, botulism, cyanide, salmonella, and organophosphates, but also various industrial and agricultural chemicals).[357] Some of the uses of these agents were documented by the Truth and Reconciliation Commission.[358]

The program was terminated in the first half of the 1990s, when the country transitioned towards majority rule. President F.W. de Klerk stated that "although by 1990 he had attempted to 'normalise' the role of the security forces, and had taken action to establish control over secret projects, he later discovered that there was a great deal kept from him."[359] In 1990 Basson briefed De Klerk about Project Coast. Basson noted that the chemical side focused on developing incapacitants and irritants. In March 1990, President F.W. de Klerk ordered that work on lethal chemical agents be halted, although he authorized continued work on incapacitants and teargas.[360] It is not possible to determine whether work on lethal agents was actually halted in 1990, although the program seems to have solely focused on the production of incapacitants and drugs like methaqualone and MDMA after this time.[361] Project Coast was finally ordered to shut down its operations and destroy all CB agents and precursors in 1992 in anticipation of signing of the CWC and destruction took place in early 1993.[362]

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352 Ibid., 12–13.
353 Gould and Folb 2002, 144.
354 Bale 2006, 42.
355 Gould and Folb 2002, 143.
356 Gould 2005, 154.
357 Gould and Folb 2000, 13; Gould and Folb 2002, 79.
358 Truth and Reconciliation Commission 1999, vol. 2, 510–23; see also Gould and Folb 2002, 159–67.
359 Gould 2005, 223.
360 Ibid., 224; Gould and Folb 2002, 118.
361 Gould and Folb 2002, 115–141.
362 Burgess and Purkitt 2001, 58; Gould 2005, 242; Gould and Folb 2000, 19.

South Africa is coded as starting pursuit of CW in 1981 when Project Coast was authorized. Although the program started the production of large quantities of CR in the mid-1980s, production of lethal agents intended for assassination and sabotage purposes began in 1987. Hence, South Africa is coded as acquiring in 1987. End of possession is coded in 1993 when Project Coast was ordered to shut down all operations and destroy all agents and precursors.

South Korea

Horowitz and Narang[363] code South Korea as pursuing from 1967-1988 and possessing from 1988-2000 based on three sources.[364] Yet, none of these sources make any references to these particular dates in connection to start of pursuit or possession.

After ratifying the CWC in 1997, South Korea declared a significant CW stockpile and one CW production facility,[365] Very little information is available in the public record about the genesis and development of South Korea's CW program. Burck & Flowerree report a stream of allegations made by North Korea in the 1980s about US-supplied CW stockpiles and CW-production facilities in the South.[366] Yet, they conclude that there is "no reliable public information that supports any allegation of a CW agent stockpile in South Korea" and that "little is known about [South Korean] research on CBW".[367]

It is plausible that South Korea's CW efforts took shape in the first half of the 1970s. A declassified 1978 CIA report on South Korea's nuclear decision making assessed that a "chemical warhead team" employing approximately 10 researchers was established in 1975 within the Agency for Defense Development, although the report goes on to state that the team was later "reportedly engaged in research with nonoffensive chemical agents".[368]

Efforts to unravel details about the CW program are thwarted by the South Korean government's extreme secrecy. South Korea refuses to publicly acknowledge its CWC declaration and has even required the OPCW to refer to it in all documents as "an unnamed state party".[369] Unfortunately, further details about South Korea's CW activities are extremely scarce in the open literature as most attention is given to its alleged nuclear ambitions. It is, therefore, not possible with any degree of certainty to settle on a pursuit and acquisition date at the present. South Korea is coded as not possessing from 1997 onwards, the year in which it ratified the CWC and declared its CW stockpile and CW production facility.[370] South Korea finished destruction of its CW stockpile in 2008.[371]

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363 Horowitz and Narang 2014.

364 Center for Nonproliferation Studies 2008; Burck and Flowerree 1991; Kerr 2008.

365 Croddy and Wirtz 2005, vol. 1, 269; Nuclear Threat Initiative 2017.

366 Burck and Flowerree 1991, 408–10.

367 Ibid., 412.

368 Central Intelligence Agency 1978, 7–8.

369 Nuclear Threat Initiative 2017; International Crisis Group 2009, 4.

370 Due to a lack of publicly available information it is not possible to establish whether the decision to shut down South Korea's CW program was taken in the years before its CWC declaration. As a result, 1997 is taken as the most conservative assessment of the end of CW possession.

371 Nuclear Threat Initiative 2017.

Soviet Union/Russia

Horowitz and Narang[372] code the Soviet Union as acquiring CWs in 1915 up to and through 2000 (the end year of their study). Russia declared its stockpile in 1997 and in October 2017, the OPCW certified the destruction of Russia's declared CW stockpile.[373]

However, Russia's presumed CW-free status came into question only a couple months later, when former Russian double-agent Sergei Skripal and his daughter Yulia were targeted in their hometown of Salisbury (England) with a powerful nerve agent. An investigation by the British authorities found that the attack was executed with a novichok-class agent, initially developed in the Soviet Union and Russian Federation between the 1970s and early 1990s. After investigation by OPCW's Rijswijk laboratory and several other OPCW-designated laboratories, the OPCW Technical Secretariat concluded that a novichok agent was indeed used in the attack.[374] The OPCW report also noted that the compound was of high purity, which indicates that it was most likely produced in a national laboratory. Later in 2018, the British authorities named two Russian nationals, who were traveling using fake identities, as suspects and reported that traces of the agent were found in the hotel room they were staying at in Salisbury.[375] The independent investigative collective Bellingcat later identified the two men as agents working for the Russian military intelligence service (GRU).[376]

The use of chemical agents in the assassination attempt in Salisbury and the likely involvement of Russian state agents raises serious questions about the veracity of Russia's CWC declarations. It is unclear as of yet what the extent and exact nature is of Russia's recent and current CW-activities and whether it will ever be known. In the meanwhile, Russia is coded as continuing to possess chemical weapons up to and through the endpoint of this study.

Sudan

Horowitz and Narang[377] code Sudan as pursuing from 1990 up to and through 2000 (the endpoint of their study) based on two sources.[378]

Sudan was suspected by the United States of having a CW research and development program. Acting on intelligence information, the United States bombed the al-Shifa Pharmaceutical Factory in Khartoum in August 1998 because it was allegedly involved in the production of nerve agents and had links with Osama bin Laden. Barletta notes that much of the evidence contradicts the U.S. government's assertions about the purpose of

372 Horowitz and Narang 2014.
373 OPCW 2017.
374 OPCW 2018.
375 BBC News 2018.
376 Bellingcat Investigation Team 2018a; Bellingcat Investigation Team 2018b; Bellingcat Investigation Team 2018c.
377 Horowitz and Narang 2014.
378 Center for Nonproliferation Studies 2008; Kerr 2008.

al-Shifa and its links to Bin Laden.[379] He concludes that "the balance of available evidence indicates that the facility probably had no role whatsoever in CW development".[380] Soon after the attack, government officials admitted to uncertainty about whether their own evidence indicated that precursor chemicals were produced at al-Shifa, or just shipped through or stored at the facility, and that they had no evidence that directly linked Bin Laden with the plant.[381] A few months later, soil samples were collected around the plant by a team led by the chairman of the chemistry department at Boston University and analyzed by two European labs certified by the OPCW. This investigation found no traces of the precursor chemicals referred to by the United States.[382]

Until the al-Shifa incident, the U.S. government had not identified Sudan, at least publicly, as a CW proliferator or a "country of concern".[383] In the following years, the United States at several occasions publicly acknowledged its suspicions. The unclassified report to U.S. Congress on the compliance with arms control agreements covering the period 2000-2001 indicates that "Sudan has been interested in acquiring a chemical warfare capability since the 1980s" and had "established a CW R&D program with the goal of indigenously producing CW."[384] The report covering the period 2002-2004 introduced some nuance, as it, for instance, notes that "numerous unconfirmed reports throughout the 1990s indicated that Sudan was researching, developing, producing, and testing CW agents." Moreover, it suggests that reports and allegations of CW use during the 1990s were either unconfirmed or "judged to be unsubstantiated".[385] Sudan is not included in any subsequent compliance report (released annually since 2010), indicating that the U.S. intelligence community either believes that Sudan has wound down its alleged CW program or it has revised its initial position. Either way, the inconsistencies surrounding the al-Shifa incident, the lack of other evidence in the public domain supporting the existence of a Sudanese CW program, and the apparent change in the U.S. intelligence communities' assessment of Sudan's CW activities does not provide sufficient basis to code Sudan as pursuing.

Sweden

Horowitz and Narang[386] code Sweden as pursuing from 1945-1973 based on one source.[387] This source gives a detailed description of the strictly defensive nature of the Swedish CW program and notes that "the manufacture of CBW agents, except for chemical irritants,

379 Barletta 1998.
380 Ibid., 116.
381 Ibid., 120.
382 Loeb 1999; Risen and Johnston 1999; Rouhi 1999.
383 Barletta 1998, 115.
384 U.S. Department of State 2003, 33–34.
385 U.S. Department of State 2005, 62.
386 Horowitz and Narang 2014.
387 Stockholm International Peace Research Institute 1973, vol. II.

is limited to the quantities needed for defence research and testing purposes."[388] Hence, Sweden is not coded as pursuing.

Syria

Horowitz and Narang[389] code Syria as pursuing from 1971-1972 and possessing from 1973 up to and through 2000 (the end point of their study) based on five sources.[390]

Various sources claim that Syria first obtained chemical weapons from Egypt either just before or after the 1973 October War with Israel.[391] Some reports note that Israeli troops even captured some of the Syrian stocks during the war.[392] Nonetheless, there are no reports that these weapons were ever used and it is doubtful that Syria had the delivery systems to strike Israeli population centers.[393] It is likely that Horowitz and Narang base their possession coding on this episode.

The available literature generally identifies three regional developments that are likely to have spurred Syria's pursuit of an indigenous CW production capability. The first development was Syria's crushing defeat in the 1973 Arab-Israeli War—in part, due to the failure of Syria's Arab allies to provide timely support—combined with Egypt's post-war attempts to bilaterally resolve its issues with Israel. Second, the signing of the 1979 Egyptian-Israeli Peace Treaty, which put the final nail in the coffin of the already fledgling Arab anti-Israel coalition, further eroded Syria's strategic position vis-à-vis Israel. Finally, Israel's 1982 invasion of Lebanon seriously exposed Syria's military vulnerability, particularly the inability of its air force to measure up against Israel's capabilities in the air.[394]

It is difficult to establish the exact moment that Syria started pursuing and producing CWs, as the evidence is circumstantial. According to Diab the experience of the 1973 war encouraged Syria to pursue a more independent military posture.[395] Shoham claims that Israel's conventional supremacy, showcased during the 1973 war, combined with its newly acquired nuclear deterrent, which the Syrians knew they could not match, convinced Syrian President Hafez al-Assad to "explore the CBW option".[396] During that same year, Assad

388 Ibid., vol. II, 259.

389 Horowitz and Narang 2014.

390 Namely, Burck and Flowerree 1991; Center for Nonproliferation Studies 2006; Center for Nonproliferation Studies 2008; Diab 1997; Kerr 2008.

391 Burck and Flowerree 1991, 213; Diab 1997, 104; Normark et al. 2004, 20; Shoham 1998, 49. These claims are possibly at odds with a 1983 U.S. intelligence assessment that contended that "both Czechoslovakia and the Soviet Union provided the chemical agents, delivery systems, and training that flowed to Syria", see Director of Central Intelligence 1983, 11.

392 Bleek and Kramer 2016, 198.

393 Normark et al. 2004, 34. Diab suggests that the CW transfer may have been intended to establish in-kind deterrence in the event that Israel initiated the use of CWs or if Syrian defenses collapsed completely, see Diab 1997, 104.

394 Diab 1997, 107.

395 Ibid.

396 Shoham 2002.

authorized relations between the Syrian military and the Scientific Studies and Research Center (SSRC) in Damascus—the civilian science institute established in 1971 that would eventually house Syria's CW program.[397] Normark et al. conclude from the available literature that "if a Syrian CW program existed prior to the early 1980s, it was probably of a rudimentary nature."[398] It is possible that Syria seriously embarked on an offensive CW development program after Egypt signed a peace treaty with Israel in 1979. Diab notes that Syria "sought to make up for the loss of Egypt's military weight and preserve the Arab-Israeli 'strategic balance' by achieving military parity with Israel."[399] The move would further make sense, as the potency of any CW stocks that Syria may have acquired from Egypt in the early 1970s would have been greatly diminished by this time.[400]

Many sources suggest that Syria's indigenous CW output began in the mid-1980s at the earliest. Burck & Flowerree, for instance, note that, while physical evidence is lacking, specific reports on CW munitions started to appear around 1986, giving some credence to the assessment that "a production capability came on line in the mid-1980s."[401] A 1983 SNIE assessed that Syria did not have any production facilities and no "indigenous capability to produce CW agents or materiel" due to Soviet assistance.[402] Within two years, public statements by U.S. government sources seemed to indicate a change in the assessment of Syria's CW activities. In 1985, the Deputy Assistant Secretary of Defense Douglas Feith stated that Syria possessed a production capability for nerve agents. In 1986, unidentified U.S. officials indicated that Syria was capable of producing "nerve agents, reportedly Sarin," while a State Department spokesperson's reply to a question about Syria's CW capability was that "they are producing chemical weapons".[403] In 1989, CIA Director William Webster stated that that Syria began producing CW agents and munition in the early 1980s.[404] Similar reports started to surface from Israel around this time, some of them repeating foreign sources, others serving as the basis for foreign reports. In 1986 Prime Minister Yitzhak Shamir stated that "Syria is arming itself with modern chemical weapons" and Defense Minister Yitzhak Rabin told the Knesset that "Syria is armed with chemical weapons—artillery shells, bombs, and ground-to-ground missile warheads carrying [chemical weapons]—including nerve gas."[405]

Based on the foregoing, Syria is coded as starting pursuit in 1979 and possession in 1986. However, these dates should be treated as uncertain since the evidence is circumstantial and derived, in part, from undisclosed U.S. and Israeli intelligence sources. Syria is coded

397 Ibid.

398 Normark et al. 2004, 34–35.

399 Diab 1997, 107.

400 The shelf life of sulfur mustard, the most likely agent to have been transferred, is a few years and can be shorter depending on the quality of the precursor materials and the storage conditions.

401 Burck and Flowerree 1991, 210.

402 Director of Central Intelligence 1983, 11.

403 Burck and Flowerree 1991, 211.

404 Ibid., 210–11.

405 Ibid., 210.

as possessing up to and through 2010 (the end date of this study), since Syria declared an offensive CW program to the OPCW in 2013 following allegations of CW use by its armed forces during the Syrian civil war.

Taiwan

Horowitz and Narang[406] code Taiwan as pursuing from 1970-1982 and possessing from 1983 up to and through 2000 (the end point of their study) based on six sources.[407] Kerr merely makes the unsourced claim that Taiwan is "likely" to have a "chemical weapons capability."[408] The other five sources center around two congressional testimonies by successive Directors of U.S. Naval Intelligence at the end of the 1980s and early 1990s. Of these five sources, Burck & Flowerree provide the most significant discussion and Horowitz and Narang note that their dates rely on their entry.

Burck & Flowerree's entry on Taiwan contains only one reference each to the years 1970 and 1983. In regards to 1970, they merely cite a 1984 *Economist Foreign Report* that stated that Taiwan "has had a high-priority chemical programme since 1970." One cannot help but notice the ambiguous use of the term "chemical programme" as opposed to "chemical weapons programme." As for 1983, Burck & Flowerree note that the Special National Intelligence Estimate (SNIE) from that year stated that Taiwan had produced mustard agent and had an "aggressive program to develop offensive and defensive capabilities".[409] Aside from the lack of disclosure of the sources and analysis that underlie this assessment, it is a stretch to deduce from this statement that Taiwanese production of mustard agent started in the year the SNIE was delivered. On the contrary, Burck & Flowerree argue that "while these reports allege the production of CW agents, and Taiwan has a well-developed chemical industry, no information is available on any specific facility to produce CW agents or weaponize them."[410]

One of the first available assessments of Taiwan's CW activities can be found in a 1974 CIA study on Taiwanese scientific research:

> A minor chaemical [*sic*] warfare (CW) research and development program is concerned with the development of locally produced CW defensive materiel. Facilities suitable for research on toxic chemical agents, munition, and detection devices are limited, but the CIST/INER complex has done some work in these areas.[411]

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406 Horowitz and Narang 2014.

407 Burck and Flowerree 1991; Center for Nonproliferation Studies 2008; Office of Technology Assessment 1993a; Kerr 2008; Nuclear Threat Initiative 2011g; Center for Defense Information 2000b.

408 Kerr 2008, 20.

409 Oberdorfer 1985; quoted in Burck and Flowerree 1991, 434. While the SNIE was declassified in the 1990s, the passage on Taiwan is still redacted, see Director of Central Intelligence 1983, 12.

410 Burck and Flowerree 1991, 434.

411 Central Intelligence Agency 1974, 6.

U.S. officials expressed concern about Taiwan's CW activities throughout the 1980s and early 1990s. Details about CIA assessments of Taiwanese CW activities in the 1983 SNIE were made public by the Washington Post soon after its release. The SNIE reportedly described Taiwan as having made chemical weapons a priority since 1979.[412] The CIA, furthermore, judged Taiwan as having "an aggressive, high-priority program to develop both offensive and defensive capabilities" and having produced at least mustard agent.[413] In 1988, Taiwan was named by the Director of Naval Intelligence Studeman in 1988 as "developing [a] chemical warfare capability." In 1989, his successor Brooks characterized Taiwan as "developing or ha[s] achieved CW capabilities" and in 1991 as "probably possess[ing] offensive CW capability".[414] In October 1989, Taiwan's ministry of defense spokesperson denied producing or possessing "biochemical weaponry", but affirmed that Taiwan would "conduct research on defense against attack of biochemical weaponry".[415] Taiwanese authorities yet again denied any involvement with offensive aspects of chemical warfare in 1991.[416]

While Taiwan was mentioned in few successive annual Congressional testimonies at the end of the 1980s and early 1990s, it quickly disappeared from U.S. government reports and testimonies.[417] Aside from the allegations made by the U.S. government as discussed earlier, there is no conclusive evidence that Taiwan produced and deployed chemical weapons. These allegations alluding to a "CW capability" coupled with their sudden disappearance provide insufficient basis to code Taiwan as pursuing or possessing chemical weapons. Hence, Taiwan is coded as not pursuing or possessing.

Thailand

Horowitz and Narang[418] code Thailand as pursuing from 1988-1993 based on the Office of Technology Assessment.[419] The OTA report finds Thailand mentioned in 3 out of 11 consulted sources, one of which expresses doubt.

Burck & Flowerree indicate that Thailand is absent from any U.S. government reports or statements by its officials.[420] Despite allegations made by Cambodia, Laos, and Vietnam that Thailand had used chemical weapons during several conflicts in the 1980s, evidence of a Thai CW capability are vague. There are no reports about CW munitions

412 Anderson 1984.
413 Oberdorfer 1985.
414 Burck and Flowerree 1991, 433; Robinson 1992, 60–61.
415 Burck and Flowerree 1991, 433f.
416 Robinson 1992, 60–61.
417 See, for instance, Director of Central Intelligence 1998; Director of Central Intelligence 1999; U.S. Department of Defense 2000; U.S. Department of Defense 2002.
418 Horowitz and Narang 2014.
419 Office of Technology Assessment 1993a, 80.
420 Burck and Flowerree 1991, 435.

stocks or production facilities and there is no reason to believe that Thailand even has a CW research capability.[421] Hence, Thailand is coded as not pursuing.[422]

United Kingdom

Horowitz and Narang[423] code the United Kingdom as possessing from 1915-1918 and from 1938-1957 based on a volume by the Stockholm International Peace Research Institute.[424]

The United Kingdom had an active CW program and possessed a substantial stockpile of CWs. In July 1956 a secret Cabinet decision was taken to abandon the offensive aspects of the program and the remainder of the stockpile was dumped into the Atlantic Ocean around 1957.[425] From the early 1960s until the early 1970s the defense establishment reconsidered acquiring chemical weapons. Nevertheless, a penultimate decision to proceed with a renewed CW program was never taken.[426] Hence, the United Kingdom is coded as ending possession in 1957.

United States

Horowitz and Narang[427] code the United States as acquiring CWs in 1915 up to and through 2000 (the end year of their study). However, the United States ratified the CWC and declared its CW stockpile and production facilities in 1997, and has been destroying its stocks since then.[428] Hence, the United States is coded as ending possession in 1997.[429]

Vietnam

Horowitz and Narang[430] code Vietnam as pursuing CWs from 1975-1989 and possessing from 1990 up to and through 2000 (the end year of their study) based on four sources.[431] It is unclear why Horowitz and Narang settle on these dates. Kerr merely states that Vietnam is "likely" to have a "chemical weapons capability," without adding any details or substantiating evidence.[432] A list by the Center for Nonproliferation Studies indicates

421 Ibid., 436.

422 Horowitz and Narang Horowitz and Narang 2014. also offer "no pursuit" as an alternative specification due to reliance on the OTA report and mention that Burck & Flowerree deem it unlikely that Thailand pursued CWs.

423 Ibid.

424 Stockholm International Peace Research Institute 1973, vol. II.

425 Balmer 2009, 67; Paxman and Harris 1982, 183; Stockholm International Peace Research Institute 1973, vol. II, 190.

426 Walker 2016, 11ff.

427 Horowitz and Narang 2014.

428 Nuclear Threat Initiative 2016b.

429 The remainder of the United States' stockpile is scheduled to be destroyed by 2023, see Higgins 2017..

430 Horowitz and Narang 2014.

431 Namely, Burck and Flowerree 1991; Center for Nonproliferation Studies 2008; Kerr 2008; Office of Technology Assessment 1993a.

432 Kerr 2008, 20.

that it is “possible” it has a CW program based on a 1991 Congressional testimony by Rear Admiral Thomas Brooks in which he identified Vietnam as a “probable” possessor of an “offensive chemical weapons capability.”[433]

The case for a Vietnamese CW program is based on allegations that have been levelled against it since the mid-1970s of use of CW agents in attacks on the H’mong in Laos, in Cambodia, and during the war with China.[434] Burck & Flowerree, however, conclude that the evidence in the public record is only strong for the use of smoke and nonlethal agents.[435] Second, they add that the existence of Vietnamese facilities to produce and weaponized CW agents is unlikely, as allegations made by the U.S. government point towards “the Soviet Union as the source and user of any CW agents.”[436] Hence, Vietnam is coded as not pursuing or possessing CWs.

Yugoslavia

Horowitz and Narang[437] code Yugoslavia as pursuing form 1958-1968 and possessing from 1969 up to and through 2000 (the end point of their study), based on six sources.[438]

Only one reference to the year 1958 can be founded in the sources consulted by Horowitz and Narang. [439]. Price describes how the Military Technical Institute-Mostar facility was founded in 1958 to synthesize “all known CW gases to meet the requirements of the Yugoslav Army (JNA).”[440] These requirements “included the development of safety and protection devices, CW detection systems, decontamination methods and systems, and the production of CW agents for training and testing purposes.”[441] Throughout the 1960s, the Mostar facility and three other plants in Yugoslavia continued to perform research into and produce CW agents. Although such activities “may have contributed to later efforts to develop an offensive capability, it is not out of character with defensive research.”[442] The shift from a defensive CW research project—albeit an ambiguous one—to an offensive project probably took place in 1976, with the initiation of the Jastrebac program, which involved “detailed research into weaponization, testing munition designs, production and munition filling equipment, dynamic tests to assess munition performance under field conditions and ultimately including open-air testing of CW filled munitions.”[443] The program proceeded

433 Center for Nonproliferation Studies 2008.
434 Burck and Flowerree 1991, 375.
435 Ibid., 386.
436 Ibid., 386–87.
437 Horowitz and Narang 2014.
438 Namely, Center for Nonproliferation Studies 2008; Federation of American Scientists 2000; Hoogendoorn 1997; Office of Technology Assessment 1993a; Price 1999; Stockholm International Peace Research Institute 1971, vol. I.
439 Price 1999.
440 Ibid.
441 Nuclear Threat Initiative 2004.
442 Nuclear Threat Initiative 2014a.
443 Nuclear Threat Initiative 2010c, 35.

at a leisurely pace and no efforts were made to produce and store significant quantities of agent in anticipation of the availability of delivery systems. In 1986-1987 a munitions filling plant was installed at the Mostar facility. The facility could fill up to 30 shells or warheads per day, which suggests that it was a pilot plant. During a trial run it produced around 250 sarin-filled 122 mm artillery shells that were put into storage.[444] It seems that a decision was taken somewhere in the towards the end of the 1980s to commence with production of a stockpile in the form of mustard and sarin-filled artillery shells, artillery rockets, and aircraft delivered bombs, scheduled to become available between 1990 and 1995.[445] To this end, 40 tons of precursor material for sarin was produced in 1988-1989.[446] With the dissolution of the Socialist Federal Republic of Yugoslavia looming, the Serbian-dominated military brass ordered the destruction of most (potentially all) of the weaponized agents, dismantled the Mostar facility, and shipped its records, vital equipment and some forty tons of precursor materials to Serbia between July 1991 and February 1992.[447]

During the Balkan Wars in the 1990s, the warring parties regularly accused each other of using chemical weapons. However, few of these claims have been independently substantiated. Many of these allegations were either false or exaggerated to advance propaganda goals. The instances where chemicals were used involved the use of non-lethal agents, such as tear gas.[448] Similarly, there is little evidence to substantiate claims that either Bosnia or the Federal Republic of Yugoslavia (Serbia and Montenegro) continued to produce CWs throughout the 1990s. Human Rights Watch, for instance, reports that a former Bosnian military officer recounted that "the Bosnian army was filling mortar shells with chemicals in 1992 and 1993, and that UNPROFOR [United Nations Protection Force] units, upon discovering the ongoing production, would destroy any such munitions they found."[449] Although the report does not specify which chemicals were used, an UNPROFOR technical inquiry into Bosnian Serb claims that Bosnian Muslim forces had used chlorine filled mortars around this time found that "most reports turned out to be falsifications or referred to the use of tear gas, smoke or incendiary white phosphorus grenades."[450]

Based on the available information it is likely that the Yugoslav CW program only turned towards explicit offensive research in 1976, with the initiation of the Jastrebac project. Pilot quantities of chemical weapons were produced, possibly around late 1987 or early 1988. Around that same time plans were made for large-scale production between 1990 and 1995.

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444 Nuclear Threat Initiative 2014a; Price 1999.

445 Nuclear Threat Initiative 2014a; Price 1999.

446 Price 1999.

447 Nuclear Threat Initiative 2004; Nuclear Threat Initiative 2010c, 28; Nuclear Threat Initiative 2014a; Price 1999.

448 Nuclear Threat Initiative 2014a. NTI's chronology of CW events in the Former Yugoslavia provides a useful overview of the allegations of CW use over the course of the 1990s, see Nuclear Threat Initiative 2010c.

449 Human Rights Watch 1997, chap. V.

450 Nuclear Threat Initiative 2010c, 24.

Hence start of at least a nominal possession of chemical weapons is coded in early 1988.[451] Plans for large-scale production of CWs never came to fruition due to the ensuing civil wars. The Yugoslav offensive CW program can be considered to have effectively ended in 1991.

451 Possession could also be coded towards the end of 1987.

7

Chronicle of Biological Weapons Programs, 1946-2010

SUMMARY

This chapter chronicles all state-run biological weapons programs after World War II. The entries in this chapter serve, first of all, as the case notes for the dataset on CBW pursuit and possession that was introduced in Chapter 3. Moreover, the entries are valuable reference materials whilst reading the other chapters in this dissertation. This chronicle describes the available information regarding biological weapons pursuit and possession for each case, analyzes how the available information is weighed, discusses how coding decisions are made, and makes note of possible alternative coding specifications.

Algeria

Horowitz and Narang[1] code Algeria as pursuing from 1999 up to and through 2000 (the endpoint of their study) based on the Center for Nonproliferation Studies' list of suspected programs, which in turn refers to Cordesman.[2] However, Cordesman only states that Algeria conducted "some low-level research activity [into biological weapons]" but that there was "no evidence of production capability," without providing any sources to back up these assessments. There are no other sources to support the assessment that Algeria has pursued biological weapons (BWs).[3] Therefore, Algeria is coded as not pursuing.

Bulgaria

Horowitz and Narang[4] code Bulgaria as pursuing from 1988-1993 based solely on the OTA report.[5] The OTA report finds Bulgaria mentioned in only 1 out of 6 consulted sources. This provides insufficient basis to code Bulgaria as pursuing.[6]

Canada

Horowitz and Narang[7] make no mention of Canada's BW program even though one of the sources they extensively cite notes that Canada had an offensive BW program during World War II.[8]

Canada's CBW research program can be traced back to World War II (WWII) and is characterized by its close connection with the British and American CBW programs during and after the war. During the WWII, likely starting in 1942, Canada cooperated with the British and Americans to develop and test BW agents, vaccines, and munitions.[9] Although the Canadian civilian and military leadership did not formulate any official policy on biological warfare, the BW program continued in earnest after the war. A January 1949 report by the Defense Research Board's (DRB) Bacteriological Warfare Research Panel (BWRP) set out the BW priorities. Noting that "each agent would require its own munition," the DRB decided botulinum toxin was to have precedence, followed by "non-sporulating species such as Brucella, Tularaemia or Melioidosis (Whitmore's Bacillus)." The members of the DRB also agreed on establishing a biological pilot plant for the production of "a number of agents" and discussed the means of disseminating agents in "likely enemy countries".[10]

1 Horowitz and Narang 2014.
2 Center for Nonproliferation Studies 2008; Cordesman 2005, 31.
3 Nuclear Threat Initiative 2018.
4 Horowitz and Narang 2014.
5 Office of Technology Assessment 1993a.
6 Horowitz and Narang also specify no pursuit as an alternative specification based on the reliance on the OTA report.
7 Horowitz and Narang 2014.
8 Center for Nonproliferation Studies 2008.
9 Avery 2009, 87f.; Stockholm International Peace Research Institute 1971, vol. I, 118f.
10 Avery 2009, 90.

Accusations of BW use during the Korean War leveled by the Communist bloc against U.S. forces provided further incentive to increase BW research. The Canadians assumed that these allegations were meant to hide accelerated Soviet work in the field of biological warfare. During the DRB's 1952 deliberations these concerns were the chief reason for expanding efforts aimed at producing "more virulent strains of B. mallei, and C. botulinum toxin, along with continued work on insect vectors," and production and storage of rinderpest vaccine "of sufficient quantities for use by US and UK as well as Canada".[11] In the aftermath of the Korean War, Canadian scientists were heavily involved with joint projects with the British and Americans to improve the quality of BW munitions and delivery systems for lethal agents.[12] The Canadian government declared in a Confidence Building Measures (CBM) submission under the Biological and Toxin Weapons Convention (BTWC/BWC) that it had an offensive BW program from 1 January 1946 until 30 June 1958, describing its activities as follows:

> In the above period offensive work undertaken by Canada included: studies of improved procedures for production of certain toxins (e.g. botulinum and diphtheria); studies on the use of insects as vectors for pathogenic bacteria and viruses; test and evaluation of munitions, including performance in cold weather; studies of weapon-produced aerosols of potential BW agents; fundamental work related to field trials, dealing with the dispersion and properties of solid particulates, preparation of finely divided solids for munitions charging and sampling of toxic particulates; development of tissue culture processes for large scale cultivation of viruses; and development of Burkholderia mallei and Burkholderia pseudomallei as new potential BW agents and continued work on Brucella suis and Pasteurella tularensis as BW agents. There was no large scale production, stockpiling, or weaponization of BW agents. When necessary, BW agents were destroyed by autoclaving.[13]

The staff of *Defense Research and Development Canada*, the government agency responsible for Canada's CBW research, noted in a 2002 volume that "evaluation of weapons employing biological warfare (BW) agents through field trials was initiated in 1944 and continued until the winter of 1956-1957 […] From a Canadian perspective [the work thereafter] was defensive in nature".[14]

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11 Ibid., 93.

12 Ibid., 94.

13 Government of Canada 2011, 43. The original 1992 submission declared that Canada had ended offensive research in 1956. This seems to have been amended in the most recent publicly available version of the declaration.

14 DRDC Staff 2011, 1f.

The official line that offensive research was halted at the end of the 1950s seems to be at odds with the archival evidence made available in recent years. As Avery shows, Canadian scientists were actively involved within the Tripartite/Quadripartite alliance's defensive and offensive CBW research throughout the 1960s.[15] However, successive Canadian governments between 1945 and 1969 were unwilling to acknowledge Canada's involvement with offensive CBW research within the alliance.[16] In turn, the Canadian scientists were displeased with their government's refusal to acknowledge their continued involvement with offensive research, particularly since it undermined their standing as full partners within the alliance.[17]

Notably, Canada had no formal CBW policy until the 1960s and the CBW issue was rarely discussed in the Cabinet until the late 1960s. As a result, most crucial decisions were made by bureaucrats.[18] The Canadian Chiefs of the General Staff issued the first policy statement on chemical and biological warfare in secret in May 1963, stating as principle that "the Canadian Armed Forces will develop the knowledge and the capacity to ensure that protective measures are adequate, and that a capability for retaliation in kind could be quickly instituted if so directed".[19] While little was done to implement this directive, Brigadier General H. Tellier issued an official statement in December 1968 on behalf of the Chiefs of the General Staff about Canada's CBW policies. He stated that, "the new policy proposes that agreements should be reached with our Allies whereby suitable weapons can be made available," even though "the Canadian Forces have no intention of holding B or CW munitions in Canada or in Europe. Our requirements would be held in British or American stockpiles, to be supplied in the event B or CW is employed against NATO forces".[20] Following President Nixon's unilateral BW renunciation, Pierre Trudeau's cabinet released a policy statement on 11 December 1969 renouncing all CBW weapons and endorsing a draft convention for the prohibition of biological weapons.[21]

Canada is coded as pursuing from as early as World War II (perhaps 1942) until 1969.

China

Horowitz and Narang[22] code China as pursuing from 1950-1961 and possessing from 1962 up to and through 2000 (the endpoint of their study) based on six sources.[23]

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15 Avery 2013.

16 Avery 2009, 86.

17 Avery 2013, 98, 102.

18 Avery 2009, 86.

19 Ibid., 96–97.

20 Ibid., 99. Although by this time the British had already put to rest offensive CBW research.

21 Avery 2013, 136.

22 Horowitz and Narang 2014.

23 Center for Nonproliferation Studies 2008; Croddy 2002; Kerr 2008; Prasad 2009; Stockholm International Peace Research Institute 1973, vol. II. A sixth source (Speiers 2010) is not included in their bibliography.

Horowitz and Narang acknowledge the uncertainty surrounding China's BW activities and therefore also indicate several alternative specifications: pursuit from 1952-2000; pursuit from 1952-1958 and acquisition from 1958-2000; or, no pursuit/acquisition at all. The degree of uncertainty is illustrated by the fact that China is the only case for which the authors perform robustness tests in their statistical analyses (namely with the base coding and no pursuit/acquisition). The various years specified by Horowitz and Narang are not mentioned in any of their consulted sources in direct connection to the start of an *offensive* BW program or BW acquisition. These specific dates are only mentioned by Croddy in connection to Chinese *defensive* BW activities.[24] According to Croddy, China's first concerted efforts at BW defense concerned the People Liberation Army's (PLA) formation of sanitation and anti-plague units in 1952 during the Korean War.[25] China has declared in its CBM submission under the BWC that its BW defense program was initiated officially in 1958 and during that same year a national epidemiological research project commenced as part of the 1958-1961 Great Leap Forward.[26]

Few details are available in the open literature about China's BW activities.[27] China has a large and advanced biotechnical infrastructure, which gives it the ability produce BW agents. While China has repeatedly stated in speeches by officials, defense white papers, and other official documents that it has not developed BWs in the past and is not currently involved in offensive biological research, the U.S. government has remained skeptical. From the first half of the 1990s until well into the 2000s, U.S. government reports have maintained that China's voluntary declarations under the BWC have not acknowledged its military BW program before joining the BWC in 1984 and that China continues to violate the provisions of the treaty by maintaining elements of a biological warfare program. In turn, Chinese officials have consistently and forcefully denied these allegations. For instance, on 25 February 1993, CIA Director Woolsey confirmed "the possibility of an offensive biological weapons program in China, but decline[d] to comment any further in public."[28] A U.S. Arms Control and Disarmament Agency report published in July 1995 accused China of violating the BWC and maintaining an offensive BW program throughout the 1980s.[29] The U.S. State Department's 2003 *Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments* report stated that "China had an offensive BW program prior to 1984 when it became a State Party to the BWC, and maintained an offensive BW program throughout most of the 1980s" and "may retain elements of its biological warfare program".[30] The 2005 compliance report noted that

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24 Croddy 2002b.
25 Ibid., 27.
26 Ibid.; Chevrier and Hunger 2000, 32.
27 GlobalSecurity.org n.d.; Nuclear Threat Initiative 2014d.
28 Nuclear Threat Initiative 2013, 18.
29 Ibid., 17.
30 U.S. Department of State 2003, 8.

"the United States believes that China began its offensive BW program in the 1950s and continued its program throughout the Cold War, even after China acceded to the BWC in 1984" and that "some reports that China may still retain elements of its biological warfare program" reinforces "the United States' continued belief that China has not abandoned its offensive BW program".[31] In a September 2006 Congressional testimony, Assistant Secretary of State for Verification, Compliance, and Implementation Paula DeSutter stated that the U.S. maintained "reservations about China's current research activities and dual-use capabilities, which raise the possibility that sophisticated BW and CW work could be underway. [...] We also continue to believe that China maintains some elements of an offensive BW capability in violation of its BWC obligations."[32]

More recent reports have not repeated previous allegations of a continuing offensive program. For instance, the 2010 State Department compliance report noted that while "information indicates China engaged during the reporting period in dual-use biological activities […] available information did not indicate these involved activities prohibited by the BWC," while still drawing attention to the lack of accountability for its alleged pre-1984 offensive BW program.[33] Assessments of China's BW intentions were further downgraded in the 2011 report, which found that "available information indicates China engaged during the reporting period in biological activities with potential dual-use applications; however, the information did not indicate that China is engaged in activities prohibited by the BWC."[34] Notably, the report did not assert that a prior offensive BW program had existed, but ambiguously noted that "China's CBM [confidence building measure] declarations have not documented a historical offensive BW program."[35] Finally, China was completely excluded from the 2016 and 2017 report's section on the BWC.[36]

Due to a lack of evidence in the public domain—and the lack of details accompanying U.S. intelligence assessments—it is not possible to determine whether China has had an offensive BW program and, if so, when it commenced with this program, when it acquired an offensive BW warfare capability, and when it ended its program. We can only conclude that the U.S. government and intelligence community have been satisfied that China has not had an offensive BW program in recent years. With less certainty it can be deduced from the wording of recent compliance reports that there are doubts within the U.S. government whether China continued an offensive program after acceding to the BWC in 1984. Finally, the silence on China's pre-1984 activities in the reports since 2011 could indicate one of at least three things: 1) The U.S. government has revised its prior assessments and does not believe anymore that China had an offensive BW program pre-1984 (but this does not

31 U.S. Department of State 2005, 17.
32 Nuclear Threat Initiative 2013, 6.
33 U.S. Department of State 2010, 12.
34 U.S. Department of State 2011a, 5.
35 Ibid.
36 U.S. Department of State 2016; U.S. Department of State 2017.

explain why it does not explicitly say so); 2) China has provided insight in its pre-1984 activities on the condition of non-disclosure; or, 3) the U.S. government has decided not to further pursue the issue in the interest of continued Sino-U.S. relations.

Due to a lack of clear evidence in the public domain and contradictory assessments by the U.S. government over the years it is not possible to determine whether (and when) China pursued and/or possessed BWs.

Cuba

Horowitz and Narang[37] code Cuba as pursuing from 1988-1993 based solely on the OTA report.[38] The OTA report finds Cuba mentioned in only 1 out of 6 consulted sources. This provides insufficient basis to code Cuba as pursuing.[39] During the early 2000s, U.S. government officials asserted at various times that Cuba was capable of sustaining a BW research effort—unsurprising due to its significant biotechnology industry—or even that it was pursuing an offensive biological warfare program. Soon after the failure to locate weapons of mass destruction in Iraq, such claims were toned down. Above all, no evidence is available to substantiate claims that Cuba has attempted to acquire biological weapons.[40] Therefore, Cuba is coded as not pursuing.

Egypt

Horowitz and Narang[41] code Egypt as pursuing from 1945-1971 and possessing from 1972 up to and through 2000 (the end point of their study) based on five sources.[42]

Claims that Egypt has an offensive BW program surfaced in the 1970s but only gained traction at the end of the 1980s. Despite regular inclusion in lists of suspected biological weapons possessors, there is next to no evidence in the public record that corroborates such an assessment. The story begins with a scarcely known meeting between Egyptian president Gamal Abdel Nasser and American officials in the early 1960s, during which Nasser told interim U.S. national security advisor Robert Komer that "we [the Egyptians] know of one BW laboratory in Israel so we have two BW installations here".[43] Better publicized is a statement by Egyptian President Anwar Sadat at a February 1972 meeting of the Arab Socialist Union National Congress. In response to a question regarding the possibility of an Israeli BW attack, he answered: "we have the instruments of biological warfare in the refrigerator and

37 Horowitz and Narang 2014.

38 Office of Technology Assessment 1993a.

39 Horowitz and Narang also specify no pursuit as an alternative specification based on the reliance on the OTA report.

40 Nuclear Threat Initiative 2012a.

41 Horowitz and Narang 2014.

42 Center for Nonproliferation Studies 2008; Kerr 2008; Office of Technology Assessment 1993a; Shoham 1998; Stockholm International Peace Research Institute 1973, vol. II.

43 Quoted in Walsh 2001, 141.

we will not use them unless they begin to use them."[44] This statement is widely considered the smoking gun concerning Egypt's BW status. Indeed, all of the sources consulted by Horowitz and Narang refer to this statement and Horowitz and Narang code the start of BW possession in that very year.[45] However, the statement is ambiguous. As the Nuclear Threat Initiative notes, Sadat did not specify the nature of Egypt's BW capability and did not mention the possession of deliverable weapons.[46] Taken literally, Sadat's statement could mean as little as Egypt possessing pathogens stored in a refrigerator, as many states do as part of a defensive research program. Naturally, there is a great difference between "stocks of pathogenic cultures stored in refrigerators and a significant military capability for waging BW." [47] In a similar vein, Nasser's boast about BW installations does not indicate the nature of activities undertaken there and, presuming they were offensive, what stage of development they were in.

A declassified 1963 special national intelligence estimate (SNIE) concluded that "despite continuing accusations by both [Egypt] and Israel that the other is developing chemical, biological, and radiological weapons of mass destruction," the U.S. intelligence community had "no evidence to confirm these charges."[48] Nevertheless, countries were believed to be able to "produce small quantities of chemical or biological warfare devices designed for clandestine use."[49] The discussion section of the report was completely redacted, making it impossible to conclude whether the intelligence community believed that a CW or BW program existed. Towards the end of 1963 American officials met with their Israeli counterparts in Washington for two-day talks. During an intelligence sharing session on the Egyptian military, the Israelis relayed that while they suspected Egyptian production of chemical weapons there were no "concrete advances" in Egypt's biological warfare program, despite Egyptian interest in BW. The Americans, in turn, emphasized that Egypt's CW and BW efforts were "on a very limited scale."[50]

During the 1970s and 1980s there was little public discussion of Egyptian BW activities. The first significant discussion of Egypt's BW activities can be found in a 1993 report by the Russian Foreign Intelligence Service (SVR), which notes that "Egypt has a program of military-applied research in the sphere of biological weapons, but no data has been obtained on the creation of biological agents in the interests of military offensive programs." The report traces the BW research program back to the 1960s, noting that "in the early 1970s President Sadat confirmed this, announcing the presence in Egypt of a stockpile of biological agents stored in refrigerated facilities".[51]

44 Stockholm International Peace Research Institute 1973, vol. II, 241.
45 Horowitz and Narang 2014.
46 Nuclear Threat Initiative 2015c.
47 Stockholm International Peace Research Institute 1973, vol. II, 241–242.
48 Director of Central Intelligence 1963, 2.
49 Ibid.
50 Sirrs 2006, 125f.
51 Foreign Intelligence Service of the Russian Federation 1993; U.S. Senate Committee on Governmental Affairs 1993, 93.

Public discussion of Egypt's CBW activities by the U.S. government took place for a while in the 1990s. Egypt was named in various editions of the *Report on Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments* in the second half of the 1990s. In the period 1995-1998, these reports noted that:

> The United States believes that Egypt had developed biological warfare agents by 1972. There is no evidence to indicate that Egypt had eliminated this capability and it remains likely that the Egyptian capability to conduct biological warfare continues to exist.[52]

This statement implies a few things. The U.S. government seemed to be of the opinion that Egypt only possessed some unspecified quantities of BW agents as the report did not speak of weaponization of these agents, the existence of munitions, or the presence of a stockpile of biological weapons. This view is further supported by the fact that the report finds that "Egypt had developed [these] biological warfare agents by 1972," the year in which Sadat made the refrigerator statement. Not only is it likely that the assessment of Egypt's possession of agents by 1972 is based on Sadat's claim, but the passage that follows ("There is no evidence to indicate that Egypt had eliminated this capability") suggests that U.S. intelligence community does not possess any new evidence (newer than Sadat's 1972 pronouncement) that suggests the existence of an Egyptian BW program. The final passage—"it remains likely that the Egyptian capability to conduct biological warfare continues to exist"—is ambiguous, as said "capability" may only refer to the existence of some stocks of pathogens that *could* be used to develop deliverable biological weapons.

In contrast to the 1990s editions of the *Report on Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments*, later editions paint a different picture. While the 2003 and 2005 report make no mention of Egypt at all, the reports since 2010 explicitly state that "available information did not indicate any of [Egypt's] activities were inconsistent with the BWC."[53] Besides, various documents published by the intelligence community make no mention of Egypt at all in connection to biological weapons.[54]

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52 Nuclear Threat Initiative 2010a; U.S. Arms Control & Disarmament Agency 1995; U.S. Arms Control & Disarmament Agency 1997; U.S. Arms Control & Disarmament Agency 1998.

53 U.S. Department of State 2003; U.S. Department of State 2005; U.S. Department of State 2010; U.S. Department of State 2011; U.S. Department of State 2012; U.S. Department of State 2013; U.S. Department of State 2014; U.S. Department of State 2015; U.S. Department of State 2016. Note that while Egypt is a signatory it has not yet ratified the BWC.

54 Nuclear Threat Initiative 2015a. See, for instance, the following section 721 reports to Congress: Deputy Director of National Intelligence for Analysis 2006a; Deputy Director of National Intelligence for Analysis 2008; Director of Central Intelligence 2001a; Director of Central Intelligence 2001b; Director of Central Intelligence 2003b; Director of Central Intelligence 2004; Director of National Intelligence 2012..

Public information about Egyptian BW activities is limited and lacks specificity. Based on Nasser's and Sadat's statements it is plausible that Egypt started a BW research program with offensive characteristics at the end of the 1950s or early 1960s rising to the level of pursuit, likely at the same time as commencing with its CW research program (see CW Chronicles). However, there is no compelling evidence in the public domain that Egypt has produced and stockpiled biological weapons. Moreover, it is still unclear whether the BW research program was ever halted or is still continuing. Egypt is coded as starting pursuit in 1958 and continuing up to and through 2010 (the end date of this study), but given the constraints this coding should be considered uncertain.

France

Horowitz and Narang[55] code France as possessing BWs from 1945-1973 based on two sources.[56] However, neither source indicates that France possessed BWs during this time period.[57]

Although much has been written on France's arms policy, particularly on nuclear weapons, its BW program is largely overlooked.[58] Indeed, it is absent from most reference works and governmental reports. When it is mentioned, it is usually passingly.[59] While France was one of the countries during the *interbellum* to dabble in BW research,[60] its post-WWII program found its origin in a memo prepared by the *Bureau Scientifique de l'Armée* and addressed to Alphonse Juin, the chief of staff of the French armed forces.[61] This memo recommended that "systematic studies" be performed to explore the option of a BW program. The memo suggested an initial meeting and presented a five-point initial outline of a future BW program.[62] In April 1948 the proposals put forward at this initial meeting were adopted and a budget of five million Francs was allocated for "the launch of a germ warfare program".[63]

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55 Horowitz and Narang 2014.

56 Dando and Nixdorff 2009; Stockholm International Peace Research Institute 1973, vol. II.

57 Dando and Nixdorff merely state that "France resumed its biological weapons development activities soon after [World War II] ended [and] continued developing biological weapons up until the agreement of the Biological and Toxin Weapons Convention (BWC) in 1972." See Dando and Nixdorff 2009, 6. The SIPRI volume notes that "it is not publicly known whether France has in fact been conducting a biological weapons programme" See Stockholm International Peace Research Institute 1973, vol. II, 188.

58 Lepick 2009, 108.

59 e.g. Nuclear Threat Initiative 2014b.

60 Lepick 1999.

61 Lepick 2009, 109.

62 The five points were: 1) studies of dispersal devices (bombs, aerosols, atomizers); 2) studies of diseases caused by exotoxins and endotoxins and of diseases capable of being transmitted by insects; 3) studies on the detection of germs in the atmosphere; 4) studies on protection; 5) studies on biological aggression (contamination of waterways and foodstuffs, livestock, and crops, and investigations into the possibility of using insects as a vehicle of biological warfare).

63 Lepick 2009, 113f.

By the mid-1950s, the strategy shifted towards France's budding nuclear weapons program and the budget for the CBW programs were drastically reduced, slowing the BW program down to one of "scientific monitoring".[64] The BW program experienced a brief revival in the early 1960s upon the French learning of the importance that U.S. military leaders attached to BWs. Fearing that France's program would fall behind, the unofficial decision was taken towards the end of 1961 to reinvest in the program. In March 1962 Prime Minister Debré informed the defense minister that the government had decided to reboot the BW program. As Lepick aptly describes, "for the first time since the end of World War I, France was considering committing the country to maintaining a BW arsenal and no longer limiting its activities to R&D."[65]

However, by the summer of 1964, the Defense Council (*Conseil de Défense*) had decided that the creation of an operational CBW arsenal "a secondary priority behind other programs judged to be more essential" and limited work to "in the field of biological warfare [to] means of protection [which includes] limited-scope offensive operations integral to the work".[66] From that moment onwards, France progressively abandoned the offensive elements of the BW program. The end of France's BW program is often dated to the adoption of a bill by the French parliament in March 1972, which banned all work on the development, manufacture, or stockpiling of biological weapons.[67] Indeed, Horowitz and Narang do so too, as apparently does France's CBM submission under the BWC.[68] However, by the time that this formal ban was passed into law, the offensive elements of the BW program were already abandoned for some time, de facto if not by a formal decision. As Lepick describes, from early 1967 onwards the minutes of meetings of *Sous Groupe de Travail et d'Études Biologiques* (SGTEB)—the working group tasked with coordinating the BW program—referred only to CW issues, while traditional references to "aggression" in reports on progress in BW suddenly disappeared from the minutes.[69] At the same time, ministerial directives setting that year's research priorities favored offensive CWs, while on the BW side secondary importance was only given to BW detection. The de facto end of the offensive BW program was confirmed yet again in February 1969, when a request by the army chief of staff to formulate a concept a concept for biological armament was met with no response.

France is coded as starting pursuit in 1948 and ending offensive pursuit in 1967.[70]

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64 Ibid., 118.

65 Ibid., 122.

66 Ibid., 127.

67 Stockholm International Peace Research Institute 1973, vol. II, 187.

68 According to Chevrier and Hunger, France declared in its CBM submission—which is not available publicly—that it performed offensive BW activities from 1946-1973. See Chevrier and Hunger 2000, 32.

69 Lepick 2009, 133.

70 The end of pursuit can alternatively be coded in 1972 when a formal ban on all offensive BW activities was adopted by the French parliament.

India

Horowitz and Narang[71] code India as *not* pursuing or possessing BWs, but provide alternative specifications for pursuit and acquisition. Neither sources they consulted indicate that India has conducted offensive BW research,[72] nor do others.[73] Hence, India's no pursuit coding is retained.

Iran

Horowitz and Narang code Iran as pursuing BWs from 1981 up to and through 2000 (the end point of their study).[74] It is unclear why they opt to code the start of the program in 1981 as none of the sources they consulted make specific reference to this year.[75] Kerr merely notes that it is "likely" that Iran has a "biological weapons capability," but does not cite any supporting evidence.[76] Giles writes that "by the late 1980s, Iran was engaged in biological weapons research."[77] The Nuclear Threat Initiative entry on Iran provides an extensive discussion of the reports and statements regarding Iran's BW program, but concludes that they "leave much open to interpretation" and that "publicly available information is thus largely inconclusive about whether Iran maintains an offensive BW program."[78] Similarly, Cordesman and Seitz note that:

> Any analysis of Iran's biological weapons effort must be even more speculative than an analysis of its chemical and nuclear weapons efforts, and the details of its missile programs. Many claims can be traced back to hardline opponents of the regime that have uncertain to dubious credibility. Others provide important insights into Iran's potential capability, but do not prove Iran has an active program, or that it has ever produced such weapons.[79]

Since 1990 until the mid-2000s, unclassified U.S. intelligence reports and statements asserted that Iran had an active offensive BW program. Since the mid-2000s these reports have declined in certainty, similar to reporting on Iran's CW activities. One of the longest-running series of such reports is the 'section 721' report to Congress prepared

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71 Horowitz and Narang 2014.
72 Center for Nonproliferation Studies 2006; Stockholm International Peace Research Institute 1973, vol. II.
73 Nuclear Threat Initiative 2015g; Croddy and Wirtz 2005, vol. 1, 161; Arms Control Association 2014.
74 Horowitz and Narang 2014.
75 Cordesman and Seitz 2008; Giles 2000; Kerr 2008; Nuclear Threat Initiative 2011a; Office of Technology Assessment 1993a.
76 Kerr 2008, 20.
77 Giles 2000, 82.
78 Nuclear Threat Initiative 2011a.
79 Cordesman and Seitz 2008, 3.

by the intelligence community. The reports from 1998 until the end of 2000 noted that "[Iran's] biological warfare (BW) program began during the Iran-Iraq war, and Iran may have some limited capability for BW deployment."[80] The report over the first half of 2002 indicated that Iran "probably maintains an offensive BW program" and found it "likely that Iran has capabilities to produce small quantities of BW agents, but has a limited ability to weaponize them."[81] From mid-2002 there seems to be a downgrading of the intelligence community's assessment of Iran's BW status. The reports covering the period from July 2002 until December 2003 noted that Iran, "probably *maintained* [emphasis added] an offensive BW program."[82] The use of the past tense may indicate the intelligence community's belief that a BW program was not active anymore. This is reinforced by the next two reports, which assessed that "the status of Iran's biotechnology infrastructure indicated that at a minimum, Iran probably had the capability to produce at least small quantities of BW agents for offensive purposes."[83] The report over the year 2006 assessed that "Iran's biotechnology infrastructure indicates that Iran probably has the capability to produce large-quantities of some Biological Warfare (BW) agents for offensive purposes, if it made the decision to do so."[84] Finally, the report covering the year 2011 stated that Iran had "previously conducted offensive BW agent research and development," but "probably has the capability to produce some biological warfare (BW) agents for offensive purposes, if it made the decision to do so."[85]

The *Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments* reports paint a similarly incongruous picture. In 1993, the report provided that "Iran probably had produced biological warfare agents and apparently had weaponized a small quantity of those agents."[86] The 1995, 1996, 1997, and 1998 reports offered the following assessment:

> The Iranian BW program has been embedded within Iran's extensive biotechnology and pharmaceutical industries so as to obscure its activities. The Iranian military has used medical, education and scientific research organizations for many aspects of BW agent procurement, research, and production. Iran has also failed to submit the data declarations called for in the CBMs. The United States reiterates its previous finding that Iran

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80 See, among others, Director of Central Intelligence 1998; Director of Central Intelligence 2000; Director of Central Intelligence 2001a; Director of Central Intelligence 2001b.

81 Director of Central Intelligence 2003a.

82 Director of Central Intelligence 2003c; Director of Central Intelligence 2003b; Director of Central Intelligence 2004.

83 Deputy Director of National Intelligence for Analysis 2006a; Deputy Director of National Intelligence for Analysis 2006b.

84 Deputy Director of National Intelligence for Analysis 2008.

85 Director of National Intelligence 2012.

86 U.S. Department of State 2010, 16.

> probably has produced BW agents and apparently has weaponized a small quantity of those agents.[87]

The 2003 report included a more extensive discussion:

> Iran's biological warfare program began during the Iran-Iraq war. Hashemi-Rafsanjani—then Acting Commander in Chief of the Armed Forces and Speaker of the Majlis—was reported to have announced during an October 1988 speech: "We should fully equip ourselves both in the offensive and defensive use of chemical, bacteriological, and radiological weapons. From now on, you should make use of the opportunity and perform this task." The United States believes Iran has endeavored to follow through on Rafsanjani's direction.
>
> Iran has a growing biotechnology industry, significant pharmaceutical experience and the overall infrastructure to support its biological warfare program. Iran has expanded its efforts to seek considerable dual-use biotechnical materials and expertise from entities in Russia and elsewhere, ostensibly for civilian reasons.
>
> The Iranian BW program has been embedded within Iran's extensive biotechnology and pharmaceutical industries so as to obscure its activities. The Iranian military has used medical, education, and scientific research organizations for many aspects of BW agent procurement, research, and production. Iran has also failed to submit the data declarations called for in the CBMs.
>
> FINDING. The United States judges, based on available evidence, that Iran has an offensive biological weapons program in violation of the BWC. Iran is technically capable of producing at least rudimentary biological warheads for a variety of delivery systems, including missiles.[88]

The 2005 report repeated and expanded upon the discussion contained within the 2003 report, adding that:

87 U.S. Arms Control & Disarmament Agency 1995; U.S. Arms Control & Disarmament Agency 1996; U.S. Arms Control & Disarmament Agency 1997; U.S. Arms Control & Disarmament Agency 1998.

88 U.S. Department of State 2003, 9f.

> Available information about Iranian activities indicates a maturing offensive program with a rapidly evolving capability that may soon include the ability to deliver these weapons by a variety of means.[89]

After the mid-2000s, assessments of Iran's BW activities became more cautious (similar to the section 721 reports). The next State Department compliance report dates back to 2010, which reported that:

> Available information indicates Iran has remained engaged in dual-use BW-related activities. The United States notes that Iran may not have ended activities prohibited by the BWC, although available information does not conclusively indicate that Iran is currently conducting activities prohibited by the [Biological Weapons Convention].[90]

The reports published in the years 2011-2015, noted that:

> Available information indicated Iran continued during the reporting period to engage in activities with potential dual-use BW applications. It remained unclear whether any of these activities were prohibited by the BWC.[91]

Finally, the reports from 2016 and 2017 only addressed Russia, citing "insufficient information to support the inclusion of other countries."[92]

From the early 1990s until the mid-2000s, U.S. government reports spoke of an active Iranian effort to obtain biological weapons, alluded to the production of small amounts of BW agents and even the capability to deploy such weapons. Since then, these assessments have been downgraded and recently Iran was even excluded from such reports. One consistent factor in public U.S. government statements is the attention given to the potential military applications of Iran's growing biotechnology industry, its expertise with pharmaceuticals, its acquisition of dual-use technologies from abroad, and research conducted at its medical, education, and scientific institutes. For instance, in 2005 the State Department reported that:

> According to open press reporting, Iran is expanding its biotechnology and biomedical industries by building large, state-of-the-art research

89 U.S. Department of State 2005, 21.

90 U.S. Department of State 2010, 16.

91 U.S. Department of State 2011a, 8; U.S. Department of State 2012, 9f.; U.S. Department of State 2013, 12; U.S. Department of State 2014, 14; U.S. Department of State 2015, 15.

92 U.S. Department of State 2016, 12; U.S. Department of State 2017, 17.

> and pharmaceutical production facilities. These industries could easily hide pilot to industrial-scale production capabilities for a potential BW program, and could mask procurement of BW-related process equipment.[93]

Indeed, Iran's techno-scientific base gives it the ability to produce at least small amounts of BW agents and its capacity to pursue an offensive program has definitely increased over time. However, the existence of this capacity in isolation is by no means evidence of an offensive BW program.

Due to the classified nature of the analysis underlying such public pronouncements, it is unclear on which basis these assessments have been made and why they have been downgraded over time. It is significant that intelligence agencies have not provided any concrete evidence or definitive and unequivocal statements concerning Iran's alleged BW program. In this regard, Cordesman and Seitz noted that "It simply is not clear whether such statements reflect any knowledge that there was or is an actual program, and whether the judgments involved reflect suspicion, potential capability, a strong probability, or a fact."[94] Similarly, the Nuclear Threat Initiative questioned whether the declining certainty in compliance reports "reflects a change in the status on the ground, a change in the standard of evidence imposed upon the assessments, or a change in the political motivations that potentially influence these assessments."[95]

Sources in the public domain provide little to no corroborating or alternative evidence of an offensive BW program either. Two systematic reviews have reflected on the shortcomings of reporting on Iranian BW activities. Cordesman and Seitz note that most non-governmental reports repeat intelligence assessments, cannot be verified, or contain information from an opposition group that "has long been a major source of information and misinformation on Iran's WMD efforts."[96] Similarly, the Nuclear Threat Initiative found that "most of the literature and accusations come from CIA reports, expert analysis without sources, and claims by Iranian dissidents."[97]

Reports of Iranian BW activities started to surface in the American press in the 1980s. In 1989, the New York Times, citing U.S. intelligence sources, reported that Iran had unsuccessfully attempted to import several strains of fungus that can be used to produce mycotoxins from Canada and the Netherlands.[98] Tellingly, the report also indicates that American officials and independent scientists offered "several likely explanations for Iran's efforts to purchase the strains," including medical research and for defensive BW research.

93 U.S. Department of State 2005, 21.
94 Cordesman and Seitz 2009, 164.
95 Nuclear Threat Initiative 2011a.
96 Cordesman and Seitz 2009, 166.
97 Nuclear Threat Initiative 2011a.
98 Gordon and Engelberg 1989.

The attempts to purchase fungal species have been cited years after the fact as evidence that Iran has an offensive BW program[99] and was even cited in the Russian Foreign Intelligence Service report on WMD.[100]

Allegations of the existence of an offensive Iranian BW program can be traced back to successive U.S. government statements and reports. Unclassified reports and testimonies have drawn attention to Iran's capability to produce BW agents and its acquisition of dual-use technologies that could advance its production capability of such agents. These reports also spoke of the existence of an offensive program and even the production and subsequent weaponization of BW agents in the 1990s until the mid-2000s. Nonetheless, no specific evidence has ever been presented to back up these assertions. Neither is there any evidence available in the public domain. Since the mid-2000s, U.S. government assessments have been consistently downgraded and since 2016 Iran has not even included in proliferation reports. Iran's advanced biotechnology industry and research capability certainly puts it in the position to develop and produce biological weapons. Yet, there is no credible evidence available to support the conclusion that it already has. It is also possible—though unproven, given the available evidence—that Iran had an offensive BW research program in the past.[101] However, based on the available evidence, which amounts to little more than unfounded assertions and extrapolations from assessments of scientific knowhow and industrial capability, Iran cannot be coded as having pursued or possessed biological weapons.

Iraq

Horowitz and Narang[102] code Iraq as pursuing from 1974-1986, possessing from 1987-1991, and returning back to pursuit from 1992 up to and through 2000 (the end point of their study) based on six sources.[103]

A United Nations Special Commission (UNSCOM) report describes that during a visit of a UN biological expert team to Baghdad in August 1995, Iraq declared that "in 1974, the [Iraqi] Government had adopted a policy to acquire biological weapons" and a "a research and development biological weapons programme was established under the Al Hazen Ibn Al Haytham Institute at a site located in Al Salman."[104] However, the Institute was said to have achieved little and it was closed in 1978.[105] The account of Iraq's biological program by the United Nations Monitoring, Verification and Inspection Commission (UNMOVIC)—

99 See, for instance, Eisenstadt 1995; Shoham 2005.

100 Foreign Intelligence Service of the Russian Federation 1993; U.S. Senate Committee on Governmental Affairs 1993, 98.

101 This seems to have been the U.S. government's position in more recent years.

102 Horowitz and Narang 2014.

103 Center for Nonproliferation Studies 2006; Center for Nonproliferation Studies 2008; Federation of American Scientists 1998b; Kerr 2008; Nuclear Threat Initiative 2011b; Office of Technology Assessment 1993a.

104 UNSCOM 1995, 22.

105 Ibid.

which was created in 1999 by the UN Security Council to replace UNSCOM—provides a more detailed view of this episode. The UNMOVIC compendium notes that the Al Hazen Ibn Al Haytham Institute's research into micro-organisms did not concern those traditionally associated with biological warfare, except for an attempt to produce botulinum toxin.[106] Surprisingly, UN inspectors found no evidence that an enhanced literature search was conducted within the Institute to determine suitable candidate agents, "which would be obvious for the start of a BW programme".[107] The authors of the UNMOVIC compendium also commented that studies that were conducted into water and food contaminants and botulinum toxin "are more indicative of regime protection or of a [*sic*] 'dirty tricks' than of a military biological warfare programme."[108] Nevertheless, "even limited progress achieved by [the institute] could possibly have provided a sound research basis for developments that were to come, and hence shorten the lead-time to the production of biological weapons."[109]

In 1981, Project 922 was established to produce and deploy chemical weapons (see CW Chronicles). For this purpose, 922 inherited some of the equipment and staff of the Al Haitham Institute. Although the express purpose of the project was to develop CW, its director Major General Nizar Attar reportedly sought and obtained approval from the Minister of Defense to include biological research and development within its CW work.[110] However, it took until 1985 for the BW work at 922 to start. According to Iraqi declarations, the biological team was to carry out R&D work necessary for the production of agents on a laboratory scale and to evaluate their suitability as BW agents. Yet, no plans were formulated for the large-scale production, weaponization, and storing of BW agents during the first few months of 1985. Based on this preliminary work, General Attar drafted a one-page report in mid-1985 proposing a BW program that could "succeed in five years to do something," which was met with a favorable response by the Minister of Defense. Perhaps as a result of this report, a five-year plan that was to lead to BW weaponization was drawn up in 1986 according to the former leader of the BW group, in an interview conducted by the Iraq Survey Group (ISG).[111]

Iraq started field-testing weapons filled with BW agents in 1988 using small quantities of agents specifically produced for this purpose. Testing was reportedly halted in mid-1988, but continued a year later until mid-January 1991.[112] As the Duelfer report notes, by early 1990, Iraq "was methodically advancing toward the acquisition of a BW component to its

106 UNMOVIC 2007, 770.
107 Ibid., 772.
108 Ibid.
109 Ibid.
110 Ibid., 775f.
111 Ibid., 777. The Iraq Survey Group was the fact finding mission led by the Central Intelligence Agency (CIA) and Defense Intelligence Agency (DIA) to find weapons of mass destruction allegedly possessed by Iraq. The ISG's final report is commonly referred to as the Duelfer report.
112 Ibid., 787.

arsenal of WMD."[113] According to the same report, the BW program was ordered to go for all out weaponization following Saddam's speech on April 2nd, 1990, that identified Israel as a threat. As Iraq invaded Kuwait on August 2nd of that year, the BW program was moving at a frantic pace, producing quantities of various BW agents with the aim of deploying filled weapons as quickly as possible. A few days after the invasion, Saddam's brother in law, General Hussein Kamel, ordered the production and filling with BW agent of 200 R-400 aerial bombs and 25 Al Hussein missile warheads, which were delivered between December 1990 and January 1991.[114]

Iraq declared in 1995 that it had destroyed all bulk BW agent and munitions in the summer of 1991 and decided to only admit work on research and development of BWs.[115] Neither UN inspectors nor the ISG have found any evidence that contradicts these claims.[116] Iraq's decision to not declare BW production must be seen in the light of its intention to resume its BW program after inspections ended and sanctions were lifted. To this end, Iraq destroyed or hid documents of the shuttered BW program, destroyed several research laboratories and a munitions filling plant, and converted one plant (Al Hakam) to commercial use—chiefly the production of bio pesticides—to save equipment from destruction by UN inspectors and retain production technology know-how.[117] As an Iraqi scientist interviewed by ISG noted, "Al Hakam was kept as potential for the BW program in the future."[118] Despite the Iraqi regime's intent to restart the BW program at a future date, the ISG found no evidence "that biological agents were researched for BW purposes post-1991, even though Iraq maintained—and in some cases improved—research capabilities that could have easily been applied to BW agents."[119]

Iraq is coded as pursuing for the first time in the period 1974-1978 and again from 1985-1989. The start of possession is coded in 1990 and the end of possession in 1991.[120]

Israel

Surprisingly, Horowitz and Narang do not discuss Israel's BW program, even though it is referred to by many of the sources they consider for other cases.[121]

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113 Duelfer 2005a, 9.

114 UNMOVIC 2007, 788. Notably, the Iraq Survey Group determined that the weapons "were not well designed technically and the result of an immature development program [...] but could have been effective in certain circumstances." See Duelfer 2005, 10.

115 UNMOVIC 2007, 791.

116 Ibid.

117 Duelfer 2005a, 11f.; UNMOVIC 2007, 1027.

118 Duelfer 2005a, 13.

119 Ibid., 18.

120 The period 1991-1995 could be considered be considered lower-level BW activity in order to retain the option to restart BW pursuit, akin to the *exploration* stage conceived of in studies of the spread of nuclear weapons. See, for instance, Singh and Way 2004; Bleek and Lorber 2014.

121 Among which, Center for Nonproliferation Studies 2006; Center for Nonproliferation Studies 2008; Cohen 2001; Cordesman 2005; Kerr 2008.

In 1948, a unit devoted to biological and chemical warfare (known by its Hebrew acronym HEMED BEIT) was set up under the Israel Defense Force's Science Corps (HEMED). In a 1993 interview, Ephraim Katzir, the former commander of HEMED and later president of Israel, stated the following on the rationale behind the founding of HEMED BEIT:

> We planned various activities, to get a sense what CBW is and how could we build a potential [in this area] should there be a need for such a potential. We needed to know how to defend [against such weapons] I thought that we ought to know what was going on in this field. We knew that in the surrounding countries others were also developing BW.[122]

Cohen, however, comments that "this retrospective account is inaccurate and self-serving. No evidence suggests that in 1948 any of the surrounding Arab countries were developing BW, and HEMED BEIT was probably not created for defensive purposes."[123] Moreover, in April 1948, David Ben-Gurion wrote a letter to a Jewish Agency operative in Europe with instructions to recruit East European Jewish scientists who could "either increase the capacity to kill masses or to cure masses; both are important."[124]

Although there is no public record of HEMED BEIT's early operations, there are credible accusations of Israeli use of biological agents to contaminate wells in many conquered Arab villages in 1948 in order to prevent Arab inhabitants from returning, while Jewish fighters have also been accused of causing outbreaks of cholera and dysentery in Egypt and Syria.[125]

In 1952, HEMED's wartime work was converted into 'Machons,' a group of research centers sponsored by the Ministry of Defense. That year saw the establishment of the Israel Atomic Energy Commission (IAEC; which assumed the work in the nuclear field) and the Israel Institute of Biological Research (IIBR; a merger of HEMED BEIT and another chemistry-oriented Machon) focusing on chemical and biological R&D.[126] Cohen argues that it is doubtful that a distinction was made between defensive and offensive research at the time.[127]

Information about Israel's BW program from government sources is scarce. While the U.S. government has expressed its belief that Israel was developing and possessed CW at various instances (see the entry on Israel in Chapter 6), its pronouncements on Israeli BW capabilities have been rare and cautious. A 1963 CIA report noted that,

> Despite continuing accusations by both the UAR and Israel that the

122 Cohen 2001, 30.
123 Ibid.
124 Ibid., 27.
125 Carus 2001, 87f.; Cohen 2001, 31; Normark et al. 2005, 34.
126 Cohen 2001, 33.
127 Ibid.

> other is developing chemical, biological, and radiological weapons of mass destruction, we have no evidence to confirm these charges. Both countries could, however, produce small quantities of chemical or biological warfare devices designed for clandestine use.[128]

During a 1974 hearing before Congress, General Almquist testified that Israeli officials had admitted to possessing an offensive CW capability, but professed ignorance about Israel's BW status.[129] In 1993 a Russian Foreign Intelligence Service reported that:

> There is no direct evidence of the existence of biological weapons in Israel. At the same time, according to various signs, an extensive program of biological studies of a general nature is being implemented in Israel, in which elements of military-applied use are present. In general, Israel has a powerful civil biotechnological base, which, if necessary, can be quickly reoriented to produce biological weapons.[130]

Details about Israel's BW program in the open literature are also scant as Israel maintains absolute secrecy over its BW activities and neither confirms nor denies possession of BW. Cohen notes in his study of Israel's CBW program that while a "near-consensus exists among experts—based on anecdotal evidence and intelligence leaks—that Israel developed, produced, stockpiled, and perhaps even deployed CW at some point in its history," assessments of its BW activities are often "tentative and speculative".[131] Israel maintains a policy of deliberate ambiguity regarding its possession of nuclear, chemical, and biological weapons, which means that it is intentionally ambiguous about its possession of weapons of mass destruction. Unlike most Western states that openly acknowledge a defensive BW program, Israel does not even characterize its biological research at IIBR as defensive and thus legitimate.[132]

The extreme measures of secrecy became apparent to the public following the uncovering of the 'Klingberg affair.' In 1983, the former deputy head of the IIBR, Marcus Klingberg, disappeared whilst traveling. It took nearly ten years before a British reporter revealed that Klingberg had been kidnapped and tried in absolute secrecy on charges of providing the Soviet Union with information on Israel's CBW activities.[133] Klingberg later wrote in his memoir that one of the reasons for becoming a Soviet spy was his belief that the secrets of weapons of mass destruction should be shared so that both sides in the Cold War would be

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128 Director of Central Intelligence 1963, 2.
129 Burck and Flowerree 1991, 192.
130 Foreign Intelligence Service of the Russian Federation 1993.
131 Cohen 2001, 39.
132 Ibid.
133 Normark et al. 2005, 37.

less likely to use them.[134] The cover-up of Klingberg's arrest and detention is similar to that of Mordechai Vanunu, the whistleblower who publicized Israel's secret nuclear weapons program just a few years later. In 1998 a newspaper reported that crews of Israeli F-16 fighter jets have been trained to load active chemical or biological weapons on their aircraft within minutes of receiving an order to engage. The report also quoted a former biologist who held a senior post in Israeli intelligence as saying that "There is hardly a single known or unknown form of chemical or biological weapon . . . which is not manufactured at the institute".[135] Regardless of its actual BW-status, it is clear that Israel purposefully maintains a policy of ambiguity that allows it to enjoy the benefits of deterring its neighbors without facing the costs associated with public acknowledgement of possession. As a result, Israel has not joined the 1972 BWC that outlaws the development, production, and possession of biological weapons.

Despite the extreme measures of secrecy, it is clear that IIBR produces large amounts of research that are relevant to the production of BW. Dutch reporter Karel Knip searched digital databases of medical literature for unclassified research conducted by around 140 IIBR-affiliated scientists over a period of nearly 50 years. His analysis revealed that from its early days the institute conducted research into bacteriological agents, incapacitating agents, and toxins.[136] While a bibliographical analysis is useful for reconstructing research interests and institutional trends, it cannot by itself indicate whether a country has an offensive CBW program.[137] Nevertheless, Knip's analysis offers intriguing indications. For one, it reveals that many IIBR-affiliated researchers only publish once every three years at most and much of the research done at IIBR lacks grounding within a longer-term research program. Only the fundamental research into acetylcholinesterase and Alzheimer's seem to be part of continued research lines. It is very likely that only a fraction of research performed at IIBR is publicized. Second, it is striking that the institute has published nothing about well-known classical biological agents such as anthrax or botulinum toxin, making it likely that this research is conducted in secret. Third, and most worrisome, is the research that was conducted since the late 1950s into freeze drying and micro-encapsulation techniques, which are predominantly of interest for offensive applications.

It is clear that the predecessor of the Israeli armed forces had pursued, developed, and even used a rudimentary BW capability in the period leading up to and during the 1948 Arab-Israeli War and Israel's declaration of independence. Hence, Israel is coded as possessing BW since 1948 (but strictly speaking pursued and acquired them before independence). Information on Israel's BW activities since the 1950s is limited. There are

134 Pringle 2014.
135 Mahnaimi 1998.
136 Knip 1999.
137 Cohen 2001, 39.

no indications that Israel ever ended its offensive BW program.[138] However, it is clear from the published research that is conducted at IIBR that Israel has a very strong technological and scientific base in the field of biotechnology and has a clear interest in the offensive military applications of it. Combined with Israel's ambiguity surrounding the topic—in particular its refusal to deny BW possession—it is plausible that Israel has an ongoing offensive BW program, possibly with possession of agents or weapons. Therefore, Israel is coded as possessing from 1948 up to and through 2010 (the end date of this study).[139]

Laos

Horowitz and Narang[140] code Laos as pursuing from 1988-1993 based solely on the OTA report.[141] The OTA report finds Laos mentioned in only 1 out of 6 consulted sources. This provides insufficient basis to code Laos as pursuing.[142]

Laos was one of the countries charged by United States in the early 1980s of having used mycotoxins supplied to it by the Soviet Union, in what is known now as the "Yellow Rain Affair". The U.S. government's investigation provided only circumstantial proof of the use of mycotoxins,[143] while subsequent research has severely criticized if not disproven the allegations.[144] Hence, Laos is coded as not pursuing BWs.

Libya

Horowitz and Narang[145] code Libya as pursuing from 1988-2000 based on five sources.[146]

Throughout the 1990s and the first two years of the 2000s, Libya was regularly accused by the United States of having a clandestine offensive BW program.[147] However, since the landmark 2003 agreement that led to the dismantlement of Libya's non-conventional weapons program no evidence of an offensive BW program has been found by inspectors. The report of the Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, commissioned by President George W. Bush, notes that "[s] ome discrepancies did exist between analysts' judgments prior to 2003 and the realities

138 At the same time, there are no definitive indications that it has continued developing its offensive BW assets.

139 Alternatively, Israel may also have ended possession at some unspecified time and continued with pursuit of a BW option, although that is less plausible from publicly available information.

140 Horowitz and Narang 2014.

141 Office of Technology Assessment 1993a.

142 Horowitz and Narang also specify no pursuit as an alternative specification because of their reliance on the OTA report.

143 Croddy and Wirtz 2005, vol. 1, 337.

144 Meselson and Robinson 2008; Pribbenow 2006; Tucker 2001b.

145 Horowitz and Narang 2014.

146 Center for Nonproliferation Studies 2006; Center for Nonproliferation Studies 2008; GlobalSecurity.org 2011; Nuclear Threat Initiative 2011c; Office of Technology Assessment 1993a.

147 For an extensive summary of these allegations, see Nuclear Threat Initiative 2015a.

found in Libya".[148] One of these discrepancies was that "no evidence of an expected small-scale Libyan biological weapons program has been uncovered [by British and American inspectors]."[149] Nevertheless, the U.S. intelligence community assessed that Libya may have intended in the past to pursue BWs. A 2003 unclassified report to Congress notes that "Libya disclosed past intentions to acquire equipment and develop capabilities related to biological warfare, but it remains unclear if these activities were offensive or defensive in nature." [150] And, the Commission on Intelligence Capabilities reported that "[o]ne Libyan official stated that while Libya intended to build an offensive biological weapons program, it never went beyond the planning stage, and that Qadafi considered the biological program too dangerous and ordered its termination sometime prior to 1993."[151] Other low-level Libyan officials interviewed by the inspectors have denied working on an offensive program and claimed to have stopped working in the (ostensibly) defensive BW program altogether in the early 1990s.[152]

While the U.S. intelligence community still has some unresolved questions about the intent behind and nature of Libya's biological activities until the 1990s, there is no evidence to suggest that it had an offensive BW research and/or production program. It is, however, possible that it conducted preliminary work towards an offensive BW program that did not go beyond the planning stage. Therefore, Libya is coded as not pursuing.

North Korea

Horowitz and Narang[153] code North Korea as pursuing from 1965-1987 and possessing from 1988 up to and through 2000 (the end point of their study) based on five sources.[154] It is unclear why Horowitz and Narang opt for these particular dates as none of the sources they cite mention them.

Information regarding North Korea's BW program is very limited. As Waldenström, Norlander and Puu note, "a critical survey of the published information shows […] that the material is meagre" and that "the same allegations are repeated from year to year, but there are very few reliable sources and no details of a programme."[155] In particular, specifics concerning the genesis of a North Korean BW program are scarce. The open-source literature contains some references to North Korean BW program beginning in "the 1960s".[156] U.S. government sources, for instance, have stated over the years that North

148 Commission on Intelligence Capabilities 2005, 252f.
149 Ibid.
150 Director of Intelligence 2004.
151 Commission on Intelligence Capabilities 2005, 255.
152 Ibid., 255f.
153 Horowitz and Narang 2014.
154 Center for Nonproliferation Studies 2008; Federation of American Scientists 1998a; Kerr 2008; Office of Technology Assessment 1993a; Wisconsin Project On Nuclear Arms Control 2005.
155 Waldenström, Norlander, and Puu 2005, 45.
156 Pinkston 2009, 113.

Korea has pursued "biological warfare capabilities" since the 1960s,[157] although it is unclear what is meant by "biological warfare capabilities" and impossible to assess the basis for this judgment.[158] The International Crisis Group reports that South Korea's chief intelligence agency informed the South Korean parliament in 1992 that "in the early 1960s, Kim Il-sung directed the Academy of Defence Sciences […] to develop biological weapons."[159] A 1999 Korean-language press report notes that in the early 1960s, Kim Il-Sung ordered the "concentrated development of biological weapons," adding that biological weapons would be "most effective in war in the future".[160] Referring to the same press report, Egan indicates that this directive was issued in 1964.[161] Finally, The Nuclear Threat Initiative cites another Korean-language press report, asserting that "Kim Il Sung ordered the establishment of a biological weapons program in the early 1960s."[162] However, the report in question[163] actually discusses North Korea's CW program, not its BW efforts. Given the extremely limited information, any coding of the start of North Korea's pursuit of biological weapons is speculative. Based on the available information, it could have taken place in the early 1960s, 1964 in particular.[164]

The South Korean, U.S., and Russian intelligence communities have commented on North Korea's BW program over the years. The most forceful accusations originate from South Korea. A 1998 defense white paper released by the South Korean Ministry of National Defense (MND), assessed that "by 1980, [North Korea] had succeeded in its experiments in bacteria and virus cultivation to produce biological weapons, and by the late 1980s had completed live experiments with such weapons"[165] In its 2006 white paper, the MND noted that "Pyongyang has been producing poison gas and biological weapons since the 1980s. It is believed that… North Korea is able to produce biological weapons such as the bacteria of anthrax, smallpox, and cholera."[166] In contrast to South Korea, U.S. government assessments of North Korea's BW program were conflicted throughout the 1990s and early 2000s. Some estimates pointed to the mere capability of producing BW agents, while others judged North Korea to be in possession of stocks of weaponized agents. A 1997 Department of Defense

157 See, for instance, U.S. Department of Defense 2001, 10; U.S. Department of State 2003, 11; U.S. Department of State 2005, 26; U.S. Department of State 2010, 20.

158 The State Department's compliance reports since 2011 have only focused on current compliance issues concerning multilateral arms control and disarmament treaties and do not comment on the history of North Korea's BW programs.

159 International Crisis Group 2009, 11.

160 As cited in Nuclear Threat Initiative 2012b, 10f.

161 Egan 2005, 51.

162 Nuclear Threat Initiative 2011d.

163 Tae-won 2004.

164 The early stages of BW and CW programs often go hand in hand, usually with BWs lagging behind, see UNMOVIC 2007, 776. Thus, the plausibility of this coding is modestly increased by its temporal proximity to the start of North Korea's CW pursuit in 1961 (see entry on North Korea in the CW Chronicle).

165 Cited in International Institute for Strategic Studies 2004, 60.

166 Cited in Nuclear Threat Initiative 2011d.

report assessed that "North Korean resources, including a biotechnical infrastructure, are sufficient to support production of limited quantities of infectious biological warfare agents, toxins, and possibly crude biological weapons."[167] That same year, the Commander of U.S. Forces in Korea, General John H. Tilelli, testified before the Senate Armed Services Committee that Pyongyang "deploys a large stock of chemical and perhaps biological weapons."[168] In 2002, Tilelli's successor, General Thomas A. Schwartz, testified before the U.S. Senate that "North Korea has the *capability* [emphasis added] to develop, produce and weaponize biological warfare agents."[169] Later that year, U.S. Under Secretary of State for Arms Control and International Security, John R. Bolton, claimed that, North Korea "has developed and produced, and may have weaponized, BW agents."[170] Finally, a 1993 Russian intelligence report on the spread of weapons of mass destruction contained the least pessimistic assessment of the North's BW activities. The report notes that North Korea was conducting "applied military biological research" with anthrax, cholera, bubonic plague and smallpox at a number of universities, medical institutions, and specialized research institutes.[171] The report also assessed that "tests are conducted with biological agents on islands belonging to the DPRK," but that no data was reported on "the offensive nature of these programs."[172] Curiously, the translation of the Russian-language report prepared by the CIA's Foreign Broadcast Information Service (FBIS), of which excerpts were made available during a U.S. Senate hearing on February 24, 1993, stated that "biological *weapons* [emphasis added] are being tested on the island territories belonging to the DPRK"[173] The translation of the Russian phrase "агентов БО" (*agentov BO*) as "biological weapons" instead of "biological weapons agents" is a meaningful translation error. On top of this, the translated excerpts made public by the Senate Committee omits the follow-up sentence that indicates the lack of intelligence on the offensive nature of the program. Taken together, they significantly misrepresent the Russian intelligence service's assessments of the scope and nature of North Korea's BW program.[174]

In recent year, government assessments of the status of North Korea's BW program have been downgraded. For instance, recent South Korean defense white papers have merely concluded that the North has the *capability* to "cultivate" and "produce" various agents such as anthrax, smallpox, pest, and cholera.[175] Similarly, U.S. government assessments have

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167 U.S. Department of Defense 1997.

168 International Crisis Group 2009, 11.

169 Nuclear Threat Initiative 2015k.

170 Bolton 2002.

171 Foreign Intelligence Service of the Russian Federation 1993.

172 Ibid.

173 U.S. Senate Committee on Governmental Affairs 1993, 65.

174 References to the Russian intelligence report in English-language literature almost always refer to the translated excerpts in the Senate hearing documentation.

175 Republic of Korea Ministry of National Defense 2008, 40; Republic of Korea Ministry of National Defense 2010, 35; Republic of Korea Ministry of National Defense 2012, 36; Republic of Korea Ministry of National Defense 2014, 32.

been revised. In 2005, the Commander of U.S. Forces in Korea, General Leon Laporte, stated that he did not believe that Pyongyang was able to weaponize biological weapons, but that "we know they have worked that and are experimenting".[176] A year later, Laporte's successor, General Burwell Bell, testified before Congress that "some reports suggest that Pyongyang may have a biological weapons research program."[177] Unclassified 'Section 721' reports to Congress have noted that North Korea "has a biotechnology infrastructure that could support the production of various BW agents" and "possesses a conventional munitions production infrastructure that could be used to weaponize BW agents".[178] The Department of State's annual compliance reports have been even less conclusive. The 2015 report, for instance, stated that while "North Korea has a longstanding BW capability and biotechnology infrastructure that could support a BW program, our information during the reporting period is not definitive and cannot support a finding of noncompliance [with the BWC]."[179]

The available intelligence assessments indicate the possible existence of a BW research and development program. However, due to the lack of access to the underlying analyses and sources it is difficult to determine the progress of the program or even whether it has an offensive component. Testimonies by North Korean defectors are an alternative source of information. A number of individuals have described chemical and biological tests on live human beings and the location of CBW research facilities.[180] However, these reports cannot be independently confirmed.

North Korea is coded as starting pursuit in 1964 and continuing to pursue up to and through 2010 (the end date of this study). However, both dates should be considered uncertain.

Rhodesia

Horowitz and Narang[181] code Rhodesia as pursuing BWs in 1975 and possessing from 1976-1980 based on Martinez,[182] but present "no pursuit/acquisition" as a potential alternative specification. However, Martinez' study does not sufficiently disentangle Rhodesia's development and use of industrial chemicals as warfare agents from its involvement with pathogens and toxins.

Research conducted by Gould and a monograph by Cross provide the most detailed insight into Rhodesia's CBW program, making use of documentary evidence and testimonies

176 Garamone 2005.

177 Bell 2006.

178 see e.g. Deputy Director of National Intelligence for Analysis 2006a; Director of National Intelligence 2012.

179 U.S. Department of State 2015.

180 International Crisis Group 2009, 11f.; International Institute for Strategic Studies 2004, 60f.; Waldenström, Norlander, and Puu 2005, 49; Bennett 2013, 2–3; Nuclear Threat Initiative 2011d.

181 Horowitz and Narang 2014.

182 Martinez 2002.

of Rhodesians involved in the program.[183] During the Rhodesian Bush War (also known as the Zimbabwe War of Liberation) in the second half of the 1970s, the security forces of the increasingly isolated white minority regime resorted to counterinsurgency operations, among which so-called "pseudo-operations," psychological warfare, assassinations, and the use of toxic substances to resist nationalist guerillas.[184] Exact dates about the program are contested. Between mid-1975 and mid-1976, a proposal for a chemical and biological (mostly toxin) weapons program was submitted and the first experiments began in 1976[185] The program was small and rudimentary and primarily focused on the developments of weapons to be used against African nationalist guerrillas based on readily available toxic industrial and agricultural chemicals rather than the development of 'traditional' chemical warfare agents.[186] The Rhodesians contaminated clothing intended for guerrillas with parathion (an organophosphate insecticide), injected canned foods and beverages with thallium (a highly toxic heavy metal used in rodenticides), and poisoned bulk foods such as mielie (corn) meal with warfarin (an anticoagulant used in rodenticides).[187] According to members of the Rhodesian CBW team, poisoning of clothes began in April 1977 and the contamination of food, beverages and medicines in May/June 1977.[188]

The BW component of the program seems to have been less prevalent and seems to have yielded no significant production of pathogens or toxins. An early document describing the possible directions of the CBW program described mostly chemicals and a few toxins that were deemed of interest, but no other biological warfare agents.[189] While the CBW team experimented with several toxins and possible even considered and experimented with some other biological agents (e.g. *V. cholera* and *B. anthracis*) it is not evident that the Rhodesians ever actually produced and/or used biological weapons. Cross assesses that the production of BW agents and toxins seems to have begun in early 1979 when Victor Noble, one of the members of the CBW team, returned from South Africa bearing a vial of *C. botulinum* and a sample of *B. anthracis*.[190] Yet, "no evidence exists to suggest that the Rhodesians ever attempted to isolate, culture or cultivate *B. anthracis*."[191] The Rhodesians did attempt to produce botulinum toxin "by heating water bowsers filled with water, corn, rotted meat and *C. botulinum*."[192] However, this is an ineffective method for cultivating *C. botulinum* and it remains unclear how successful this procedure was.[193] The toxin was

183 Gould and Folb 2002; Gould 2005; Cross 2017.
184 Bale 2006, 30.
185 Cross 2017, 74.
186 Ibid., 249f.
187 Ibid., 106–110; Gould and Folb 2000, 26ff.
188 Cross 2017, 74.
189 Ibid., 80.
190 Ibid., 111.
191 Ibid.
192 Ibid.
193 Ibid.

allegedly used in attacks on guerrilla camps in Mozambique, but no confirmation exists to substantiate the claim.[194] The only biological weapon to have actually been used was *V. cholera*e. The causative agent for cholera was reportedly used by Rhodesian troops to contaminate wells and other water sources in Mozambique starting around 1973. This predates the establishment of the CBW program in the second half of the 1970s. There are several published accounts of the use of *V. cholera* by Rhodesian forces.[195] However, it remains unclear how Rhodesia's armed forces obtained the cultures, particularly since its medical laboratories did not possess the capability to produce pathogens in significant quantities, making it most likely that the cultures and possibly 'finished' agents were provided by South Africa.[196]

Rhodesia is coded as starting pursuit of chemical and biological weapons in 1976. Possession of chemical weapons started in early 1977. There are no indications that that the CBW program in the second half of the 1970s led to BW possession. The use of *V. cholerae* starting in the early 1970s at most indicates the possession of some limited amounts of BW. However, questions surrounding the origins of the pathogen and Rhodesia's ability to produce it without South African assistance leads to Rhodesia not being coded as not possessing (although possession is a possible alternative coding). Rhodesia is coded as ending possession of CW and pursuit of BW when the war came to a close in 1979.[197]

South Africa

Horowitz and Narang[198] code South Africa as pursuing from 1945-1975 and possessing from 1976-1993 based on six sources.[199]

As the Apartheid regime felt increasingly threatened by internal unrest and the escalation of hostilities in neighboring Angola and Mozambique, a feasibility study for the establishment of a CBW program with the code name 'Project Coast' was commissioned by the chief of defense force in August 1981 and later that year the minister of defense officially approved the establishment of a CBW R&D program.[200] The offensive nature of the program was confirmed in a secret November 1989 military report. The report, prepared by Project Coast's head, dr. Wouter Basson, stated that Project Coast was designed with, among others, the following in mind:

- "Research with regards to the basic aspects of chemical warfare (offensive)."

194 Ibid., 113.
195 Ibid., 111–13.
196 Ibid., 111.
197 Ibid., 135.
198 Horowitz and Narang 2014.
199 Burgess and Purkitt 2004; Center for Nonproliferation Studies 2008; Gould and Folb 2000; Office of Technology Assessment 1993a; Prasad 2009; Stockholm International Peace Research Institute 1971, vol. I.
200 Gould and Folb 2000, 12.

- "Research with regard to the basic aspects of biological warfare (offensive)."
- "Research with regard to offensive systems, both covert and conventional."
- "The creation of an industrial capability with regard to the production of offensive and defensive CBW equipment. In this regard, the project provides access to the basic technology through acting as a middleman between the local and overseas companies."
- "Support to CBW operations (offensive and defensive) through the export of security forces. This is usually divided into two sections: Conventional: this support usually includes distribution of equipment (offensive and defensive) which is not yet authorized for use in terms of standard procedures. This includes the storage of equipment. Covert: This support is provided to the Commanding Officer Special Forces and his organizations, Chief of Staff Intelligence and his organizations, the South African Police and National Intelligence. This service includes the preparation of equipment, training in the use thereof, transport thereof as well as support during use."
- "The conduct of [our] own CBW operations. This is carried out in a similar way to covert support except that [our] own operators are used as a result of access and other circumstances."[201]

The main biological research and production facility, Roodeplaat Research Laboratories (RRL), was established in 1983.[202] Project Coast researched and produced small quantities of mustard, nerve, and blister agents no standard lethal chemical warfare agents were produced on a large-scale. Basson testified, during his 1999-2002 criminal trial, that all research on lethal CBW agents for conventional weapons delivery had been concluded by 1986 or 1987, implicitly acknowledging that South Africa had initially considered deploying CBW agents as conventional battlefield agents.[203] By the second half of the 1980s, the program had only produced large quantities (20 tons) of the lachrymatory agent CR.[204] However, the program also produced small quantities of lethal chemical and biological agents to be used for assassination and sabotage purposes. According to a sales list ("verkope lys") obtained from the trunk of Basson's car, Project Coast had produced cigarettes contaminated with anthrax, and food, beverages, and household items contaminated with various lethal biological and chemical agents (among which, botulism, cyanide, salmonella, and organophosphates, but also various industrial and

201 Ibid., 12–13.

202 Gould and Folb 2002, 60.

203 Bale 2006, 42.

204 Gould and Folb 2002, 143.

agricultural chemicals).[205] Some of the uses of these agents were documented by the Truth and Reconciliation Commission.[206]

The program was terminated in the first half of the 1990s, when the country transitioned towards majority rule. President F.W. de Klerk stated that "although by 1990 he had attempted to 'normalise' the role of the security forces, and had taken action to establish control over secret projects, he later discovered that there was a great deal kept from him".[207] In 1990 Basson briefed De Klerk about Project Coast. De Klerk was told that the chemical side focused on developing incapacitants and irritants, while the biological program entailed a research and production facility that was used to produce "new organisms in order to develop a preventative capacity as well as treatment." In March 1990, President F.W. de Klerk ordered that work on lethal agents be halted, although he authorized continued work on incapacitants and teargas.[208] Project Coast was finally ordered to shut down its operations and destroy all CB agents and precursors in 1993.[209] It is not possible to determine whether work on lethal agents was actually halted in 1990, although the program seems to have solely focused on the production of incapacitants and drugs like methaqualone and MDMA after this time.[210]

South Africa is coded as starting pursuit of BW in 1981 when Project Coast was authorized. Based on the sales list obtained from Basson's car, it seems that South Africa produced some items laced with BW agents. It is unclear when production of these agents exactly started. The main BW facility (RRL) was established in 1983. It is possible that CW agents for use by the armed forces and police were developed quickly after establishment of the facility. Hence, South Africa is coded as acquiring BW in 1984 (although this date is uncertain). End of possession is coded in 1993 when Project Coast was ordered to shut down all operations and destroy all agents and precursors.

Soviet Union/Russia

Horowitz and Narang[211] code the Soviet Union (and its Russian successor state) as possessing BW from 1945 up to and through 2000 (the end date of their study) based on seven sources.[212,213]

Leitenberg, Zinlinskas and Kuhn's detailed study of the Soviet BW program dates the start of the USSR's offensive BW program and possession to the decades before WWII.[214]

205 Gould and Folb 2000, 13; Gould and Folb 2002, 79.

206 Truth and Reconciliation Commission 1999, vol. 2, 510–23; see also Gould and Folb 2002, 159–67.

207 Gould 2005, 223.

208 Ibid., 224; Gould and Folb 2002, 118.

209 Burgess and Purkitt 2001, 58; Gould and Folb 2000, 19.

210 Gould and Folb 2002, 115–141.

211 Horowitz and Narang 2014.

212 Center for Nonproliferation Studies 2008; Kerr 2008, OTA; Nuclear Threat Initiative 2011e; Office of Technology Assessment 1993a; Stockholm International Peace Research Institute 1973, vol. II.

213 Two of the seven cited sources (Alibek 1998; Alibek 1999) are not included in Horowitz and Narang's bibliography.

214 Leitenberg, Zilinskas, and Kuhn 2012.

The BW research program was initiated in 1928 as result of a secret decree issued by the Revolutionary Military Council.[215] Ken Alibek, the former deputy director of the Soviet BW program in the 1980s and 1990s, recalled reading reports that indicated that the first Soviet biological weapon became reality in "the 1930s".[216] The program faltered in the years preceding WWII due to Stalin's Great Purge, but continued throughout and after the war. In 1973—the year after the BWC, of which the USSR was one of three depositaries, was opened for signature—Leonid Brezhnev initiated a program to modernize and expand the Soviet BW arsenal. By the 1980s it had transformed into the largest and most advanced in the world, with tens of thousands of personnel at dozens of institutions.[217] British and American intelligence agencies suspected the USSR was conducting activities in violation of the BWC, resulting in diplomatic pressure on the USSR to come clean about the program. From the mid-1980s, Mikhail Gorbachev attempted to curtail the BW program and make it more transparent. However, the military and intelligence apparatus, aided by the extreme compartmentalization of the program, succeeded in hiding the true scale of the program from the civilian leadership and scuttle attempts to end it.[218]

In the early months of 1992, Boris Yeltsin admitted both privately to British foreign secretary Douglas Hurd and U.S. President George H.W. Bush, and at least two occasions publicly to members of the press, that the USSR had lied about the existence of a BW program.[219] This admission was also included in Russia's 1992 CBM submission under the BWC, which noted that an offensive program had existed from at least 1946 until 1992.[220] In February and April of 1992, Yeltsin signed two decrees ordering a halt to all BW work and committing Russia (as the successor state of the USSR) to the BWC.[221]

The 1992 Trilateral Agreement between Russia, the United States, and the United Kingdom formalized a BW disarmament process that included reciprocal visits to (former) BW sites. The first visits to selected Soviet BW sites had already occurred in January 1991, prior to the formalization of the Trilateral Agreement, and further fueled British and American suspicions that a significant offensive BW program existed.[222] Although no follow-up visits took place until 1994, two significant defections from the Russian BW program—among which, the deputy director of the ostensibly civilian front agency 'Biopreparat'—provided the Americans with extensive information on the scope of the Soviet program and its continuation in spite of Yeltsin's promises.[223] The latter is of little surprise as much of the 'old

215 Ibid., 21.
216 Ibid., 21–22.
217 Koblentz 2009, 113; Nuclear Threat Initiative 2015b.
218 Leitenberg, Zilinskas, and Kuhn 2012, chap. 21.
219 Koblentz 2009, 120; Leitenberg, Zilinskas, and Kuhn 2012, 632.
220 Koblentz 2009, 123; Chevrier and Hunger 2000, 32.
221 Koblentz 2009, 122; Leitenberg 2001, 632–33.
222 Koblentz 2009, 118.
223 Ibid., chap. 3.

guard' stayed in charge of BW activities during Yeltsin's tenure.[224] The next round of visits took place in 1994 and "demonstrated that a 'substantial infrastructure with no commercial purpose' and with links to the Russian military remains largely intact".[225] Around this time, Trilateral cooperation began to rapidly deteriorate. In a May 1994 meeting, Russian negotiators recanted Yeltsin's 1992 admission of the USSR's offensive BW program. During the four years that followed the 1992 the Trilateral Agreement, the Russian representatives "sought to shift the negotiations as much as possible onto a discussion of US activities and away from their own past BW programs and the continued withholding of US-UK access to the RF-MOD [Russian Federation Ministry of Defense] BW facilities."[226] The Trilateral process ended in 1996 and failed to determine whether the BW program had ended and Russia had come into compliance with the BWC.

It is likely that the BW program continued after Yeltsin's formal orders to shut it down in 1992 as evidenced by the findings during 1994 inspection visits, Russian stonewalling during the Trilateral process, and information provided by the former deputy-director of the program after his defection at the end of 1992. Little additional information about the fate of the program is available. Numerous U.S. government reports since the mid-1990s have reported dissatisfaction with Russia's lack of transparency. A 1996 compliance report, for instance, stated the following:

> With regard to former Soviet biological weapon- related facilities, some research and production facilities are being deactivated and many have taken severe personnel and funding cuts. However, some facilities, in addition to being engaged in legitimate activity, may be maintaining the capability to produce BW agents. The Russian Federation's 1993-1996 BWC data declarations contained no new information and its 1992 declaration was incomplete and misleading in certain areas. With regard to the trilateral process that began in 1992, while there has been progress toward achieving the openness intended in the Joint Statement (which calls for a series of confidence-building visits and information exchanges), the progress has not resolved all U.S. concerns.[227]

The 2005 report noted that, while the "massive BW program Russia inherited from the Soviet Union has been considerably reduced," "the United States judges based on all available evidence that Russia continues to maintain an offensive BW program in violation of the [Biological Weapons] Convention."[228] A more recent report, from 2017, further

224 Ibid., 122.
225 Leitenberg, Zilinskas, and Kuhn 2012, 648.
226 Ibid., 650, 656.
227 U.S. Arms Control & Disarmament Agency 1996.
228 U.S. Department of State 2005, 30, 31.

underscores the difficulty of ascertaining Russia's compliance with the BWC:

> Although Russia had inherited past offensive programs of biological research and development from the Soviet Union, Russia's annual BWC CBM submissions since 1992 have not satisfactorily documented whether the BW items under these programs were destroyed or diverted to peaceful purposes, as required by Article II of the BWC.[229]

It is clear that the Soviet Union initiated an offensive BW program in the decades before WWII and possessed BWs prior to 1946 (pursuit commenced in 1928 and acquisition may have taken place in the mid-1930s). Possession continued at least until 1992. However, due to Russian stonewalling it is not possible to determine whether the program was ended in 1992 as Russia claimed, as there are some indications that it continued. Hence, Russia is coded as continuing to possess biological weapon up to and through 2010 (the end date of this study).

Syria

Horowitz and Narang[230] code Syria as pursuing biological weapons from 1990 up to and through 2000 (the endpoint of their study) based on two sources.[231] However, neither source makes any reference to these particular dates.

In the past, U.S. government officials have claimed in unclassified statements that Syria maintained an offensive BW program. However, these claims have not been accompanied by any details regarding the size, scale, and scope of the alleged program, and no supporting evidence has been presented.[232] Horowitz and Narang's primary source,[233] cites five such statements from the 1990s and early 2000s to back up the claim that Syria has a "research program with possible production". As a report from the Swedish Defense Research Agency notes, these U.S. government reports together with some reports in the open literature "paint a similar picture by citing each other and more or less unanimously saying" that: 1) Syria has not ratified the BWC; 2) Syria is probably developing an offensive BW capability; 3) Syrian biotechnology infrastructure is capable of limited agent development; 4) Syria is not believed to have put agents into weapons; and 5) for the foreseeable future it is unlikely that Syria could produce significant amounts of BWs without substantial foreign assistance. Of course, merely taking note of Syria's, admittedly limited, dual-capable industry cannot imply or confirm the existence of an offensive biological weapons program.[234]

229 U.S. Department of State 2017, 18.
230 Horowitz and Narang 2014.
231 Center for Nonproliferation Studies 2008; Kerr 2008.
232 Nuclear Threat Initiative 2014c.
233 See Center for Nonproliferation Studies 2008.
234 Normark et al. 2004, 32.

Recent governmental assessments have been even less specific and certain. For instance, the Director of the Defense Intelligence Agency testified in 2009 that:

> We judge some elements of the program may have advanced beyond the research and development stage and may be capable of limited agent production. Syria is not known to have successfully weaponized biological agents in an effective delivery system, but it possesses a number of conventional and chemical weapon systems that could easily be modified for biological agent delivery.[235]

The unclassified 'Section 721' report to Congress over the year 2006 stated that "Syria's biotechnical infrastructure is capable of supporting limited biological agent development. We do not assess the Syrians have achieved a capability to put biological agents into effective weapons."[236] And, the Section 721 report over the year 2011 merely stated that "Syria's biotechnical infrastructure is capable of supporting BW agent development."[237] Meanwhile, the open source literature only indicates that Syria's infrastructure and technical expertise could allow for BW agent production but does not state whether an actual offensive program exists.[238]

Given the lack of details and supporting evidence underlying U.S. government allegations of an offensive BW program combined with the lack of supporting evidence in the open literature, Syria is coded as not pursuing. It should be noted that Syria declared a ricin production plant to the OPCW as a Chemical Weapons Production Facility (CWPF) in July 2014.[239] Although Ricin is a scheduled substance under both the BWC and CWC, for the purposes of this study it is subsumed under Syria's CW program.[240]

Taiwan

Horowitz and Narang[241] code Taiwan as pursuing from 1975-1993 based on five sources.[242] The consulted sources, however, do not make any reference to these particular dates and provide insufficient basis to code Taiwan as having pursued in the past.

The literature, including some of the sources cited by Horowitz and Narang, notes that the U.S. intelligence community and government have alluded to a Taiwanese BW

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235 Nuclear Threat Initiative 2014c.
236 Deputy Director of National Intelligence for Analysis 2008.
237 Director of National Intelligence 2012.
238 Nuclear Threat Initiative 2014c.
239 OPCW Director General 2014, 2.
240 See the coding rules described in Chapter 4.
241 Horowitz and Narang 2014.
242 Center for Defense Information 2000a; Center for Nonproliferation Studies 2008; Kerr 2008; Nuclear Threat Initiative 2011f; Office of Technology Assessment 1993a. Horowitz and Narang also indicate "no pursuit" as a potential alternative specification.

program in the 1990s, although these assessments have completely disappeared since. A 1993 newspaper article referred to in the Nuclear Threat Initiative's entry on Taiwan, which Horowitz and Narang cite, reported that "U.S. officials […] are concerned that […] Taiwan may have maintained a germ weapons program of its own, which […] dates from the 1970s."[243] No evidence was presented to back up this assessment and the NTI entry concludes that the U.S. government no longer suspects Taiwan of having a BW program. Kerr and the Center for Nonproliferation Studies observe that the annual *Adherence to and Compliance with Arms Control Agreements* reports to Congress in the second half of the 1990s reported that Taiwan was "upgrading its biotechnology capabilities," but that "evidence indicating a BW program is not sufficient to determine if Taiwan is engaged in activities prohibited by the BWC".[244] Kerr also notes that later iterations of the compliance reports have not mentioned any concerns about Taiwan.[245] Finally, the Center for Nonproliferation Studies cites a 1993 Russian intelligence report that found that "Taiwan does not have biological weapons…[however], it has shown signs of conducting biological research of an applied military nature" and the 1997 edition of compliance reports mentioned above.[246]

There is no evidence that Taiwan has had an offensive BW program. Hence, it is coded as not pursuing.

United Kingdom

Horowitz and Narang[247] code the United Kingdom as possessing BWs from 1945-1956 based on a volume by the Stockholm International Peace Research Institute.[248] However, it is unclear why they settle on these dates, as they do not cite any specific pages in the SIPRI volume.

The British government first authorized covert BW research in late 1940 and soon established close links with the American and Canadian BW research programs. During WWII, the BW team developed, tested, and stockpiled anthrax-contaminated cattle feed cakes (an anti-livestock weapon).[249] The British also worked on, and towards the end of the

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243 Smith 1993.

244 Kerr 2008, n. 50; Center for Nonproliferation Studies 2008, n. 9; see U.S. Arms Control & Disarmament Agency 1995; U.S. Arms Control & Disarmament Agency 1997; U.S. Arms Control & Disarmament Agency 1998.

245 See U.S. Department of State 2003; U.S. Department of State 2005; U.S. Department of State 2010; U.S. Department of State 2011a; U.S. Department of State 2012; U.S. Department of State 2013; U.S. Department of State 2014; U.S. Department of State 2015.

246 Center for Nonproliferation Studies 2008.

247 Horowitz and Narang 2014.

248 Stockholm International Peace Research Institute 1973, vol. II.

249 The cattle feed cakes were incinerated towards the end of the war Paxman and Harris 1982, 105..

war placed an order with the Americans for delivery of, antipersonnel anthrax bombs.[250] In October 1945, the Defence Committee issued a directive approving continued BW research after the war. The offensive aspect was "implicit" in this general directive according to a BW policy memo written in 1950. The offensive aspect soon became clear, as the Air Staff requested the development of an antipersonnel, strategic biological weapon towards the end of 1946.[251] In 1947, the importance of biological weapons was reiterated when the influential Defense Research Policy Committee (DRPC) recommended that "research on chemical and biological weapons should be given priority effectively equal to that given to the study of atomic [weapons]." And, a month later the Chiefs of Staff decided that the UK should be prepared as "a cardinal principle of policy [...] to use weapons of mass destruction," which were defined as nuclear, biological, and chemical weapons.[252]

By the early 1950s, the relative importance ascribed to BWs started to decline. Due to the costly involvement in the Korean War, the Chiefs of Staff ordered an exhaustive strategy review, which was released in April 1952. This Global Strategy Paper stated that as war would probably be a short and intense affair, a greater emphasis should be placed on nuclear weapons. In preparation for the Paper, the Chiefs of Staff also released a report on the state of biological warfare in which they noted that while the Americans were focusing on offensive BW research—especially, weapons development—British research focused mainly on assessing the dangers of biological warfare. The report proposed that resources be shifted to "immediate defensive problems" and to "diminish our effort on short term offensive problems but [...] strengthen them on research aimed at very long range offensive possibilities."[253] A review of defense R&D by the DRPC in March 1954 found that of the WMD program, only the nuclear weapons work had yielded results, while the "development of offensive biological weapons has been largely disappointing." The final version of the review stated that the UK "could not afford to undertake any work that had not primarily a defensive bias. Our effort should be limited to the defence aspect of BW." Perhaps as a direct result of this review, the Air Ministry cancelled its request for an antipersonnel biological weapon in the summer of 1954.[254]

By the mid-1950s, the importance accorded to biological warfare was severely diminished due to cost cutting and increasing reliance on nuclear deterrence (the UK performed its first successful nuclear weapons test in October 1952). According to Balmer the gradual shifts in

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250 Balmer 2009, 48; Balmer 2001, 50–54; Paxman and Harris 1982, 103. The British placed an order for 500,000 anthrax bombs in the spring of 1944. The Americans reportedly produced an initial batch of 5,000 bombs intended for Britain, but is disputed whether any of them were delivered. U.S. authorities have in the past denied delivering the 5,000 bombs, see Jones and Lewis 1987, 42. Even if delivery had taken place, the relative crudeness of these first-generation weapons combined with the lack of indigenous production capability would hardly have constituted the possession of an offensive biological warfare capability

251 Balmer 2009, 51.

252 Ibid., 50.

253 Ibid., 61.

254 Ibid., 64.

the biological warfare program and policy did not result in a firm Cabinet-level decision to adopt a purely defensive biological warfare policy, but this was included implicitly in a secret Cabinet decision taken in July 1956 to abandon an offensive CW capability.[255] While there was no explicit mention of BWs in the records of this decision, the DPRC staff interpreted the decision as follows: "The arguments which led to the cancellation of weapons for the offensive use of chemical warfare agents largely apply to BW weapons."[256] This is confirmed by the United Kingdom's CBM declaration under the BWC, which states that "by 1957 the UK had abandoned work on an offensive BW capability."[257] Hence, after 1956 the UK's BW program was of a defensive character only.[258]

The United Kingdom is coded as starting pursuit in 1940, when the British government first authorized offensive BW research. It developed, tested, and stockpiled anthrax-contaminated cattle feed cakes (an anti-livestock weapon) during the war but destroyed them by 1945 (this constitutes the end of a brief period of possession). The offensive research program wound down in the first half of the 1950s, before focusing exclusively on defensive research from 1957 onwards. As there is no evidence that the UK possessed biological weapons after WWII, it is coded as ending pursuit in 1956 with no acquisition having taken place.

United States

Horowitz and Narang[259] code the United States as possessing BWs from 1940-1973 based on a volume by the Stockholm International Peace Research Institute.[260] However, these dates are off by at least a couple of years.

As the 1971 SIPRI volume—directly preceding the one Horowitz and Narang refer to—states that "the US [BW] programme […] began around 1941."[261] In 1941, Secretary of War Henry L. Stimson directed the National Academy of Sciences to establish the Biological Warfare Committee to study the threat of biological warfare. Based on the Committee's findings, Stimson wrote to President Roosevelt in April 1942 recommending that a civilian agency be tasked with performing both defensive and offensive BW research. Two weeks later, in May 1942, Roosevelt approved the creation of the BW program.[262]

By the winter of 1943, the Allied BW research effort began work on an anthrax bomb (code named "N-Bomb"). In March of the following year, British Prime Minister Winston Churchill ordered Ernest Brown, the director of the British Biological Warfare Committee,

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255 Ibid., 66.
256 Balmer 2001, 158.
257 Government of the United Kingdom of Great Britain and Northern Ireland 2017, 44.
258 Balmer 2009, 67.
259 Horowitz and Narang 2014.
260 Stockholm International Peace Research Institute 1973, vol. II.
261 Stockholm International Peace Research Institute 1971, vol. I, 119.
262 Brophy, Miles, and Cochrane 1988, 102ff.; Paxman and Harris 1982, 95f.; Smart 1997, 42f.

to place an order for 500,000 anthrax bombs with the Americans.[263] Two months later, in May 1944, an initial batch of 5,000 of these bombs rolled of the pilot production line at Camp Detrick. Paxman and Harris indicate that "the bombs were to be shipped to Britain for storage in case they were needed quickly for 'operational use' in the European theatre."[264] However, this initial batch was probably not delivered to the British.[265]

The United States' offensive BW program was halted when President Nixon issued a statement in November 1969 which stated, among others, that the United States "shall renounce the use of lethal biological agents and weapons, and all other methods of biological warfare," "will confine its biological research to defensive measures," and that "the DOD [Department of Defense] has been asked to make recommendations as to the disposal of existing stocks of bacteriological weapons." Four months later, in February 1970, Nixon extended the renunciation to "toxins, whether produced by bacteriological or any other biological method or by chemical synthesis."[266] Destruction of antipersonnel BW stocks and munitions commenced in May 1971 and was finalized in May 1972.[267]

The United States is coded as starting pursuit and possession during World War II (before the start date of this study, 1942 and 1944 respectively) and ending possession in 1972 when it completed destruction of BW stocks.[268]

263 Paxman and Harris 1982, 100f.

264 Ibid., 103.

265 Balmer 2001, 53; Balmer 2009, 48.

266 Stockholm International Peace Research Institute 1971, vol. I, 185f.

267 Department of the Army 1977, vol. 1, 55.

268 Horowitz and Narang likely code possession ending in 1973 as the last *anticrop* BW stocks were destroyed in that year, see Ibid., vol. 1, 5. Nonetheless, this dating is inconsistent with other coding decisions. Horowitz and Narang, for instance, code South Korea as ending CW possession in 1997 when it ratified the CWC and made its declaration to the OPCW, while it only finished destroying its declared stockpile in 2008 (see the entry on South Korea in the CW Chronicles).

8

Conclusion: Contributions, Implications, and Reflections

The spread of chemical, biological, and nuclear weapons has been one of the most enduring international policy dossiers of the post-World War II era. Yet, the spread of chemical and biological weapons has been understudied by scholars, especially when compared to the attention that IR and ISS scholars have paid to the spread of nuclear weapons. This discrepancy can largely be attributed to the prevalent view among scholars and policymakers that CBWs spread among states because they are a cheap and easy to acquire alternative to nuclear weapons. U.S. Senator Charles Percy explained the thesis succinctly in 1984: "We all know that any proliferation of nuclear weapons threatens humanity. Now we are learning that for other, less costly, easier-to-make weapons, far less sophistication is required, although they may pose a threat approaching the horror of nuclear war and nuclear arms. That is why some are calling chemical and biological weapons the poor man's atomic bomb."[1] This 'poor man's atomic bomb' thesis was frequently invoked by policymakers as they warned about an impending cascade of CBW proliferation among 'Third World' nations in the 1980s and 1990s.[2] In this dissertation I have addressed the dearth of scholarly research on the magnitude and drivers of the spread rollback of CBW programs after World War II through the following research question:

To what extent have chemical and biological weapons spread among states and what has driven the spread and rollback of chemical and biological weapons programs after World War II?

The main findings of this study can be summed up in five central claims:

1. Extant assessments of CBW spread frequently suffer from methodological flaws and rely heavily on inflated threat assessments from U.S. government sources.
2. CBW spread has been less prevalent than is commonly thought. Restraint and rollback are the trend.
3. 'Poor' or 'Third World' states have no particular disposition towards CBWs.
4. States ascribe different tactical and strategic functions to chemical, biological, and nuclear weapons.
5. Leading theories of CBW spread and restraint that focus on the availability of technology and/or security seeking behavior do not properly explain why states embark on or end CBW programs. The spread and rollback of CBW programs is a complex social and political phenomenon. Different paths—consisting of different combinations of conditions related to the external security environment, international legal rules and norms, and domestic political and conflict circumstances—have led states to embark on or end CBW programs.

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1 U.S. Senate Committee on Foreign Relations 1984, 34.

2 See, for instance, DeFrank and McDaniel 1989; Darst 1988; Webster 1988, 11; Bush 1989c; U.S. House Committee on Armed Services 1989, 39f.; U.S. Senate Committee on Foreign Relations 1989, 29f.; Cheney 1990; U.S. Senate Committee on Armed Services 1991; Lord Lyell 1996; U.S. Assistant Secretary of Defense for Public Affairs 1997; U.S. Secretary of Defense 1998.

In this concluding chapter, I elaborate further on the study's main findings, its methodological contributions, theoretical implications, metatheoretical grounding, and discuss implications for policy.

MAIN FINDINGS

In order to paint a reliable picture of which states have and have not had CBWs, it is first necessary to understand how the idea that CBWs have spread widely, especially in the 'Third World', has come to exist and persist. An in-depth study of extant assessments of CBW spread in Chapter 2 has shown that the answer is twofold. On the one hand, assessments of CBW spread frequently suffer from a number of methodological flaws—namely, improperly or insufficiently defined concepts, lacking documentation of the analyses underlying the assessment, a strong bias towards vague and unverifiable proliferation allegations originating from U.S. government sources, and persistent circular referencing—that sustain faulty allegations, inflated estimates, and inaccurate pronouncements about the 'poor man's atomic bomb'. The other half of the answer is found by considering the social context in which knowledge about unconventional weapons is produced. This reveals an interplay between governmental and non-governmental analyses that creates, feeds, and entrenches a dominant paradigm that chemical, biological, and nuclear weapons are desirable, that they will inevitably 'proliferate' among states, and that concerted action is required to prevent this from happening.

Chapter 3 addressed the question to what extent CBWs have spread among states by introducing a unique data collection effort on 42 alleged chemical weapons programs and 21 alleged biological weapons programs in the post-World War II era. The data showed that the number of states that have pursued or possessed is substantially smaller, particularly among 'poor' states, than is commonly assumed. Roughly half of the countries that have been alleged to have pursued or possessed CBWs have not actually done so (or there is no evidence to conclude that they have).[3] Many countries that have pursued or possessed CBWs have done so for a shorter period of time than is commonly assumed. Moreover, the vast majority of states that have pursued or possessed CBWs have eventually reversed course and ended their CBW programs.[4]

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3 Countries like Afghanistan, Algeria, Ethiopia, Laos, Somalia, Sudan, and Thailand have, among others, been accused of trying to develop CWs, while East-Germany, Kazakhstan, Pakistan, and Saudi Arabia have, among others, been accused of possessing CWs. On the biological side, Algeria, Bulgaria, Cuba, Iran, and Libya have, among others, been accused of attempting to develop BWs, while Egypt, North Korea, and Rhodesia have, among others, been accused of possessing BWs. A more extensive list of countries that have (erroneously) been described as pursuing or possessing CBWs can be found in Chapter 3.

4 It is likely that after 2010, the endpoint of this study, only Israel, North Korea, Russia, and Syria continued to possess CWs, while Egypt may have continued to pursue CWs. Moreover, it is likely that only Israel and Russia continued BW possession after 2010, while Egypt and North Korea continued pursuing BWs. The BW status of one country (China) remains unknown due to a lack of information.

Turning to the causes of CBW spread, this dissertation began with a quantitative test that showed that the 'poor man's atomic bomb' thesis does not explain why states pursue and acquire CBWs. The statistical analyses conducted in Chapter 4 indicated that a state's demand for nuclear weapons has no effect on the likelihood of it initiating pursuit of chemical or biological weapons. Likewise, a state's economic development does not affect the likelihood of it pursuing chemical or biological weapons, unlike what is commonly assumed.

Subsequently, Chapter 5 investigated the conditions under which states have begun and terminated the pursuit or possession of CBWs. The main finding is that this process is complex with different pathways, often consisting of a combination of conditions rather than a single explainer, leading different groupings of states to embark on or end the pursuit or possession of CBWs. Three important findings surfaced. First, external security considerations almost never were sufficient by themselves for producing CBW decisions, contradicting predictions from the realist security model of unconventional weapons spread. Notably, facing a nuclear-armed adversary has played a limited role in states' decisions to pursue or acquire CBWs. In cases where adversaries were salient in CBW decisions, it usually concerned the presence or absence of CBW-armed or conventionally stronger rivals rather than nuclear weapons possessors. Second, in line with extant work on regime security and CBWs, I found that some regimes (e.g. Chile's Pinochet regime, Rhodesia's white minority regime, Apartheid-era South Africa, and Yugoslavia under Communist rule) turned to CBWs when they experienced domestic challenges to their rule. High domestic unrest combined with external security threats to produce paths towards CW pursuit, CW possession, and BW pursuit among some of these cases. High domestic unrest was also sufficient by itself in a path towards BW possession. Conversely, low domestic unrest or the occurrence of regime transition combined with the absence of external threats to produce the end of CW pursuit, end of BW pursuit, and end of BW possession. The occurrence of regime transition was even sufficient by itself to produce paths towards the end of CW possession and BW pursuit. Third, treaties act as constraints on demand for unconventional weapons. The majority of paths towards the start of CW pursuit and CW possession include the non-existence of the Chemical Weapons Convention (CWC). Conversely, membership of the CWC is sufficient by itself for ending CW pursuit and ending CW possession.

METHODOLOGICAL CONTRIBUTIONS

This dissertation makes an important methodological contribution, one that also has theoretical implications, by drawing attention to the challenges associated with studying unconventional weapons programs. In Chapter 2, I have extensively discussed the data collection shortcomings as well as methodological weaknesses that are common to a substantial part of the extant assessments of CBW programs. Paying explicit attention to such issues as concept formation, selection of sources, and proper documentation of the research process is especially important in the study of unconventional weapons given the field's inherent data problem caused, in part, by the many layers of secrecy that shroud most state-run weapons programs. Chapter 2 shows that these problems have played a substantial role in perpetuating inflated estimates of CBW spread, adding to a growing body of literature that scrutinizes biases in quantitative political science datasets.[5] Chapter 2 offers recommendations to address some of the most commonly occurring issues. These recommendations were implemented throughout this dissertation, particularly in the process of collecting the new data on CBW pursuit and possession as described in Chapter 3. Moreover, extensive documentation of the data collection process is included in the *CW and BW Chronicles* in Chapters 6 and 7. These chapters describe the available information, analyze how the available information is weighed, discuss how coding decisions are made, and make note of possible alternative coding specifications for each alleged state-run CBW program. These entries also reflect on the uncertainties about what is known and what can reasonably be concluded from the balance of available evidence, allowing other researchers to replicate findings presented in this study.

During the process of collecting the new CBW data (described in Chapter 3) I encountered a number of challenges. It is useful to describe some of these challenges and how they were dealt with it, so that they can serve as precautions for future researchers.[6] The secrecy in which unconventional weapons programs are usually shrouded and the scale of the study presented key constraints. Due to national security implications most states are hesitant to reveal details about current and past weapons programs. For some countries documentary evidence or officially sanctioned histories exist, while for other countries information is limited to a handful of uncorroborated allegations. Yet, even the best known programs are often incompletely documented. Moreover, the vast scale of the data collection process made any systematic (local) archival research or interviewing of key decision makers—approaches one could apply when conducting one or a few case studies—unworkable. Much of the readily available information on CBW program in the public domain, then, comes from governmental assessments and allegations—predominantly of American origin—or from press reports that cite unnamed officials or classified documents. Yet, it is often difficult to independently verify this information as the sources, methods, and analyses (including nuances and qualifications that contextualize the assessment) that underlie these assessments and allegations are not made available. Moreover, the reporting is frequently inconsistent between different government sources and assessments of particular countries have changed considerably over time. Taken together, these issues affect the reliability of government reporting considerably. To broaden the evidentiary basis of this study and to prevent accepting (possibly erroneous or inflated) threat assessments

5 See, for instance, Colgan 2019; Braut-Hegghammer 2019; Montgomery and Sagan 2009.

6 These and other recommendations are also discussed in the final section of Chapter 2.

at face value, I surveyed a wealth of primary and secondary sources available in the public domain.[7] I privileged these sources—provided that the information from these sources was reliable, consistent, and plausible—when they conflicted with government information that could not be independently verified.

A second challenge was that allegations and pessimistic assessments are frequently repeated by successive officials, journalists, and experts, until they come to be considered established fact. During the process of collecting the new CBW data, I traced back all information I encountered in source materials to the original source, as can be seen in the *CBW Chronicles* entries in Chapters 6 and 7. This was done to prevent falling into a circular referencing trap and to ensure that the context of information is not lost due to (selective) quoting and paraphrasing by intermediary sources. Moreover, this approach gives a more transparent and complete picture of the balance of available evidence rather than presenting a collage of voices that repeat the same information in different words.

Third, in many allegations about unconventional weapons programs and reports about the spread of CBN weapons, core concepts—such as 'chemical weapons capability' or 'biological warfare capability'—are frequently used but often left undefined even though they can mean very different things at different times—and can reflect particular biases—when they are used by different officials, experts, and reporters. This is doubly problematic when allegations or assessments are uncritically reported by others. To ensure the validity of this study, and in order to allow other researchers to replicate the data collection process, I have defined the core concepts and coding rules for the new CBW dataset in detail.[8] Moreover, I have scrutinized how these concepts are understood and used in the sources I considered during the data collection process so as prevent the careless reproduction of faulty assumptions.[9]

Finally, some of the available information about unconventional weapons programs originates from sources—both governmental and non-governmental—that may want to discredit adversaries or have other parochial agendas. In the process of collecting CBW data I have explicitly considered whether sources had an interest in presenting information in a particular way or whether there was a history of exaggerated, erroneous, or even outright false reporting.

Despite the efforts made to address the challenges I described before, imperfections and biases undoubtedly remain in the CBW data. Bias may be introduced by the reliance on

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7 Extensive use was made of, among others, monographs, edited volumes, and journal articles by scholars, studies conducted by think tanks and other non-governmental organizations, governmental reports (among which reports on the activities of other states but also self-reporting such as the voluntary confidence building measures submissions related to the Biological Weapons Convention), reports from news media, and reports by intergovernmental organizations such as the Organisation for the Prohibition of Chemical Weapons and United Nations.

8 See Chapter 3.

9 See the critique of extant literature in Chapter 2 and the analysis of available evidence for each case in the *CW and BW Chronicles* in Chapters 6 and 7.

English-language sources. While English is a scholarly lingua franca, plenty research is still published in other languages. Moreover, American—or more broadly, Western—hegemony in IR leads to an underrepresentation of non-Western viewpoints in IR scholarship and influences the profile of the discipline (I return to this point in this chapter's final section on metatheory).[10] And, beyond academic publications, more pertinent non-English source materials in the form of, among others, government reports, news reports, and expert analyses, as well as a wealth of primary sources in national archives exist. A handful of exceptions notwithstanding,[11] the sources consulted during this study's data collection process were all in the English language. This is a shortcoming that may lead to incomplete views about programs for which there already are limited insights available.[12] At the same time, it is an issue that would be difficult to rectify for a project with a geographical scope as broad as this dissertation. An important lesson to be drawn from this is that the field at large can benefit greatly when graduate students and other researchers are trained in foreign languages and when primary documents are made available.[13]

A second issue relates to the secretive nature of intelligence reporting. For various reasons described before, this study posits that researchers too readily accept proliferation allegations and threat assessments originating from government sources without supporting evidence. In this study I have privileged open source information when it conflicted with information from government sources that could not be independently verified. However, it cannot be excluded that in some of these cases allegations and assessments of wrongdoing are, in fact, correct when this study came to different conclusions. It is, nonetheless, impossible to say so without further insight into the classified intelligence information underlying these public pronouncements. This reflects a more general issue that is especially acute in this domain due to the secrecy surrounding unconventional weapons programs and the dual-use nature of chemical, biological, and nuclear technology: it is often difficult to prove that no activities of an offensive military nature took place. In many situations we can only say that there is absence of evidence (rather than evidence of absence) or show that something is impossible or implausible.

This study also makes a contribution by showcasing the benefits of Qualitative Comparative Analysis (QCA) for the study of international politics.[14] As discussed in

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10 Hoffmann 1977; Waever 1998; Smith 2002; Maliniak et al. 2018.

11 I made use of one investigative report in my native language by Dutch reporter Karel Knip. I also made use of a German government report aided by the knowledge of the German language left over from high school. An English translation made available by the CIA allowed the use of an intelligence report in Russian. Finally, I cited a Korean news report with the help of Google Translate.

12 Studies on, for instance, the Swedish and Norwegian nuclear programs have been hampered by their dependence on English-language secondary sources. See Jonter 2016, 11; Braut-Hegghammer 2019.

13 Pelopidas 2015, 344.

14 QCA has already found some applications in International Relations, but has yet to be applied to the study of unconventional weapons. See, among others, Kiser, Drass, and Brustein 1995; Harvey 1999; Chan 2003; van der Maat 2011; Pinfari 2011; Thiem 2011; Mello 2014; Grynaviski and Hsieh 2015; Haesebrouck and Thiem 2018; Bobić 2019; Mello 2019.

Chapter 1, the benefits of QCA are twofold. First, QCA is particularly apt for studying complex social phenomena like weapons spread since the method accounts for the possibility that combinations of conditions can jointly explain an outcome (*conjunctural causation*); that different pathways to an outcome may exist (*equifinality*), and that explanations for the occurrence and non-occurrence of an outcome may consist of different conditions (*causal asymmetry*). QCA demonstrates its value in Chapter 5 by identifying the different paths, and the conjunctural nature of these paths, towards embarkation on or termination of the pursuit and possession of CBWs. As I discussed in Chapter 1, regression approaches are unable to account for equifinality, conjunctural causation, and causal asymmetry. This shortcoming helps explain why the quantitative literature has failed to offer strong explanations for the spread of unconventional weapons (see Chapter 4).[15] Qualitative case studies, on the other hand, can deal with complex causation, but unfortunately comparing more than a handful of cases in one study is highly impractical. This ties in directly with the second advantage of QCA: its flexibility regarding case numbers. The extant empirical literature on the causes and consequences of unconventional weapons spread consists predominantly of single case studies, small-N between case variation, and large-N quantitative studies. Where in-depth qualitative case studies are limited to very few cases and regression approaches require large amounts of data, QCA is agnostic about sample size. The spread of chemical, biological, and nuclear weapons is essentially a medium-N phenomenon due to the relatively limited number of historical 'proliferation events'. To illustrate, the case numbers in Chapter 5 range from five for the analyses of start and end of BW possession to twenty-four for the analyses of start and end of CW possession. QCA is well suited for these small to intermediate sample sizes, while allowing for the observation of patterns across a sample larger than a handful of cases. Yet, due to its case-based and qualitative nature QCA maintains the strengths of small-N qualitative approaches. Most importantly, it is well suited for dealing with causal complexity and allows the researcher to observe case-level explanations. Taken together, QCA has proven itself as a valuable addition to the field's methodological toolset.

While QCA is a valuable addition to the field's methodological toolset, it also has its limitations. For one, QCA can identify sufficient and necessary (combinations) of conditions that lead to an outcome, but such cross-case patterns do not reveal underlying causal mechanisms and processes.[16] As one author noted, "cross-case regularities (consistent set relationships) are not themselves causal mechanisms; they are empirical manifestations of underlying causal mechanisms."[17] It is, therefore, typical of QCA research to 'go back to the cases' to evaluate the causal quality of QCA solutions, while more in-depth qualitative case studies are needed to understand causal mechanisms and identify potentially omitted conditions.[18]

15 See also Bell 2016.

16 Verweij and Trell 2019, 312.

17 Rutten 2020, 3.

18 Schneider and Rohlfing 2014.

A second, and closely related, limitation of QCA is the lack of a temporal dimension. QCA solutions provide a snapshot of causal conditions and an outcome at a particular point in time. Temporal QCA (TQCA) and coincidence analysis (CNA) are set-relational techniques that show sequences of conditions at a cross-case level.[19] However, a return to the cases is necessary to attain a more detailed understanding of underlying causal mechanisms and chronological causality.[20]

THEORETICAL IMPLICATIONS

This dissertation makes several theoretical contributions to the study of the spread and rollback of unconventional weapons programs. First of all, it challenges the popular 'poor man's atomic bomb' thesis about the spread of CBWs. This study engages with the thesis on two levels. First it contests the thesis as a theory of state behavior. In short, the thesis proposes that CBWs have and will spread because states, particularly 'poor' ones in the 'Third World', consider them to be cheap, easy to acquire, and effective alternatives to nuclear weapons. Yet, Chapters 3, 4, and 5 have shown that CBWs cannot fulfill the same political or military functions as nuclear weapons, that states have rarely pursued or acquired CBWs to serve as replacements for nuclear weapons, and that 'poor' states are *not* especially partial to them. Second, this study contends that the 'poor man's atomic bomb' thesis is inaccurate as a theory of process. Although the PMAB thesis predicts a rapid and wide spread of CBWs, Chapters 2 and 3 have shown that these weapons have not spread fast or widely.

More broadly, this dissertation mounts a critique against the structural realist and technological determinist assumptions that dominate thinking about the history and future of chemical, biological, and nuclear weapons. It does so by considering the social context in which experts and policymakers generate knowledge about unconventional weapons (see Chapter 2), adding to the growing body of critical securities scholarship on the subject.[21] The idea that such weapons spread fast, widely, and in a domino-like manner finds expression among experts and policymakers through the proliferation paradigm.[22] This paradigm approaches the history and imagined future of unconventional weapons as a story of chemical, biological, and nuclear *proliferation*. It leads to the pathological—in the literal bioscience meaning of the word but also to indicate an obsessive compulsive tendency—scrutiny of other states as potential sites where weapons programs can establish

19 On TQCA see Caren and Panofsky 2005. On CNA see Baumgartner 2013; Baumgartner and Epple 2014.

20 Schneider and Rohlfing 2014, n. 14.

21 For the extant literature, see, among others, Mutimer 1997; Krause and Latham 1998; Harrington de Santana 2009; Mathur 2014; Pelopidas 2011; Pelopidas 2016; Ritchie and Egeland 2018.

22 Mutimer 1997; Pelopidas 2011.

themselves in the same way that malignant tumors metastasize. At the same time, it primes the analyst to ignore positive or even transformational outcomes (that the intentions of actors have been misunderstood or that the preferences of actors can and have experienced change) and expunging past errors of judgement about states' activities and intentions.

Racialized hierarchies and civilizational discourses have been important modalities through which this proliferation threat as well as the policies to combat it have been constructed. Policymakers, experts, and commentators have frequently spoken of the fear of 'the poor man's atomic bomb', 'an Islamic bomb', and WMD-armed 'rogue states'.[23] In the discourse about unconventional weapons an "imaginary line of civilizational apartheid" separates possession of these weapons by Western states—infused with progressive characteristics: rational, liberal, necessary, responsible—from non-Western states and their regressive features: irrational, despotic, dangerous, untrustworthy.[24]

The proliferation paradigm, and the policy prescriptions that flow from it, cannot be divorced from its American (or more broadly Western) hegemonic origins. European Enlightenment ideas about the progressive role of the West have inclined Western policymakers and experts to view the West as having the natural role of 'benign hegemon' that has to take a leading role in shaping and enforcing 'global' non-proliferation, arms control, and disarmament norms, as well as defend the liberal order.[25] Consider how then-U.S. Secretary of State George Shultz spoke of this special responsibility in 1984:

> [T]here will be insecure or *irresponsible* leaders [emphasis added] who seek to shift the balance of power dramatically by acquiring a 'secret weapon.' *We and other responsible members of the international community* [emphasis added] are ceaselessly at work to deter [them].[26]

By highlighting foreign threats that are yet to occur, the threats posed by extant weapons on the territory of the analyst herself—or those of allied states that provide a security guarantee—can be ignored. It is meaningful that this view has been promoted tenaciously by countries, like the United States, that have 'proliferated' themselves and are projecting their own fears, prejudices, and decision-making rationales onto others.[27] It is, after all, an effective way to enforce a state of exception for the 'haves' versus the 'have nots'.

The supposed ubiquity of unconventional weapons in the hands of radical, dangerous, and untrustworthy regimes—the 'Other'—have also provided an argument for possessors to retain and upgrade existing chemical, biological, and nuclear weapons arsenals. 'Their' unconventional weapons are labelled as 'weapons of mass destruction' (WMD). 'Our'

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23 See also Gusterson 1999; Mathur 2016; Mathur 2014.

24 Hobson 2007, 94. See also Said 1978.

25 Krause and Latham 1998, 41.

26 Shultz 1984, 1.

27 Abraham 2010, 50.

technologies, on the other hand, are in 'responsible hands' and serve to defend the liberal order, thus delinking them from the moral opprobrium and heightened sense of threat that are constructed around the term 'WMD' in popular and academic discourse.[28] For instance, as government officials, experts, and journalists from the United States issued frequent warnings about the supposed proliferation of chemical (and biological) weapons among so-called Third World states in the 1980s, the United States was implementing a major chemical rearmament project.[29] And, while the U.S. Secretary of State touted the work of "responsible members of the international community" in confronting "irresponsible leaders" trying to acquire a "secret" nuclear weapon in the mid-1980s,[30] the Reagan administration was escalating the nuclear arms race to confront the Soviet "evil empire".[31] More recently, the United States has been executing an ambitious plan to modernize and upgrade its nuclear weapons arsenal at an estimated cost of at least 1 trillion US dollars,[32] even though the last three administrations have exerted tremendous pressure on Iran to halt its supposed nuclear weapons ambitions.

The reproduction of these dominant discourses about the proliferation of unconventional weapons is intimately connected with the revolving door between government and knowledge producing institutions as universities, think tanks, government agencies, and interest groups that make up the "nonproliferation complex" vie for financial resources, policy relevance, and political access.[33] The process of producing knowledge about unconventional weapons is not simply rational but reflect interests and power that define what Kuhn calls "normal science."[34] The social forces that are empowered by these definitions and institutionalized knowledges will understandably be hesitant to acknowledge major anomalies and resist change. In other words, the discourse about the supposed proliferation of unconventional weapons both disciplines and constitutes its subjects.

The framing of proliferation as the key analytical and policy problem is persistent in the empirical literature, which has largely examined why states embark on chemical, biological, and nuclear weapons programs, while often overlooking the termination of such programs. This is especially true for the quantitative literature that has focused almost exclusively on the variables that are hypothesized to increase or decrease the risk of 'proliferation' rather

28 Cooper 2006, 365; Krause and Latham 1998, 41–42.

29 Smart 1997, 70f.

30 Shultz 1984, 1.

31 Reagan 1983.

32 Wolfsthal, Lewis, and Quint 2014.

33 Craig and Ruzicka 2013. As Walt notes, policy and scholarly debates on security and strategy are heavily influenced by the political and organizational interests of participants and potential critics may become discouraged from voicing dissent for fear of ostracization. See Walt 1987, 147–148. An October 2020 report revealed that at least 1 billion US dollars in funding from defense contractors and U.S. governments agencies went to the top fifty think tanks in the United States. See Freeman 2020.

34 Mittelman 1998, 65; Kuhn 1996. This notion is explored especially in the writings of Karl Marx and others working in the Marxist tradition. See, among others, Marx and Engels 1998, 67–71; Gramsci 1971; Foucault 1980.

than reversal. This dissertation, on the other hand, emphasizes that understanding which countries have terminated weapons development programs or have renounced extant weapons, and their reasons for doing so, is just as important as knowing which states embark on such programs and why.[35] Studying which countries have abandoned CBW activities reveals not only that termination of CBW development programs is more common than acquisition of CBWs but also that the majority of one-time possessors have eventually given up their weapons. The focus on weapons spread, thus, emphasizes negative conclusions and has inspired pessimistic predictions that have not come true, while ignoring successes and transformational outcomes. Moreover, security model explanations of the termination of unconventional weapon programs—focusing on absence of threat or the extension of (great power) security guarantees—often fall short because structural realism "cannot really account for renunciation as a purposive and deliberate strategy and suffers from underdetermination in its specification of the variables at play."[36] (In fact, much of the post-World War II realist thought is characterized by the ahistorical attitude that "things will never change."[37]) Indeed, as the empirical analyses in this dissertation (see Chapters 4 and 5 in particular) have illustrated, the process of CBW acquisition and abandonment should not be understood merely as security-seeking behavior.[38]

In turn, this study, in line with earlier scholarship, finds that technological determinist and realist security models fall short of explaining why some states have desired unconventional weapons and why many of these states have reversed course. Unlike what structural realists assume, systemic mechanisms of socialization and competition do not produce roughly homogeneous behavior among members of a competitive self-help system.[39] States are not unitary black boxes and as a result there is significant differentiation in policy choices regarding unconventional weapons among states that have faced similar security circumstances. That is not to say that international security considerations are irrelevant to weapons programs, but rather that they are not necessary explainers and only in some cases are they sufficient for explaining why states pursue or acquire unconventional weapons or roll back their programs.

In line with the extant literature on regime security as a driver of demand for and use of CBWs,[40] this dissertation finds that domestic conflict considerations have played a role in state-run CBW programs. The scholarly and policy focus has predominantly laid on

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35 A third question, which this dissertation has not focused on deeply, is why some states explore the option of a weapons program but opt to not proceed and why the vast majority of states have never shown any interest in these weapons technologies.

36 Pelopidas 2015, 340.

37 Mittelman 1998, 73; Cox 1981, 131; Ashley 1984, 228.

38 Pelopidas makes a similar point regarding nuclear weapons, see Pelopidas 2015, 341.

39 Compare this to Waltz 1979, 74–77; Wendt 1992, 181. This is recognized, to a limited extent, by more recent varieties of realism. Neo-classical realists, for instance, argue that systemic conditions are filtered through intervening variables at the state or individual level to produce different types of foreign policy. See Bajema 2010, 62.

40 Koblentz 2013; Koblentz 2018.

intrastate dimensions of CBW possession and use. Even though chemical weapons have been used after 1945 in some interstate conflicts—among others, by Egyptian forces during the 1963-1967 Yemen War, by U.S. forces in the 1960s during the Vietnam War, and by Iraqi forces during the 1980-1988 war with Iran—most cases of CBW use in recent decades have been perpetrated by governments, often authoritarian ones, to repress domestic opponents at home or abroad. Some of these programs were initiated with the goal of developing weapons for domestic use in mind, such as the South African and Rhodesian programs. In other cases, like Iraq and Syria, CW programs were not initially envisioned to serve domestic purposes but chemical weapons were later used against civilian populations.[41] The latter is significant as directions of weapons programs, and motivations for maintaining them, can and do change over time.

Furthermore, international legal prohibitions play an important contextual role as the vast majority of CBW programs began absent any legal prohibitions against the respective weapon systems. One of the limitations of this dissertation is that is has not properly grappled with the mechanism behind the working of social and legal norms on CBW behavior. While nuclear weapons have sometimes been considered as symbols of modernity and legitimacy, CBWs have not conferred the same prestige due to stigmas surrounding their use.[42] Yet, the role of anti-CBW norms on CBW forbearance and rollback is underexplored. This falls back to two long-debated questions in IR (and International Legal Studies): 1) do norms and (legal) rules have a significant effect on state behavior, and 2) are their roles epiphenomenal (and instrumental) or phenomenal (and mutually constitutive).[43] Extant scholarship on the role of moral stigmas against the *use* of chemical, biological, and nuclear weapons (i.e., the

41 And in yet other cases, external security considerations as well as repression of political opponents were vital aspects of CBW programs. The Soviet Union, and later Russia, have, in particular, had a long history of assassinating regime opponents with CBW agents, starting with the poisoning of Soviet foreign intelligence chief Abram Slutsky in 1938, through the infamous murder of Bulgarian dissident Georgi Markov in London in 1978, all the way to the attempt on the life of former double-spy Sergei Skripal in 2018.

42 Harris 1990, 71–72; Tucker 2000, 28; Roberts 1996, 121.

43 Arend 1997 provides a useful overview of (neo)realist, liberal institutionalist, and constructivist approaches to this question. Most realists are cynical about the role of international law (and rarely, if ever, speak of norms), believing that principles, norms, rules, and decision-making procedures have no significant effect on state behavior. They are considered epiphenomenal representations of underlying interests and power relations that are disregarded or changed at will. See Krasner 1982, 190; Abbott 1999, 365; Arend 1997, 114–116. Neoliberal institutionalists are slightly more optimistic about international law, viewing it as providing useful mechanisms to solve market failure problems. They also concentrate on the role that international institutions play in easing the security dilemma by providing information about the intentions and capabilities of others and by monitoring and enforcing compliance. See Krasner 2002, 265; Solingen 2007, 14. Take for instance the Nuclear Non-Proliferation Treaty (NPT), which institutionalists consider primarily useful because it provides information on state compliance through the International Atomic Energy Agency's centralized monitoring system (the CWC has a similar mentoring system, although the BWC lacks one). See Dai 2007; Nye 1981; Smith 1987. Social constructivists contend that social forces such as knowledge, ideas, rules, and norms have an impact on actors' interests and identities. In this view, norms and legal regimes not only constrain state behavior, but the very act of participation influences the way states view themselves and how they define their interests. See Arend 1997, 132; Tannenwald 1999, 437.

chemical, biological, and nuclear 'taboos') and studies on the role of anti-nuclear norms on *possession* of nuclear weapons provide a useful departure point for future research on this issue.[44] Another important avenue of research that is understudied is the role that identity conceptions play in CBW decisions.[45] The nuclear weapons literature on this topic provides useful leads that cross (meta)theoretical positions and cases on this issue.[46]

Moreover, this dissertation theorizes that the spread and rollback of unconventional weapons program is a complex social phenomenon. While scholars have previously noted the 'multi-causal' nature of weapons spread,[47] no studies have systematically addressed the spread and reversal of unconventional weapons programs in such a way that properly appreciates the underlying complexity. This QCA analysis in Chapter 5 shows that conditions at both the unit level as well as system level interact in the process of (foreign) policymaking. International security circumstances, domestic conflict conditions, legal prohibitions against unconventional weapons, and changing ideas about the desirability or appropriateness of such weapons combine in complex ways to produce different paths towards start and termination of CBW programs for different constellations of cases. While this study shows that these interactions take place, future qualitative research could further investigate the mechanisms behind these interactions.

METATHEORETICAL REFLECTIONS

All research has underlying epistemological and ontological assumptions that give shape to the questions we ask, dictate what we think makes up the social and political world, and determine what we see as valid knowledge of that world.[48] A recurring puzzle throughout this dissertation has been why the spread of unconventional weapons has received so much, and such enduring, attention from policymakers, scholars, and pundits. I have engaged with this puzzle on several levels. Empirically, this study shows, among others, that the 'common wisdom' about the rampant spread of chemical and biological weapons,

44 On taboos regarding CBN weapons *use*, see Price 1995; Price and Tannenwald 1996; Price 1997; Cole 1998. On the taboo against nuclear weapons *use*, see Tannenwald 1999; Tannenwald 2007. On norms against nuclear weapons possession, see Rublee 2009; Sagan 1996.

45 Price has written on conceptions of civilization and attitudes towards the use and non-use of CWs, see Price 1995. However, the literature on identity conceptions and CBW pursuit/acquisition is limited.

46 Jacques Hymans has, for instance, applied insights from social psychology to study how leaders' conceptions of national identity have shaped decisions regarding nuclear weapons, see Hymans 2006b. T.V. Paul, on the other hand, has looked at the role of enduring rivals, see Paul 2000. Jasper introduced a post-positivist approach to identity conceptions and nuclear decisions, see Jasper 2013; Bucher and Jasper 2017. For a post-colonial perspective, see Abraham 1998. More generally, see Sagan 1996, 73–85.

47 See, for instance, Sagan 1996, 63, 85; Bell 2016, 521; Singh and Way 2004, 861; Jo and Gartzke 2007, 167.

48 Reus-Smit 2013, 590.

especially among so-called 'poor' states, is incorrect. Many of the states that were suspected of having CBW programs never did or did so for significantly shorter periods of time. Methodologically, I show that definitional issues, overconfidence in and excessive reliance on U.S. government allegations, and, not seldom, bad research habits perpetuate erroneous assessments of weapons spread. Theoretically, the dissertation traces these issues back to the dominance of realist and technological determinist thinking, which found particular expression among scholars and policymakers in the realm of unconventional weapons through the proliferation paradigm.

Throughout these levels, this study has invariably dealt with questions such as, 'what is the connection between theoretical expectations and empirical reality?', 'what can theories tell us about how International Relations and Security Studies work as disciplines?', 'what is the purpose of theory?', and 'what ends does scholarship serve?' These considerations fall in the realm of metatheory or the systematic discourse in which theory figures as the main subject matter; the "theories about theories."[49] In this section, I will reflect more thoroughly on the metatheoretical underpinnings of this study, particularly how the issue of unconventional weapons, and security more broadly, should and should not be studied, the disciplining nature of the fields of International Relations and International Security Studies, and the limits that scholarship place on policy innovation.

Knowledge, Hegemony, and the Status Quo

In a seminal 1981 article, Robert Cox introduced a useful analytical division between two metatheoretical orientations and the purposes they serve.[50] On one hand, *problem-solving theory* "takes the world as it finds it, with the prevailing social and power relationships and the institutions into which they are organised, as the given framework for action" and aims to "make these relationships and institutions work smoothly."[51] This approach is status-quo oriented and ahistoric because it views institutions and power relations as fixed.[52] *Critical theory*, on the other hand, "stands apart from the prevailing order of the world and asks how that order came about" and as a result "is directed towards an appraisal of the very framework for action, or problematic, which problem-solving theory accepts as its parameters."[53]

49 Freire 2013, 275; Kurki and Wight 2013, 14.
50 Cox 1981.
51 Ibid., 128–129.
52 Ibid., 129.
53 Ibid.

Critical scholars in the field of International Relations have taken particular aim at structural realism's fatalistic and static view of global politics.[54] In response, Waltz, the author of the canonical structural realist text *Theory of International Politics*, quipped that critical scholars "would transcend the world as it is, meanwhile we [the realists] have to live in it."[55] Yet, under this veneer of 'value-free' theory—represented by the reduction of problems to physical power relations and a disdain for moral goals—lies an assumption of fixity that is not merely a convenience of method but a normative bias that can serve particular national, sectional, or class interests that may be comfortable with the status quo, essentially preserving an existing order and making it hegemonic.[56] Hence, the observation that "theory is always *for* someone and *for* some purpose."[57]

The two orientations sketched by Cox inform different approaches to the *problématique* of unconventional weapons. Starting from the premise that chemical, biological, and nuclear weapons are highly destructive and their spread undesirable, typical questions to ask are "what causes the proliferation of nuclear/chemical/biological weapons?", "who is proliferating or is likely to do so in the future?", and "how do we stop it?" These questions have been at the forefront of policy and scholarly debates since the early 1960s. As a student, these were the questions I encountered in the courses I followed on International Relations and Security Studies. In turn, they were the topics I centered some of my own courses around as I began teaching. And, as I embarked on this dissertation some years ago, these were the very questions I planned to write about.

Yet, these questions presuppose a number of things. For one, that the further spread of unconventional weapons is the core policy and scholarly problem to be solved, rather than confronting the continued existence of such weapons in the hands of a few major powers.[58] Second, these questions presuppose that unconventional weapons *proliferate*,

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54 Cox criticized post-war American realism for moving away from the historicist approach of classical realists like E.H. Carr and Machiavelli and adopting the fixed ahistoric framework of problem-solving theory. Cox noted that while the works of these classical realists seems to be addressed to the powerful, the *palazzo*, they actually enlighten the less powerful, the *piazza*, about the machinations of power: "Classical Realism is to be seen as a means of empowerment of the less powerful, a means of demystification of the manipulative instruments of power." See Cox 1992, 169. Booth spoke in similar terms about British post-war realism, noting that "by the 1960s realism showed rather little of the complexity, sophistication, and moral anguish of Reinhold Niebuhr and the other founding fathers […] By the 1950s realism was a body of ideas neatly packaged for teaching purposes in order to make them palatable to students. It was made into a persuasive story. The fast-food version was also very congenial to politicians and officials." See Booth 1997, 92.

55 Waltz 1996, 338. Similar opinions have been voiced by other realists. See Schweller 1999; Mearsheimer 1994, 235–236.

56 Cox 1981, 129–130.

57 Ibid., 128.

58 I am working on a manuscript that analyzes how an initial focus on 'nuclear disarmament' receded as the primary policy problem in the early years after World War II and a new consensus formed around the need to identify and stop future proliferators (non-proliferation) and to prevent arms races turning into war between nuclear weapons possessors (arms control). I presented some early thoughts on this topic at the 2017 Young Pugwash conference in Astana, Kazakhstan. See Poor Toulabi 2017.

that is, spread in a rapid, uncontrolled, chain reaction-like manner. In turn, the danger of (imagined) proliferation is frequently employed as justification by the 'haves' to maintain their privileged positions and as justification for—not seldom, destructive and inhumane—policies to deny the 'have nots' from obtaining similar capabilities.[59] It is the express objective of the critical approach to lay bare and problematize these very presuppositions and unveil the politics behind ostensibly neutral knowledge. After all, scholarship is a political act—especially in the social sciences—and researchers exercise power by deciding which problems to highlight. Accordingly, theories of international relations are not merely interesting as explanations of (contemporary) world politics but also fundamental aspects of world politics that require explanation.[60]

This dissertation questions the commonly accepted wisdom about the spread of CBWs by exploring a number of interrelated questions. What do experts and policymakers purport to know about the magnitude and drivers of CBW spread? Where does this knowledge come from? Does it stand up to scrutiny? Why is it 'sticky' and which ends does it serve? What emergences, then, from this study is a critique of the prevailing scholarly and policy orientation towards unconventional weapons specifically and security more broadly.

As this dissertation shows, many influential voices in the CBW expert community as well as in government have been singing a similar tune: that numerous countries—especially 'Third World' ones in Africa, Asia, and South America—were trying to acquire CBWs or had already done so because they are a 'poor man's atomic bomb'. This orientation presupposes cause and effect all at once: it tells us something about the magnitude and speed of CBW spread (namely, rampant proliferation), the subject ('poor' states that cannot have nuclear weapons), and the drivers of CBW spread (because those states are insecure and they *can* have CBWs). Security experts and policymakers have, in many ways, had a hand in creating the world that they purport to explain. As Booth aptly observed, "instead of positivism's seeing is believing, the social world is in important ways constructed by the phenomenon of believing is seeing."[61]

That experts and policymakers have exaggerated the spread of chemical and biological weapons (but similarly, nuclear weapons) is, to use a clichéd computer programmer joke, 'not a bug but a feature'. It would be a mistake to treat it as merely a methodological defect to be repaired, even though there are certainly methodological improvements to be made as suggested in Chapter 2. Inflated threat assessments should be attributed to an underlying theoretical position (a potent combination of neo-realism's fatalistic and conflictual neo-utilitarian view of the nature of the international system and the determinist notion that technologies and weapons inevitably spread that finds expression through metaphors about 'proliferation' and the 'poor man's atomic bomb') and a yet deeper-lying status-quo oriented and ahistoric metatheoretical orientation.

59 I return to this point below.

60 Walker 1993, 6.

61 Booth 1997, 93.

Critical Sensibility and Methodological Eclecticism

An oft-heard criticism of critical-theoretical scholarship is that it is not empirical. This misses the mark as plenty research in the critical tradition relies on factual claims about the empirical world.[62] Critical scholars rather situate themselves in a reflexive post-positivist epistemology and ontology due to skepticism about problem-solving theory's predominantly empiricist, rationalist, and materialist nature. Yet, for Cox this did not mean that problem-solving and critical theory are necessarily mutually exclusive. In a conversation with Peer Schouten, Cox noted that "the strength of problem-solving theory relies [*sic*] in its ability to fix limits or parameters to a problem area, and to reduce the statement of a particular problem to a limited number of variables which are amenable to rather close and clear examination."[63] In another conversation, with Randall Germain, Cox further clarified his position on the distinction between critical and problem-solving theory: "Some people have read this to mean that I am against problem-solving theory, which was not at all my point. The important consideration for me is that problem-solving theory is useful within its limits, but that one needs to be aware that, in a period of rather important and significant structural change, these limits are a constraint that prevents you from seeing where you can go and what sorts of problems you are facing."[64]

There is potential for critical theory and a positivist problem-solving approach to be applied together as "regularities in human activities may indeed be observed […] and thus the positivist approach can be fruitful within defined historical limits."[65] In this study I have combined a critical sensibility with an eclectic mix of methods, some of which are typically associated with the (positivist) problem-solving approach. Let me illustrate this with three examples. First, this study's critique of the tendency towards erroneously pessimistic assessments and predictions about the spread of unconventional weapons among experts and policymakers is informed and strengthened by an extensive effort to collect and analyze data on CBW programs in the post-World War II period. Second, the study's critique of structural realist and technological determinist accounts of unconventional weapons spread, like the 'poor man's atomic bomb' thesis, is reinforced by systematic empirical tests across the universe of cases with the use of quantitative techniques. The strength of these techniques lies in their ability to isolate the independent effects of individual variables on an outcome, making them useful for adjudicating between different theories.[66] From a methods point of view, this should be a 'soft test' for structural realist (and technological determinist) theorizing due to its emphasis on parsimony and explanatory power. That it fails to pass the test, among other challenges raised throughout this dissertation, helps to build the case against it. Finally, the use of QCA allows for historically informed empirical

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62 Jackson 2010, 24.
63 Schouten 2010.
64 Hoogvelt, Kenny, and Germain 1999, 392–393.
65 Cox 1996, 244.
66 Mahoney and Goertz 2006, 235; Ragin 2008, 177–179.

analyses of the complex contexts in which weapons programs are started and terminated, while engaging in a dialogue between theory and cases throughout the research process.

The Limits on Innovation and the Tragedy of Nonproliferation Policies

Traditional approaches to security have not only perpetuated an inaccurate view about the nature and magnitude of unconventional weapons spread, as I show in this study, but also severely limit the universe of policy options, crowd out viable alternatives, and legitimize or justify inhumane strategies and policies that have made much of the world's population insecure. Let me provide three examples. First, the deterministic belief that weapons technology will find a way to spread itself manifests itself in policies to restrict the availability of technology at the supply-side, while discounting human agency and the role of politics in the realm of security and foreign policymaking.

Second, the view of a proliferation chain reaction driven by security considerations is used to legitimate the continued possession of unconventional weapons. The United States, for instance, embarked on an ambitious chemical rearmament program in the 1980s, while at the very same time sounding the alarm about an impending cascade of CBW proliferation in the 'Third World'.[67] Strategies like nuclear deterrence and mutually assured destruction, the brainchildren of the American strategic studies community of the 1950s and 1960s, continue to threaten the extermination of life as we know it on a daily basis. Just recently, the world commemorated the 75th anniversary of the horrific atomic bombings of Hiroshima and Nagasaki, which killed over 200,000 people. Yet, even now, the belief that the use of these two bombs was crucial in bringing the war in the Pacific theater to a close and preventing the further loss of life—albeit only American ones—is alive and well,[68] despite persuasive arguments to the contrary.[69] Similarly, the idea that the continued existence of these weapons, albeit only in the hands of a select few, has been the decisive factor in preventing another world war continues to be cited as a rationale for maintaining nuclear weapons arsenals. Yet, nuclear weapons are certainly not indispensable for preventing war between major powers.[70] Moreover, that no nuclear weapons have been used deliberately or accidentally since 1945 (of course, not counting over 2,000 nuclear explosive tests performed since then, mostly on and around indigenous lands, with long-term deleterious health and environmental effects), has more to do with luck than is commonly accepted.[71]

Third, the inevitable consequence of this traditional approach to the 'proliferation problem' is the rejection of the possibility of transformative outcomes (that intentions of

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67 Smart 1997, 70f.

68 See, for instance, a recent reflection on the atomic bombings of Hiroshima and Nagasaki in the New York Times: Von Drehle 2020.

69 Wilson, for instance, argues that it was the Soviet Union's declaration of war was the deciding factor for the Japanese leadership to surrender rather than the use of nuclear weapons. See Wilson 2013, chap. 1.

70 Mueller 1988; Vasquez 1991; MccGwire 2006.

71 Schlosser 2013; Pelopidas 2017.

actors may have been misunderstood or that preferences regarding unconventional weapons can change), giving way to the idea that only external shock—like economic sanctions, preventive strikes, or preventive war—can halt proliferation ambitions.[72] The pathological connotation of the proliferation metaphor—the idea that malignant growths have to be monitor and forcefully confronted—is quite evident. Yet, the cure is much deadlier than the affliction. The human toll of coercive non- and counter-proliferation policies in the Global South has been devastating and most of the long-term effects likely have not been well documented yet. The post-Cold War era offers a number of examples, of which I will discuss two.

On August 20, 1998, Tomahawk cruise missiles launched by the United States destroyed the al-Shifa pharmaceutical plant in the Sudanese capital Khartoum. The U.S. government claimed that the plant was a secured chemical weapons facility with ties to Osama bin Laden.[73] Doubts soon arose about the credibility of these allegations.[74] A month after the attack, U.S. government officials admitted that they were uncertain whether evidence indicated that nerve agent precursors were produced at al-Shifa and that they had no direct evidence linking Bin Laden with the plant.[75] Even though scientists found no traces of the alleged chemicals in soil samples taken around the plant, the U.S. government has repeatedly blocked attempts to initiate a UN Security Council investigation into the matter.[76] The al-Shifa plant was Sudan's largest and most important pharmaceutical facility, supplying more than half of the country's human pharmaceutical needs at a fraction of the cost of imported drugs as well as all of the veterinary drugs.[77] Its products included medicines for treating, among others, tuberculosis, malaria, diabetes, and rheumatism, as well as all of Sudan's veterinary drugs.[78] The attack on al-Shifa also severely disrupted international aid efforts addressing an ongoing famine that put millions of lives at risk. According to Human Rights Watch, UN agencies and other aid organizations in Khartoum evacuated their staff and many relief efforts were postponed indefinitely.[79] It is difficult to determine the exact human cost of the bombing—the bombing has received little media or scholarly attention in the last twenty years—but it is very likely that in a country ravaged by decades-long civil conflict, famine, and frequent outbreaks of infectious diseases, the effects were considerable.

The economic sanctions imposed on Iraq in the 1990s over its alleged unconventional weapons programs, in combination with the destruction caused by the Gulf War, created a

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72 Pelopidas 2011, 308–309.

73 Coordinator for Counterterrorism, Department of State 1998.

74 Barletta 1998; Loeb 1999.

75 Barletta 1998, 120; Lobel 1999, 544–545.

76 Loeb 1999; Risen and Johnston 1999; Rouhi 1999; Lacey 2005.

77 Barletta 1998, 118; Astill 2001. Al-Shifa's pharmaceutical production was known to the U.S. government, as American diplomats at the United Nations had greenlighted the sale of drugs it had produced to Iraq earlier that year, see Barletta 1998, 118.

78 Barletta 1998, 118.

79 Human Rights Watch 1998.

humanitarian disaster that may have led to hundreds of thousands of excess Iraqi civilian deaths.[80] Ironically, Saddam's inner circle succeeded in shielding themselves from the effects of sanctions and even benefitted financially from them, further exacerbating the suffering of the population.[81] Moreover, an estimated 1.25 million Iraqis fled the country and between 800,000 and 2 million were internally displaced as a result of sanctions, U.S. bombings to enforce a no-fly zone, and mounting poverty during the period 1991-2003.[82] The existence of ongoing chemical, biological, and nuclear weapons programs were cited by the U.S. and U.K governments as the principal reason for the invasion of Iraq in 2003 by a United States-led coalition, even though a fact-finding mission concluded afterwards that Iraq had actually abandoned its chemical, biological, and nuclear weapons programs in the early 1990s.[83] The invasion heralded a nearly two decades-long period of political instability, (sectarian) violence, military operations, and humanitarian crisis. Between 2003 and 2020, an estimated 9.2 million Iraqis were forcibly displaced—as refugees, asylum seekers, or as internally displaced persons—by violent conflict.[84] Moreover, approximately 200,000 Iraqi civilians died between 2003 and 2020 as a result of coalition and Iraqi military action, insurgent action, sectarian violence, and criminal action attributable the breakdown of law and order following the 2003 invasion.[85]

How do we study security and what means are there to achieve security? There is a danger in letting the orthodoxies of a statist, militarized, masculinized, Anglo-American view of security shaped by experiences of the Cold War define the answers to these questions.[86] Doing so would mean replicating an "ethnocentric and time-bound set of theories of 'peace' and 'security'" that do little to advance our understanding of the challenges that our world will face over the course of this century or to improve the prospects of human life.[87] This should not be taken to imply that questions of war and peace are irrelevant or, given the subject matter of this dissertation, that the spread of chemical, biological, and nuclear weapons is immaterial. It is, rather, a call to investigate the disciplining role of the fields of International Relations and International Security Studies, to privilege emancipation over power and order, and to promote policies that are friendly to humans and the environment. After all, scholars and researchers ought to be architects of possibility rather than scribes of the powerful.[88]

80 Mueller and Mueller 1999.

81 Andreas 2005, 353–354.

82 Vine et al. 2020, n. 51.

83 Duelfer 2005a; Duelfer 2005b; Duelfer 2005c.

84 Vine et al. 2020.

85 The most reliable numbers are provided by the Iraqi Body Count project, which maintains a database of documented civilian deaths from post-invasion violence in Iraq compiled from news media reports, reports from NGOs, and official records released publicly. See https://www.iraqbodycount.org/.

86 Booth 1997, 112.

87 Ibid.

88 Ibid., 115.

Appendices

APPENDIX A: OPERATIONALIZATION AND CALIBRATION OF CONDITIONS

Outcome: CW Pursuit (PURS_CW)

Factor level: start / end pursuit

The crisp outcome condition *PURS_CW* takes two values: the start of chemical weapons pursuit (0) or the end of chemical weapons pursuit (1). The coding for this condition draws on the CBW pursuit and possession dataset introduced in Chapter 3. A country is coded as pursuing chemical weapons (crisp score of 0) in the year that it begins a period of chemical weapons pursuit, and it is coded as ending pursuit (crisp score of 1) in the last year of a period of chemical weapons pursuit. A country may experience difference episodes of pursuit and, therefore, more than one case of start/end of pursuit per country may be included in the data.

Outcome: CW Possession (POSS_CW)

Factor level: start / end possession

The crisp outcome condition *POSS_CW* takes two values: the start of chemical weapons possession (0) or the end of chemical weapons possession (1). The coding for this condition draws on the CBW pursuit and possession dataset introduced in Chapter 3. A country is coded as possessing chemical weapons (crisp score of 0) in the year that it begins a period of chemical weapons possession, and it is coded as ending possession (crisp score of 1) in the last year of a period of chemical weapons possession. A country may experience difference episodes of pursuit and, therefore, more than one case of start/end of pursuit per country may be included in the data.

Outcome: BW Pursuit (PURS_BW)

Factor level: start / end pursuit

The crisp outcome condition *PURS_BW* takes two values: the start of biological weapons pursuit (0) or the end of biological weapons pursuit (1). The coding for this condition draws on the CBW pursuit and possession dataset introduced in Chapter 3. A country is coded as pursuing biological weapons (crisp score of 0) in the year that it begins a period of biological weapons pursuit, and it is coded as ending pursuit (crisp score of 1) in the last year of a period of biological weapons pursuit. A country may experience difference episodes of pursuit and, therefore, more than one case of start/end of pursuit per country may be included in the data.

Outcome: BW Possession (POSS_BW)

Factor level: start / end possession

The crisp outcome condition *POSS_BW* takes two values: the start of biological weapons possession (0) or the end of biological weapons possession (1). The coding for this condition draws on the CBW pursuit and possession dataset introduced in Chapter 3. A country is coded as possessing biological weapons (crisp score of 0) in the year that it begins a period of biological weapons possession, and it is coded as ending possession (crisp score of 1) in the last year of a period of biological weapons possession. A country may experience difference episodes of pursuit and, therefore, more than one case of start/end of pursuit per country may be included in the data.

Condition: Nuclear Weapons-Armed Rival (RIVAL_NW)

Factor level: nuclear rival absent / nuclear rival present

The crisp condition *RIVAL_NW* indicates whether a country faced one or more enduring rivals that possessed nuclear weapons during the year that it started or ended pursuit/ possession of CBWs. A value of 0 indicates that a country has no nuclear-armed rivals, whereas a value of 1 means that it has.

The dates for the periods that states have possessed nuclear weapons are taken from Bleek's dataset.[1] The data on enduring rivalries are taken from version 2.01 of the Goertz et al. peace data.[2] Their data describe the relationships between pairs of states in the period 1900-2015 on a peace scale. Each dyadic relationship can take one of five values in a given year: 0.0 (serious rivalry), 0.25 (lesser rivalry), 0.50 (negative peace), 0.75 (warm peace), and 1.0 (security community). For the condition nuclear rival, only serious rivalries are coded as an enduring rivalry.

Condition: Chemical Weapons-Armed Rival (RIVAL_CW)

Factor level: chemical rival absent / chemical rival present

The crisp condition *RIVAL_CW* indicates whether a country faced one or more enduring rivals that possessed chemical weapons during the year that it started or ended pursuit/ possession of CBWs. A value of 0 indicates that a country has no chemical-armed rivals, whereas a value of 1 means that it has.

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1 Bleek 2017.

2 Goertz, Diehl, and Balas 2016. The directed dyad-year dataset was obtained by email from the authors.

The dates for the periods that states have possessed chemical weapons are taken from the CBW pursuit and possession dataset presented in Chapter 3. The data on enduring rivalries are taken from version 2.01 of the Goertz et al. peace data.[3] Their data describe the relationships between pairs of states in the period 1900-2015 on a peace scale. Each dyadic relationship can take one of five values in a given year: 0.0 (serious rivalry), 0.25 (lesser rivalry), 0.50 (negative peace), 0.75 (warm peace), and 1.0 (security community). For the condition chemical rival, only serious rivalries are coded as an enduring rivalry.

Condition: Biological Weapons-Armed Rival (RIVAL_CW)

Factor level: biological rival absent / biological rival present

The crisp condition *RIVAL_BW* indicates whether a country faced one or more enduring rivals that possessed biological weapons during the year that it started or ended pursuit/possession of CBWs. A value of 0 indicates that a country has no biological-armed rivals, whereas a value of 1 means that it has.

The dates for the periods that states have possessed biological weapons are taken from the CBW pursuit and possession dataset presented in Chapter 3. The data on enduring rivalries are taken from version 2.01 of the Goertz et al. peace data.[4] Their data describe the relationships between pairs of states in the period 1900-2015 on a peace scale. Each dyadic relationship can take one of five values in a given year: 0.0 (serious rivalry), 0.25 (lesser rivalry), 0.50 (negative peace), 0.75 (warm peace), and 1.0 (security community). For the condition biological rival, only serious rivalries are coded as an enduring rivalry.

Condition: Conventionally Stronger Rival (RIVAL_STR)

Factor level: stronger rival absent / stronger rival present

The crisp condition *RIVAL_STR* indicates whether a country's enduring rivals were conventionally stronger during the year it started or ended pursuit/possession of CBWs. A value of 0 indicates that the combined material capabilities of a country's enduring rivals do not outweigh the capabilities of the country itself, while a value of 1 indicates that the enduring rivals have combined capabilities that are stronger than the country itself.

The data on enduring rivalries are taken from version 2.01 of the Goertz et al. peace data.[5] Their data describe the relationships between pairs of states in the period 1900-2015 on a peace scale. Each dyadic relationship can take one of five values in a given year: 0.0 (serious rivalry), 0.25 (lesser rivalry), 0.50 (negative peace), 0.75 (warm peace), and 1.0

3 Ibid. The directed dyad-year dataset was obtained by email from the authors.
4 Ibid. The directed dyad-year dataset was obtained by email from the authors.
5 Ibid. The directed dyad-year dataset was obtained by email from the authors.

(security community). For the condition chemical rival, only serious rivalries are coded as an enduring rivalry.

A country's strength is operationalized as the aggregate of its conventional (thus, not including nuclear, chemical, and biological weapons-related) material capabilities. The data on states' material capabilities are taken from version 5 of the Correlates of War Project's (COW) dataset on National Material Capabilities (NMC).[6] The NMC dataset includes six individual measures of states' national capabilities (military expenditures, military personnel, energy consumption, iron and steel production, total population, and urban population). A seventh measure, the Composite Index of National Capabilities (CINC), aggregates the six measures per country year into an average of the state's material capabilities as a share of the world system's total, with the constituent measures weighted equally.

A capability ratio (*CR*) between the sum of *CINC* scores of country *i*'s rivals and country *i*'s *CINC* score in a given year is calculated, using equation (1):

$$\boldsymbol{CR_i = \frac{\sum_{j=1}^{k} CINC_j}{CINC_i}} \tag{1}$$

If the value of the ratio is greater than 1, then the country is coded as having stronger rivals on the condition *RIVAL_STR* (score of 1). If the value of the ratio is smaller than or equal to 1, then the country is coded as not having stronger rivals on the condition *RIVAL_STR* (score of 0).

Condition: Nuclear Weapons Defense (NW_DEF)

Factor level: no nuclear defense / nuclear-armed ally / nuclear weapons possession

The multivalent condition *NW_DEF* indicates whether a country benefits from a nuclear deterrent during the year that it started or ended pursuit/possession of CBWs. A value of 0 indicates that the country has no nuclear defense, a value of 1 indicates that it has a defense pact with a nuclear-armed state, and a value of 2 indicates that the country itself possesses nuclear weapons.

The data on nuclear weapons possession are taken from Bleek.[7] The data on defense pacts are taken from version 4 of the Alliance Treaty Obligations and Provisions (ATOP) dataset.[8]

6 Singer, Bremer, and Stuckey 1972. The data is available for download on the COW website: https://correlatesofwar.org/data-sets/national-material-capabilities.

7 Bleek 2017.

8 The ATOP data can be downloaded from: http://www.atopdata.org/. See also Leeds et al. 2002.

Condition: Chemical Weapons Convention (CWC)

Factor level: pre-conclusion of the CWC in 1993 / not having signed or ratified the CWC after conclusion in 1993 / signed the CWC / ratified the CWC

The multivalent condition *CWC* indicates whether a country was party to the 1993 Chemical Weapons Convention. A value of 0 indicates that the CWC was not yet concluded when a country started or ended pursuit/possession of chemical weapons, a value of 1 indicates that the country had not signed/ratified the CWC after the conclusion of the Convention, a value of 2 indicates that the country had signed the CWC, and a value of 3 indicates that the country had ratified the CWC.

The data on CWC signature and ratification were obtained from the website of the Organisation on the Prohibition of Chemical Weapons (OPCW).[9]

Condition: Biological Weapons Convention (BWC)

Factor level: pre-conclusion of the BWC in 1972 / not having signed or ratified the BWC after conclusion in 1972 / signed the BWC / ratified the BWC

The multivalent condition *BWC* indicates whether a country was party to the 1972 Biological Weapons Convention. A value of 0 indicates that the BWC was not yet concluded when a country started or ended pursuit/possession of biological weapons, a value of 1 indicates that the country had not signed/ratified the BWC after the conclusion of the Convention, a value of 2 indicates that the country had signed the BWC, and a value of 3 indicates that the country had ratified the BWC.

The data on BWC signature and ratification were obtained from the United Nations Disarmament Treaty Database.[10]

Condition: Domestic Unrest (UNR)

Factor level: low unrest / high unrest

The crisp condition *UNR* indicates whether a country was experiencing high or low domestic unrest in the three years preceding the year it started or ended pursuit/possession of CBWs. This condition can take two values: low domestic unrest (0 and high domestic unrest (1).

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9 http://web.archive.org/web/20190101115629/www.opcw.org/evolution-status-participation-convention.

10 https://web.archive.org/web/20190703145103/http://disarmament.un.org/treaties/t/bwc.

The data on domestic unrest are taken from Banks and Wilson's Cross-National Time-Series Data Archive (CNTS).[11] The CNTS data includes eight variables that count how often particular domestic conflict events (i.e., assassinations, general strikes, guerilla warfare, major government crises, purges, riots, revolutions, and anti-government demonstrations) occurred per country-year. Furthermore, it includes an aggregate variable that combines the aforementioned eight measures into a weighted domestic conflict event measure.[12]

An unrest ratio (*UR*) between the sum of country *i*'s weighted unrest scores (*WUS*) in the preceding three years and the sum of its weighted unrest scores (*WUS*) in the preceding ten years is calculated using equation (2):

$$\boldsymbol{UR_i = \frac{\sum_{i=-1}^{-3} WUS_i}{\sum_{i=-1}^{-10} WUS_i}} \tag{2}$$

If the value of the ratio is greater than 1, then the country is coded as experiencing high domestic unrest (score of 1 on *UNR*). If the value of the ratio is smaller than or equal to 1, then the country is coded as experiencing low domestic unrest (score of 0 on *UNR*).

Condition: Regime Transition (REGTRANS)

Factor level: no regime transition / regime transition

The crisp condition *REG* indicates whether a country was experiencing a regime transition during the year it started or ended pursuit/possession of CBWs. The condition can take two values: no regime transition (0) and regime transition (1).

To create this condition I make use of the regime transition ("regtrans") variable from the 2016 version of the Polity IV dataset.[13] A regime transition is defined by the Polity IV project as a at least a three-point change in a polity's democracy or autocracy score, or when one of the following events occur: authority interruption, state failure, state disintegration, state transformation, state demise, or state creation.[14] An episode of regime transition is a process that can span several consecutive years. Hence, a state may be coded as undergoing regime transition over a period of years.

The binary Polity IV regime transition variable is coded directly into a binary condition *REG*.

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11 Banks and Wilson 2018.

12 The following weights are assigned: assassinations (25), strikes (20), guerrilla warfare (100), government Crises (20), purges (20), riots (25), revolutions (150), and anti-Government demonstrations (10).

13 Marshall, Gurr, and Jaggers 2017a. The data can be downloaded from: www.systemicpeace.org/inscrdata.html.

14 Marshall, Gurr, and Jaggers 2017b, 35–36.

APPENDIX B: TRUTH TABLES

Table B.1: Truth table for start of CW pursuit

Conditions					Outcome			
RIV_CW	RIV_STR	CWC	NW_PURS	UNR	CW_PURS{S}	N	Incl.	Cases
1	1	0	0	0	1	5	1.000	Egypt1_SPT_1958, Iran_SPT_1985, Iraq_SPT_1971, NorthKorea_SPT_1961, Syria_SPT_1979
0	1	0	0	1	1	2	1.000	Chile_SPT_1975, Rhodesia_SPT_1976
0	0	0	0	1	1	1	1.000	SouthAfrica2_SPT_1981
0	1	0	1	0	1	1	1.000	Israel_SPT_1955
1	0	0	0	0	1	1	1.000	France_SPT_1988
1	0	0	0	1	1	1	1.000	Egypt2_SPT_1974
1	1	0	1	0	1	1	1.000	Libya_SPT_1984
0	0	0	0	0	0	4	0.500	Australia_EPT_1946, Canada_SPT_1946, Canada_EPT_1969, Yugoslavia_SPT_1976
0	0	2	0	1	0	1	0.000	France_EPT_1993
0	1	0	0	0	0	1	0.000	Chile_EPT_1976

Note: RIV_CW = chemical weapons rivals; RIV_STR = conventionally stronger rivals; CWC = Chemical Weapons Convention; NW_PURS = nuclear weapons pursuit; UNR = domestic unrest; CW_PURS{S} = start chemical weapons pursuit; Incl. = inclusion; SPT = start pursuit; EPT = end pursuit

Table B.2: Truth table for end of CW pursuit

Conditions					Outcome			
RIV_CW	CWC	NW_PURS	NW_DEF	UNR	CW_PURS{E}	N	Incl.	Cases
0	0	0	1	0	1	2	1.000	Canada_EPT_1969, Chile_EPT_1976
0	2	0	2	1	1	1	1.000	France_EPT_1993
0	0	0	0	0	0	3	0.333	Australia_EPT_1946, Canada_SPT_1946, Yugoslavia_SPT_1976
1	0	0	0	0	0	4	0.000	Egypt1_SPT_1958, Iran_SPT_1985, Iraq_SPT_1971, Syria_SPT_1979
0	0	0	0	1	0	1	0.000	Rhodesia_SPT_1976
0	0	0	1	1	0	1	0.000	Chile_SPT_1975
0	0	0	2	1	0	1	0.000	SouthAfrica2_SPT_1981
0	0	1	0	0	0	1	0.000	Israel_SPT_1955
1	0	0	0	1	0	1	0.000	Egypt2_SPT_1974
1	0	0	1	0	0	1	0.000	NorthKorea_SPT_1961
1	0	0	2	0	0	1	0.000	France_SPT_1988
1	0	1	0	0	0	1	0.000	Libya_SPT_1984

Note: RIV_CW = chemical weapons rivals; CWC = Chemical Weapons Convention; NW_PURS = nuclear weapons pursuit; NW_DEF = nuclear weapons defense; UNR = domestic unrest; CW_PURS{E} = end chemical weapons pursuit; Incl. = inclusion; SPT = start pursuit; EPT = end pursuit

Table B.3: Truth table for start of CW possession

Conditions					Outcome			
RIV_ NW	RIV_ CW	CWC	UNR	REG	CW_POSS{S}	N	Incl.	Cases
0	0	0	1	0	1	3	1.000	Rhodesia_SPN_1977, SouthAfrica2_SPN_1987, Yugoslavia_SPN_1988
1	1	0	0	0	1	8	0.750	Egypt1_SPN_1963, Iran_SPN_1987, Iran_EPN_1991, Iraq_SPN_1983, Israel_SPN_1956, Libya_SPN_1989, Syria_SPN_1985, UnitedKingdom_EPN_1957
1	1	0	1	0	0	2	0.500	Egypt1_EPN_1974, NorthKorea_SPN_1989
0	0	0	1	1	0	3	0.000	Myanmar_EPN_1990, Rhodesia_EPN_1979, Yugoslavia_EPN_1991
0	0	0	0	0	0	1	0.000	SouthAfrica1_EPN_1946
0	0	2	0	1	0	1	0.000	SouthAfrica2_EPN_1993
0	0	3	0	0	0	1	0.000	Libya_EPN_2004
0	1	0	0	0	0	1	0.000	France_EPN_1988
0	1	3	0	0	0	1	0.000	SouthKorea_EPN_1997
0	1	3	1	0	0	1	0.000	United States_EPN_1997
1	0	3	0	0	0	1	0.000	India_EPN_1997
1	1	3	0	0	0	1	0.000	China_EPN_1997

Note: RIV_NW = nuclear weapons rivals; RIV_CW = chemical weapons rivals; CWC = Chemical Weapons Convention; UNR = domestic unrest; REG = regime transition; CW_POSS{S} = start chemical weapons possession; Incl. = inclusion; SPN = start possession; EPN = end possession

Table B.4: Truth table for end of CW possession

Conditions					Outcome			
RIV_ NW	RIV_ CW	RIV_ STR	CWC	REG	CW_ POSS{E}	N	Incl.	Cases
0	0	1	0	1	1	2	1.000	Myanmar_EPN_1990, Rhodesia_EPN_1979
0	1	0	3	0	1	2	1.000	SouthKorea_EPN_1997, UnitedStates_EPN_1997
0	0	0	0	1	1	1	1.000	Yugoslavia_EPN_1991
0	0	0	2	1	1	1	1.000	SouthAfrica2_EPN_1993
0	0	0	3	0	1	1	1.000	Libya_EPN_2004
0	1	0	0	0	1	1	1.000	France_EPN_1988
1	0	0	3	0	1	1	1.000	India_EPN_1997
1	1	0	0	0	1	1	1.000	Egypt1_EPN_1974
1	1	0	3	0	1	1	1.000	China_EPN_1997
0	0	0	0	0	0	3	0.333	SouthAfrica1_EPN_1946, SouthAfrica2_SPN_1987, Yugoslavia_SPN_1988
1	1	1	0	0	0	9	0.222	Egypt1_SPN_1963, Iran_SPN_1987, Iran_EPN_1991, Iraq_SPN_1983, Israel_SPN_1956, Libya_SPN_1989, NorthKorea_SPN_1989, Syria_SPN_1985, UnitedKingdom_EPN_1957
0	0	1	0	0	0	1	0.000	Rhodesia_SPN_1977

Note: RIV_NW = nuclear weapons rivals; RIV_CW = chemical weapons rivals; RIV_STR = conventionally stronger rivals; CWC = Chemical Weapons Convention; REG = regime transition; CW_POSS{E} = end chemical weapons possession; Incl. = inclusion; SPN = start possession; EPN = end possession

Table B.5: Truth table for start of BW pursuit

Conditions				Outcome			
RIV_ BW	REG	NW_ PURS	UNR	BW_ PURS{S}	N	Incl.	Cases
0	0	0	1	1	2	1.000	Rhodesia_SPT_1976, SouthAfrica_ SPT_1981
1	0	1	0	1	1	1.000	Iraq2_SPT_1985
1	0	0	0	1	5	0,8	Egypt_SPT_1958, France_SPT_1948, Iraq1_SPT_1974, NorthKorea_SPT_1964, UnitedKingdom_EPT_1957
0	0	0	0	0	2	0.000	Canada_EPT_1969, France_EPT_1967
0	1	0	1	0	1	0.000	Rhodesia_EPT_1979
1	0	0	1	0	1	0.000	Iraq1_EPT_1978

Note: RIV_BW = biological weapons rivals; REG = regime transition; NW_PURS = nuclear weapons pursuit; BW_PURS{S} = start biological weapons pursuit; Incl. = inclusion; SPT = start pursuit; EPT = end pursuit

Table B.6: Truth table for end of BW pursuit

Conditions				Outcome			
RIV_ BW	REG	NW_ PURS	UNR	BW_ PURS{E}	N	Incl.	Cases
0	0	1	0	1	1	1.000	Canada_EPT_1969
0	0	2	0	1	1	1.000	France_EPT_1967
0	1	0	1	1	1	1.000	Rhodesia_EPT_1979
1	0	0	1	1	1	1.000	Iraq1_EPT_1978
1	0	2	0	1	1	1.000	UnitedKingdom_EPT_1957
1	0	0	0	0	3	0.000	Egypt_SPT_1958, Iraq1_SPT_1974, Iraq2_SPT_1985
0	0	0	0	0	1	0.000	France_SPT_1948
0	0	0	1	0	1	0.000	Rhodesia_SPT_1976
0	0	2	1	0	1	0.000	SouthAfrica_SPT_1981
1	0	1	0	0	1	0.000	NorthKorea_SPT_1964

Note: RIV_BW = biological weapons rivals; REG = regime transition; NW_PURS = nuclear weapons pursuit; UNR = domestic unrest; BW_PURS{E} = end biological weapons pursuit; Incl. = inclusion; SPT = start pursuit; EPT = end pursuit

Table B.7: Truth table for start of BW possession

Conditions			Outcome			
RIV_STR	NW_ DEF	UNR	BW_ POSS{S}	N	Incl.	Cases
0	2	1	1	1	1.000	SouthAfrica_SPN_1987
1	0	0	1	1	1.000	Israel_SPN_1948
1	0	1	1	1	1.000	Iraq2_SPN_1990
0	0	0	0	1	0.000	SouthAfrica_EPN_1993
1	2	0	0	1	0.000	United States_EPN_1972

Note: RIV_STR = conventionally stronger rivals; NW_DEF = nuclear weapons defense; UNR = domestic unrest; BW_POSS{S} = start biological weapons possession; Incl. = inclusion; SPN = start possession; EPN = end possession

Table B.8: Truth table for end of BW possession

Conditions			Outcome			
REG	BWC	NW_ DEF	BW_ POSS{E}	N	Incl.	Cases
0	2	2	1	1	1.000	United States_EPN_1972
1	3	0	1	1	1.000	SouthAfrica_EPN_1993
0	2	0	0	1	0.000	Iraq2_SPN_1990
0	3	2	0	1	0.000	SouthAfrica_SPN_1987
1	0	0	0	1	0.000	Israel_SPN_1948

Note: REG = regime transition; BWC = Biological Weapons Convention; NW_DEF = nuclear weapons defense; BW_POSS{E} = end biological weapons possession; Incl. = inclusion; SPN = start possession; EPN = end possession

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English Summary

Preventing the spread of chemical, biological, and nuclear weapons among states has been one of the most visible national and international policy priorities since the end of World War II. Nevertheless, scholars and policymakers have spent little effort to understand how and why the spread of chemical and biological weapons (CBWs) occurs, especially in comparison to the amount of attention given by them to nuclear weapons. The prevailing view about CBWs is that they are cheap and easy to acquire alternatives to nuclear weapons; in other words, a 'poor man's atomic bomb'. According to this view, CBWs have spread widely among states because the knowhow and technology are easily available and the application is cheap. These weapons are, therefore, thought to exert particular attraction on developing countries in conflict-ridden regions of the 'Third World' that are precluded from having nuclear weapons due to financial and technological barriers. This dissertation, however, shows that this 'poor man's atomic bomb' thesis misrepresents the role and appeal of CBWs.

To address the gaps in our extant knowledge about the spread of CBWs, this dissertation addresses the following question: *To what extent have chemical and biological weapons spread among states and what has driven the spread and rollback of chemical and biological weapons programs after World War II?* The study's central findings can be summed up in five claims.

First, assessments of CBW spread often suffer from methodological flaws and present and perpetuate inflated threat assessments. In Chapter 2 of this dissertation I present an in-depth study of past assessments of CBW spread in order to understand how the idea that CBWs have spread widely, especially in the 'Third World', have come to be accepted by experts and policymakers. I find that many assessments of CBW spread suffer from serious methodological flaws. Core concepts are often improperly or insufficiently defined and the analyses upon which assessments of CBW spread are based are usually poorly documented. Moreover, the evidentiary basis of these assessments is frequently thin because a significant share of the publicly available information on weapons programs is comprised of vague, inconsistent, and unverifiable proliferation allegations originating from U.S. government sources that are eagerly (and often uncritically) consumed by experts and journalists. Furthermore, a persistent tendency to resort to circular referencing—with successive publications citing each other—leads faulty allegations, inflated estimates, and inaccurate pronouncements about the rapid spread of the 'poor man's atomic bomb' to eventually be seen as established facts. This interplay between governmental and nongovernmental analyses creates, feeds, and entrenches the dominant paradigm that chemical, biological, and nuclear weapons are desirable, that they will inevitably 'proliferate', especially among 'Third World' states, and that concerted action is required to turn back the tide.

Second, the spread of CBWs has been less prevalent than is commonly thought. In Chapter 3, I introduce a unique data collection effort on 42 alleged chemical weapons (CW) programs and 21 alleged biological weapons (BW) programs in the period 1946-

2010. This data shows that the number of states that have pursued or possessed CBWs is significantly smaller than is often assumed. Around half of the states that have been thought to have pursued or possessed CBWs have actually not done so. The countries that have pursued or possessed CBWs have often done so for a shorter period of time than is commonly assumed. More importantly, the vast majority of states that have pursued or possessed CBWs have eventually reversed course and ended their programs. In other words, **restraint and rollback are the trend, not proliferation.**

Third, 'poor' or 'Third World' states have no particular disposition towards CBWs. The new dataset on CBW programs in Chapter 3 reveals that so-called 'poor' or 'Third World' states have no particular disposition towards chemical and biological weapons. In fact, a considerable number of 'Third World' countries have incorrectly been accused of pursuing of possessing CBWs. There are actually a wide variety of states that have pursued or possessed CBWs—among them plenty industrialized states of the Global North. This finding is confirmed by a large-scale statistical study in Chapter 4, which reports no relationship between states' economic development and their propensity to embark on either chemical, biological, or nuclear weapons development programs.

Fourth, states generally do not view or treat CBWs as replacements for nuclear weapons. The new CBW dataset, and the accompanying case descriptions in Chapters 6 and 7, show that the military objectives of state-run CBW programs have varied considerably. Most CBW programs in the post-World War II era have been small (employing between a few dozen and a few hundred staff), have had limited (often tactical) military objectives, and have frequently made use of improvised dissemination methods. These programs have, for instance, set out to develop weapons for assassinations or sabotage, counterinsurgency operations, terrorizing civilian populations, and for use as force multipliers against numerically superior opponents on the battlefield. While chemical weapons and biological weapons are often lumped together under the 'poor man's atomic bomb' moniker, only the biological kind has the potential of producing mass casualties like nuclear weapons. However, creating an effective and dependable biological warfare capability with an eye to producing mass casualties is exceedingly difficult and costly. In fact, among all historical BW programs, only those of the United States and Soviet Union had the express objective of creating weapons that could match the casualty potential of nuclear weapons. In other words, there is little evidence to support the idea that CBWs are a stand-in for nuclear weapons. This conclusion is reinforced by a large statistical study in Chapter 4 that investigates the relationship between the demand for chemical, biological, and nuclear weapons. I find that states that pursue or possess chemical weapons and states that possess biological weapons are more likely to also begin pursuing nuclear weapons. On the other hand, the pursuit or possession of nuclear weapons has no effect on the likelihood that a state will begin pursuing chemical weapons or biological weapons. In other words, there is evidence of a complementary relationship between the different weapons systems (since CBW programs increase the likelihood of nuclear weapons programs), but there is no indication that there is a replacement effect at play (since nuclear weapons programs do not lower the likelihood of CBW programs).

Fifth, the spread and rollback of CBW programs is a complex social and political phenomenon that cannot be reduced merely to national security-seeking behavior. Despite the dominance of the 'poor man's atomic bomb' narrative, the academic literature contains a few studies that have theorized the drivers of CBW spread (focusing on three strands of thought: national security considerations, domestic politics and regime security, and international law and norms) and some empirical case studies of historical CBW programs. Chapter 5 attempts to synthesize theory and empirics through a systematic inquiry into the drivers of all CBW programs after World War II with the help of Qualitative Comparative Analysis (QCA). This chapter not only examines why states embark on CBW programs but also why they terminate them. This is an important contribution since the reversal of weapons programs is understudied in the literature on chemical, biological, and nuclear weapons. QCA is a method that is especially suited for unravelling such complex processes because it explicitly accounts for the possibility that causes can occur jointly (*conjunctural causation*), that different pathways can lead to an outcome (*equifinality*), and that the occurrence and non-occurrence of an outcome may require different explanations (*causal asymmetry*).

Four significant findings arise from Chapter 5. For one, states follow different pathways, which often consist of differing combinations of conditions rather than a single explainer, towards a decision to start or end the pursuit or possession of CBWs. This is noteworthy as proliferation scholarship often focuses on finding a silver bullet explanation rather than seeking synthesis and considering complexity. Second, external security conditions play a much more nuanced role in shaping demand for CBWs than is often thought. External security factors are usually insufficient by themselves for explaining CBW decisions. Instead, they almost always exert an effect in combination with other conditions, contradicting predictions from the realist security model that foreign threats (especially from nuclear-armed adversaries) are the reason that states want unconventional weapons. In fact, facing a nuclear-armed adversary has played a limited role in states' decisions to pursue or acquire CBWs. In cases where adversaries were salient in CBW decisions, it usually concerned the presence or absence of CBW-armed or conventionally stronger rivals rather than nuclear weapons possessors, indicating that states consider these weapons as in-kind deterrents or force multipliers rather than general strategic deterrents or deterrents against nuclear-armed adversaries. Third, some regimes have turned to CBWs when they experienced domestic challenges to their rule (for instance, Chile's Pinochet regime, Rhodesia's white minority regime, Apartheid-era South Africa, and Yugoslavia under Communist rule). The combination of high domestic unrest and external security threats provides a particularly fertile ground for states to embark on CBW programs, while low domestic unrest or the occurrence of regime transition has led to the end of CBW programs when combined with the absence of external security threats. Notably, the occurrence of regime transition—both in cases of a move towards democratic majority rule (like in South Africa at the latter stages of Apartheid) as well as regime breakdown (like in Yugoslavia)—was even sufficient by itself to produce paths towards the end of BW pursuit and CW possession. Fourth, treaties act as important constraints on the demand for unconventional weapons. The majority of paths towards the start of CW pursuit and CW possession occurred prior to the existence of the Chemical Weapons Convention (CWC), while membership of the CWC was sufficient by itself to produce paths towards the end of CW pursuit and the end of CW possession. Taken together, these findings suggest that the extant literature tends to overstate the importance of realist security model explanations of CBW spread and restraint and that more attention should be extended to understand how the preferences of actors are shaped by domestic politics and regime security considerations, as well as international law and behavioral norms.

Fundamentally, this dissertation mounts a critique against the structural realist and technological determinist assumptions that dominate thinking about unconventional weapons and depict the history and future of chemical, biological, and nuclear weapons as a story about *proliferation*. This proliferation paradigm requires the constant scrutiny of other states as potential sites where weapons programs can—and are expected—to establish themselves. These ideas are expressed in a powerful manner through the metaphor of the 'the poor man's atomic bomb'. Not only does this metaphor effectively voice the notion that unconventional weapons are inherently desirable and will spread rapidly and uncontrollably, but it is also a prime example of the way that racialized hierarchies and civilizational discourses are utilized to construct the proliferation threat as well as the policies to combat it.[1] By highlighting foreign threats that are yet to occur, the concrete threats posed by existing weapons on the territory of the analyst or the policymaker herself—or those of allied states that provide a security guarantee—can be ignored. At the same time, the supposed threat of chemical, biological, and nuclear weapons in the hands of the radical, untrustworthy, and uncivilized 'Other' is a key argument for possessors to indefinitely retain their own weapons arsenals in order to 'maintain deterrence'. Thus, the discursive construction of the proliferation threat is an effective way to enforce a state of exception for the longstanding 'haves' versus the 'have nots'.

Tragically, the proliferation paradigm primes analysts and policymakers to overlook positive or even transformational outcomes (for instance, that intentions of actors may have been misunderstood or that their preferences may have changed) and consequently leads to the notion that coercive measures—like sanctions, sabotage, military strikes, and preventive wars—are needed to halt proliferation ambitions. These nonproliferation and counterproliferation policies have frequently had disturbing humanitarian consequences and negative spillover effects as has, for instance, been the case with the 2003 invasion of

1 Other notable examples are the notions of the 'WMD-armed rogue state' and the 'Islamic bomb'.

Iraq after it was falsely accused of having acquired weapons of mass destruction. This study is, therefore, a call to experts and policymakers to reassess the traditional view that casts the history of chemical, biological, and nuclear weapons as a story about proliferation, to challenge damaging and ineffectual nonproliferation, counterproliferation and deterrence policies, and to promote security policies that prioritize human wellbeing.

Nederlandse Samenvatting

Het voorkomen van de verspreiding van chemische, biologische en kernwapens is al sinds het einde van de Tweede Wereldoorlog een van de belangrijkste nationale en internationale beleidsprioriteiten. Desondanks hebben wetenschappers en beleidsmakers weinig aandacht geschonken aan de vraag hoe en waarom chemische en biologische wapens (CBW's) verspreid raken, met name in vergelijking met de hoeveelheid aandacht die kernwapens hebben gekregen. De heersende opvatting over CBW's is dat ze voordelige en eenvoudig te verkrijgen alternatieven voor kernwapens zijn; kortgezegd een '*poor man's atomic bomb*' ('kernwapen van de arme man'). Volgens deze visie zijn CBW's onder veel landen verspreid geraakt omdat de kennis en technologie alom beschikbaar zijn en de toepassing goedkoop is. Deze wapens zouden daardoor vooral een onweerstaanbare aantrekkingskracht uitoefenen op ontwikkelingslanden uit conflictregio's van de 'derde wereld' die vanwege hoge kosten en technologische barrières geen kernwapens kunnen bemachtigen. Dit proefschrift laat, echter, zien dat de notie van de '*poor man's atomic bomb*' een verkeerd beeld schetst van de rol en aantrekkingskracht van CBW's.

Om de hiaten in de bestaande kennis over de verspreiding van CBW's te dichten gaat dit proefschrift in op de volgende onderzoeksvraag: *In hoeverre zijn chemische en biologische wapens verspreid geraakt onder staten en wat heeft de verspreiding en het terugdraaien van chemische en biologische wapenprogramma's gedreven na de Tweede Wereldoorlog?* De centrale bevindingen van dit proefschrift kunnen in vijf beweringen worden opgesomd.

Ten eerste lijden bestaande inschattingen van de verspreiding van CBW's aan methodologische gebreken en presenteren en bestendigen ze opgeblazen dreigingsanalyses. Hoofdstuk 2 van dit proefschrift onderzoekt de bestaande analyses van de verspreiding van CBW's om te ontrafelen hoe het idee dat CBW's wijdverspreid zijn, met name onder 'derdewereldlanden', ingeburgerd is geraakt onder experts en beleidsmakers. Dit hoofdstuk toont aan dat veel analyses van de verspreiding van CBW's—zowel van overheidswege alsmede van de hand van experts en journalisten—lijden aan ernstige methodologische tekortkomingen. Belangrijke concepten worden veelal onvoldoende of verkeerd gedefinieerd en de analyses waarop de inschattingen van de verspreiding van CBW's zijn gebaseerd zijn vaak slecht gedocumenteerd. Bovendien is de bewijsbasis voor deze inschattingen vaak zeer dun doordat het merendeel van de beschikbare informatie over wapenprogramma's in het publieke domein bestaat uit vage, inconsistente en niet verifieerbare aantijgingen afkomstig van de Amerikaanse overheid, die op hun beurt gretig (en vaak kritiekloos) worden geconsumeerd door experts en journalisten. Tenslotte worden analyses over CBW-verspreiding geteisterd door circulaire verwijzingen—een praktijk waarin opeenvolgende publicaties naar elkaar refereren—waardoor onjuiste aantijgingen, opgeblazen dreigingsinschattingen en inaccurate verwijzingen naar de rappe verspreiding van de '*poor man's atomic bomb*' op den duur als algemeen bekende feiten worden gezien. Deze wisselwerking tussen gouvernementele en niet-gouvernementele analyses creëert en voedt het dominante gedachtekader dat stelt dat chemische, biologische en nucleaire wapens begeerlijk zijn, dat het onvermijdelijk is dat ze zullen 'prolifereren'—met name onder 'derdewereldlanden'—en dat ingrijpen van buitenaf nodig is om het tij te keren.

Ten tweede is de verspreiding van CBW's veel minder voorgekomen dan algemeen wordt aangenomen. In hoofdstuk 3 wordt een unieke dataset geïntroduceerd die 42 vermeende chemische wapen (CW) programma's en 21 vermeende biologische wapen (BW) programma's in de periode 1946-2010 beslaat. Deze data toont aan dat het aantal landen dat CBW's heeft geprobeerd te ontwikkelen of in bezit heeft gehad beduidend kleiner is dan algemeen wordt aangenomen. Van de landen waarvan vaak wordt gedacht dat ze CBW's hebben nagestreefd of bezeten heeft ruim de helft dat in werkelijkheid helemaal niet gedaan. De landen die wél geprobeerd hebben CBW's te ontwikkelen of hebben bezeten, hebben die activiteiten vaak over een kortere periode ontplooid dan algemeen wordt aangenomen. Nog belangrijker is dat de overgrote meerderheid van landen die CBW's hebben geprobeerd te ontwikkelen ofwel in bezit hebben gehad uiteindelijk van koers zijn veranderd en deze activiteiten hebben beëindigd. Oftewel, **terughoudendheid en het beëindigen van wapenprogramma's—niet de proliferatie ervan—is de trend**.

Ten derde hebben 'arme' of 'derdewereldlanden' geen bijzondere voorkeur voor CBW's. De nieuwe dataset van CBW-programma's uit hoofdstuk 3 laat zien dat zogenaamde 'arme' of 'derdewereldlanden' niet meer dan andere landen geneigd zijn om CBW's programma's te hebben. Integendeel, een aanzienlijk aantal 'derdewereldlanden' is ten onrechte beschuldigd van het nastreven of bezitten van CBW's. De landen die wel CBW-programma's hebben gehad vormen een gevarieerd gezelschap, waaronder ook een significant aantal geïndustrialiseerde landen uit het Globale Noorden. Deze bevinding wordt ook bevestigd door een grootschalige statistische analyse in hoofdstuk 4, waarin geen verband wordt gevonden tussen de economische ontwikkeling van landen en de neiging om ontwikkelprogramma's voor chemische, biologische en kernwapens op te starten.

Ten vierde beschouwen en behandelen landen CBW's over het algemeen niet als een vervanging voor kernwapens. De nieuwe dataset uit hoofdstuk 4 en de bijbehorende case beschrijvingen in hoofdstukken 6 en 7 tonen aan dat de militaire doelstellingen van CBW-programma's sterk uiteenlopen. De meeste CBW-programma's na WOII waren kleinschalig (de personeelsbestanden varieerden van een paar tientallen tot een paar honderd werknemers), hadden beperkte (veelal tactische) militaire doelstellingen en maakten vaak gebruik van geïmproviseerde verspreidingsmethoden voor chemische stoffen en ziekteverwekkers. Deze wapens waren onder andere bedoeld als specialistische wapens voor moord of sabotage, voor het neerslaan van opstanden, het terroriseren van burgerbevolkingen en als *force multipliers* tegen numeriek superieure tegenstanders op het slagveld. Hoewel chemische en biologische wapens vaak op één hoop worden gegooid onder de '*poor man's atomic bomb*' noemer, hebben alleen biologische wapens de potentie om op massale schaal slachtoffers te veroorzaken net zoals kernwapens. Echter, is het creëren van een effectief en betrouwbaar biologisch oorlogsvoeringvermogen dat op massale schaal slachtoffers kan veroorzaken buitengewoon kostbaar en ingewikkeld. Het is niet voor niks dat alleen de biologische wapenprogramma's van de Verenigde Staten en de Sovjet-Unie het nadrukkelijke doel hadden om wapens te creëren die het slachtofferpotentieel van nucleaire wapens konden benaderen. Er is dus weinig bewijs dat CBW's vervangers zijn voor kernwapens of dat staten ze als zodanig behandelen. Deze conclusie wordt verder ondersteund door een grootschalige statistische analyse in hoofdstuk 4 waarin de relatie tussen de vraag naar chemische, biologische en kernwapens wordt onderzocht. Deze analyse toont namelijk aan dat wanneer een land chemische wapens ontwikkelt of bezit en wanneer het biologische wapens bezit het land een hogere kans loopt om ook kernwapens te proberen te ontwikkelen. Het ontwikkelen of bezitten van kernwapens, daarentegen, vergroot noch verkleint het risico dat chemische en biologische wapens worden nagestreefd. Er lijkt dus een complementaire relatie tussen de drie wapensystemen te bestaan (de kans op kernwapenprogramma's lijkt toe te nemen met het bestaan van CBW-programma's), maar er is geen bewijs voor een vervangingseffect (kernwapenprogramma's verlagen het risico op CBW-programma's niet).

Ten vijfde is de verspreiding en terugdraaiing van CBW-programma's een complex sociaal en politiek fenomeen dat niet gereduceerd kan worden tot alleen nationale-veiligheidzoekend gedrag. Ondanks de dominantie van het '*poor man's atomic bomb*' narratief zijn er in de academische literatuur een aantal theoretische studies over de oorzaken van de verspreiding van CBW's (met een focus op nationale veiligheidsoverwegingen, binnenlandse politiek en regime veiligheid en internationaal recht en gedragsnormen) en een aantal empirische casestudies die focussen op specifieke CBW-programma's te vinden. In hoofdstuk 5 wordt de verbinding tussen theorie en empirie gezocht door middel van een systematisch onderzoek naar de drijfveren achter alle CBW-programma's in de periode na WOII met behulp van Qualitative Comparative Analysis (QCA). Hierbij wordt niet alleen gekeken waarom landen CBW-programma's opstarten maar ook waarom ze die programma's beëindigen. Dit is een belangrijke bijdrage aangezien in de literatuur over chemische, biologische en kernwapens onvoldoende aandacht wordt geschonken aan het terugdraaien van wapenprogramma's. QCA is een zeer geschikte methode om dit soort complexe processen te ontrafelen doordat het er expliciet rekening mee houdt dat oorzaken gezamenlijk op kunnen treden (*conjuncturele causaliteit*), dat verschillende routes tot een uitkomst kunnen leiden (*equifinaliteit*) en dat verschillende verklaringen ten grondslag kunnen liggen aan het wel en niet optreden van een uitkomst (*causale asymmetrie*).

Uit de QCA-analyse in hoofdstuk 5 komen een aantal belangrijke bevindingen naar voren. Ten eerste toont analyse aan dat landen verschillende routes, die vaak bestaan uit combinaties van meerdere factoren, volgen naar het beginnen en beëindigen van CBW-programma's. Deze bevinding is veelzeggend omdat het bestaande onderzoek—en met name de statistische literatuur—zich vooral bezighoudt met het arbitreren tussen concurrerende theorieën over proliferatiegedrag in plaats van synthese te zoeken en complexiteit in ogenschouw te nemen. Ten tweede spelen externe veiligheidscondities een genuanceerdere rol bij het vormgeven van de vraag naar CBW's dan algemeen wordt aangenomen. De analyse laat zien dat externe veiligheidsfactoren op zichzelf meestal onvoldoende zijn om CBW besluiten van staten te verklaren. Deze factoren oefenen bijna altijd een effect uit in combinatie met andere factoren, wat tegen de verwachtingen ingaat van het neorealistische veiligheidsmodel dat stelt dat buitenlandse bedreigingen (met name van tegenstanders met kernwapens) dé reden zijn dat staten naar onconventionele wapens verlangen. Opvallend genoeg hebben nucleair-bewapende opponenten maar een beperkte rol gespeeld in de besluiten van landen om CBW's na te streven of te verwerven. In de gevallen waarin vijandschap wel een rol speelden was er voornamelijk sprake van tegenstanders die CBW's bezaten of van conventioneel sterkere tegenstanders. Dit suggereert wederom dat landen CBW's met name als afschrikmiddelen tegen andere CBW's en als *force multipliers* op het slagveld beschouwen en niet zozeer als algemene strategische afschrikmiddelen of als afschrikmiddelen tegen nucleair-bewapende landen. Ten derde hebben sommige regimes zich tot CBW's gewend als reactie op binnenlandse onrust en tegenstand tegen hun heerschappij (bijvoorbeeld in het geval van het regime van Pinochet in Chili, het blanke minderheidsregime in Rhodesië, Zuid-Afrika ten tijde van Apartheid en Joegoslavië onder het communistische bewind). De aanwezigheid van een hoge mate van binnenlandse onrust in combinatie met externe veiligheidsdreigingen hebben een vruchtbare voedingsbodem gevormd om CBW's programma's te beginnen, terwijl lage binnenlandse onrust of regime transitie routes vormden naar het beëindigen van CBW-programma's wanneer ze gecombineerd werden met de afwezigheid van externe veiligheidsdreigingen. Bovendien was het plaatsvinden van regime transitie—zowel in gevallen van een democratiseringsproces zoals in het laatste stadium van Apartheid in Zuid-Afrika alsmede in gevallen van het instorten van regimes zoals in Joegoslavië in de vroege jaren '90—op zichzelf voldoende om paden richting het ten einde brengen van het nastreven van biologische wapens en het beëindigen van chemisch wapenbezit te bewerkstelligen. Tenslotte laat de QCA-analyse zien dat internationale verdragen belangrijke beperkingen vormen op de vraag naar onconventionele wapens. De meerderheid van de paden naar het ontwikkelen van chemische wapens alsmede het verwerven van chemische wapens deden zich voor nog voordat het Chemisch Wapenverdrag bestond. Daarentegen was lidmaatschap van dit verdrag op zichzelf voldoende om paden richting het beëindigen van CW-ontwikkelprogramma's en het beëindigen van CW-bezit te produceren. Alles bij elkaar genomen, suggereren deze bevindingen dat de bestaande literatuur de neiging heeft om de relevantie van neorealistische veiligheidsverklaringen van CBW-besluitvorming te overdrijven. Er moet juist meer aandacht besteed worden aan de wijze waarop binnenlandse politiek en zorgen van politieke elites over binnenlandse rivalen en gewapende opstanden, maar ook het internationaal recht en gedragsnormen bepalen hoe actoren denken over dit soort wapens.

Dit proefschrift bekritiseert het traditionele denken over onconventionele wapens dat sterk gevoed is door enerzijds het technologisch determinisme en anderzijds het neorealistisch veiligheidsdeterminisme. Dit dominante paradigma schildert de geschiedenis en toekomst van chemische, biologische en kernwapens af als een verhaal over *proliferatie*. Het proliferatieparadigma veronderstelt op achterdochtige wijze dat er constant toezicht gehouden moet worden op andere landen omdat het potentiële locaties zijn waar wapenprogramma's zich kunnen (en verwacht worden) te vestigen. De '*poor man's atomic bomb*' metafoor drukt deze ideeën op een uiterst effectieve wijze uit. Deze metafoor omvat niet alleen het idee dat chemische, biologische en nucleaire wapens inherent aantrekkelijk zijn en zich snel en ongeremd zullen verspreiden, maar het is ook een schoolvoorbeeld van hoe geracialiseerde hiërarchieën en beschavingsdiscoursen gebruikt worden om een proliferatiedreiging te construeren en de beleidsvoorstellen vorm te geven om die voorgestelde dreiging te bestrijden.[2] Door nadruk te leggen op buitenlandse dreigingen die nog moeten plaatsvinden wordt de tastbare dreiging genegeerd die dagelijks uitgaat van bestaande wapens op het grondgebied van de analist of de beleidsmaker zelf (of de wapens van geallieerde landen die een veiligheidsgarantie bieden). Tegelijkertijd is de veronderstelde dreiging van chemische, biologische en kernwapens in de handen van de radicale, onbetrouwbare en onbeschaafde 'Ander' een belangrijk argument voor de huidige bezitters om hun eigen wapenarsenalen voor onbepaalde tijd te behouden omwille van 'het in stand houden van afschrikking'. De discursieve constructie van de proliferatiedreiging is dus een uiterst effectieve manier om een uitzonderingstoestand af te dwingen voor de landen die vaak al een lange tijd dit soort wapens bezitten ten opzichte van de landen die ze niet bezitten.

Het proliferatieparadigma beïnvloedt (onbewust) analisten en beleidsmakers om positieve of zelfs transformationele uitkomsten (bijvoorbeeld dat de intenties van actoren verkeerd zijn begrepen of dat hun voorkeuren met de tijd veranderd zijn) over het hoofd te zien en propageert het geloof dat dat dwangmaatregelen—zoals sancties, sabotage, militaire aanvallen en preventieve oorlogen—nodig zijn om proliferatieambities een halt toe te roepen. Zulk non-proliferatie en contraproliferatie beleid heeft, echter, vaak verontrustende humanitaire gevolgen en andere negatieve neveneffecten, zoals bijvoorbeeld het geval is geweest bij de invasie van Irak in 2003 naar aanleiding van onjuiste beschuldigingen dat het in bezit zou zijn van massavernietigingswapens. Dit proefschrift is dus een oproep aan experts en beleidsmakers om de traditionele kijk die de geschiedenis van chemische, biologische en nucleaire wapens neerzet als een verhaal over proliferatie opnieuw te beoordelen, om schadelijk en contraproductief non-/contraproliferatiebeleid en afschrikkingsbeleid te betwisten en in plaats daarvan juist veiligheidsbeleid te bevorderen dat menselijk welzijn centraal stelt.

2 Andere sprekende voorbeelden van dit soort geracialiseerde hiërarchieën en beschavingsdiscoursen zijn verwijzingen naar 'schurkenstaten met massavernietigingswapens' en het idee van een 'Islamitische bom'.