SOCIAL ACTION, ROGUE REACTION:
US POST-COLD WAR NUCLEAR COUNTERPROLIFERATION STRATEGIES

A DISSERTATION
SUBMITTED TO THE DEPARTMENT OF POLITICAL SCIENCE
AND THE COMMITTEE ON GRADUATE STUDIES
OF STANFORD UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

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September 2005
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Abstract

Which US post-Cold War counterproliferation strategies towards nuclear aspirants have been most successful and why? Military capabilities, economic needs, and social desires provide both motivations for nuclear proliferation and opportunities for states to counter these motivations. I argue that strategies involving the use of military or economic tools alone are not only unsuccessful but are actually counterproductive. I demonstrate using the cases of North Korea and Iran that including social benefits in the form of symbolic and diplomatic gestures is crucial to the success of these strategies.

To generate hypotheses regarding the effects of different types of strategies on nuclear outcomes, I combine realist, liberal, and constructivist theories with spiral and deterrent models. I include the effects of three intervening mechanisms: domestic political structures, positive feedback loops, and the effects of multiple-country interactions. To test these hypotheses, I break down strategies into individual actions directed at either suppressing the demand for or halting the supply of nuclear technologies to individual proliferants. I use vector autoregression to uncover action-reaction cycles and establish general interaction patterns between the United States and North Korea. I then use within-case congruence procedures to compare theoretical predictions of the effects of different types of strategies with nuclear outcomes in both North Korea and Iran. I find in both cases that feedback played an important role in amplifying US strategies and that social incentives were consistently related to success. Finally, I perform a cross-case comparison of how the structure of proliferation networks among second-tier nuclear aspirants has affected weapons development times; I find that tacit knowledge constrained the A.Q. Khan nuclear network to a hub-and-spoke structure, minimizing its effectiveness. Together, these findings imply that to stop proliferation, social benefits should be used to target existing and potential hubs of proliferation networks; future research should find that other proliferation networks are similarly constrained and that social motivations play a large role in proliferation decisions.
Acknowledgements

This dissertation is the result of five years of following an occasionally circuitous path from an initial inquiry into the effects of social sanctions on nuclear aspirants to the (finally) finished product. I could not have completed it without the assistance of many individuals along the way. Any shortcomings of this work (including forgetting to thank them) are my own; any virtues are in large part due to their assistance.

I would first like to thank the members of my committee. Scott Sagan provided invaluable guidance throughout the project, from compiling an initial reading list to reading the final draft on a very tight schedule; his suggestions on all parts of the dissertation have been invaluable. Lynn Eden gave copious advice on numerous occasions, spending a great deal of time on everything from brainstorming to polishing; her door was always open. John Meyer brought a very different perspective to the table; his ability to offer concise and pertinent advice within a day of every draft is unparalleled. I would like to thank Steve Krasner for comments on early drafts, and David Holloway for readily stepping in as a committee member late in the process. I would also like to thank Woody Powell for chairing my defense.

I received invaluable help from many seminar participants. Ted Hopf and Steve Biddle offered useful tips on an early version of Chapters 2-4 given as a paper at the 2004 meeting of the American Political Science Association. Chaim Braun, Christopher Chyba, and Dean Wilkening offered helpful feedback on an early draft of Chapter 6 given as a paper at the Stanford Center for International Cooperation and Security (CISAC). Gili Drori provided extensive comments on a version of my prospectus presented at CISAC. I would like to thank them as well as the rest of the participants of the Research Seminar at CISAC.

Most of my dissertation writing occurred at the Kennedy School at Harvard University, where I was a pre-doctoral fellow for two years. I would particularly like to thank Jim Walsh, Matt Bunn, John Park, Anthony Wier, and Chen Zak at Managing the Atom and Steve Miller and Sean Lynn-Jones at the International Security Program for discussions on
North Korea and Iran during my time at Belfer. I would also like to thank Diane McCree for extensive editing on Chapter 6, which is forthcoming as an article in International Security. I also received many comments from the rest of the participants of the Managing the Atom Project and the International Security Program seminars at the Belfer Center for Science and International Affairs.

Financial assistance was provided by a Graduate Research Fellowship from the National Science Foundation, the Political Science department at Stanford University, the Stanford Center for International Security and Cooperation at the Freeman Spogli Institute for International Studies, and the Belfer Center for Science and International Affairs, John F. Kennedy School of Government, Harvard University. I would like to thank Jeanette Lee-Oderman, graduate student administrator in Political Science at Stanford, for sorting out innumerable bureaucratic complications as well as general support.

I am fortunate enough to have many colleagues who are also good friends; they provided support during the long process of researching and writing. My friends Paul MacDonald and Stacie Goddard gave me early comments on important parts of the dissertation and helped to keep me sane while I was in Cambridge. Ron Hassner, Taylor Fravel, and Todd Sechser, my immediate predecessors in security studies at Stanford and fellow fellows in Cambridge, were equally good with their advice and company. Karthika Sasikumar, fellow student of nonproliferation, gave me suggestions on multiple subjects. Emilie Hafner-Burton, Dan Nexon, and Janice Bially Mattern provided encouragement during the researching and writing process. Adrienne LeBas was a wonderful commiserator during the final few months of writing.

Finally, I would like to thank my friends and relatives for their support and patience over the years, both preceding and during the overlong dissertation process. My parents, Judy and Doug, have been very supportive during the entire process, despite any doubts they may have had about how long it was going to take to finish the final product. My grandparents Bill, Jeanne, Edison, and Ruth have been very encouraging of my work whether it was readable or not. Without their support as well as the support of my entire family and friends (especially Brian and Orion), this dissertation would not have been possible.
# Contents

## Abstract

## Acknowledgements

## List of Tables

## List of Figures

## 1 Introduction

1.1 Defining the Question ........................................ 5
1.2 Case Selection ........................................... 8
1.3 Overview ................................................ 11

## 2 Theory and Method

2.1 Introduction ............................................. 17
2.2 Theory .................................................. 20
2.3 Method .................................................. 34
2.4 Evidence ................................................. 39
2.5 The Technology of Proliferation ............................ 43
   2.5.1 The Plutonium Route ................................ 46
   2.5.2 The Uranium Route .................................. 50
2.6 Sources .................................................. 53

## 3 Social Action, What Reaction?

3.1 Introduction ............................................. 57
3.2 Quantitative Methodology .................................. 60
   3.2.1 Data Coding .......................................... 60
   3.2.2 Event Scaling ......................................... 62
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2.3</td>
<td>Vector Autoregression (VAR)</td>
<td>64</td>
</tr>
<tr>
<td>3.2.4</td>
<td>Crisis Periods and Time</td>
<td>68</td>
</tr>
<tr>
<td>3.3</td>
<td>US–DPRK Interactions</td>
<td>71</td>
</tr>
<tr>
<td>3.3.1</td>
<td>The First North Korean Nuclear Crisis</td>
<td>74</td>
</tr>
<tr>
<td>3.3.2</td>
<td>The Second North Korean Nuclear Crisis</td>
<td>79</td>
</tr>
<tr>
<td>3.4</td>
<td>Conclusion</td>
<td>81</td>
</tr>
<tr>
<td>3.5 A</td>
<td>Lag Lengths and Coefficients</td>
<td>83</td>
</tr>
<tr>
<td>3.5 B</td>
<td>Event Codes</td>
<td>86</td>
</tr>
<tr>
<td>4</td>
<td>North Korea</td>
<td>91</td>
</tr>
<tr>
<td>4.1</td>
<td>Introduction</td>
<td>91</td>
</tr>
<tr>
<td>4.2</td>
<td>The North Korean Nuclear Program, 1950–2003</td>
<td>93</td>
</tr>
<tr>
<td>4.2.1</td>
<td>North Korean Motivations</td>
<td>93</td>
</tr>
<tr>
<td>4.2.2</td>
<td>The Origins of the Program</td>
<td>94</td>
</tr>
<tr>
<td>4.2.3</td>
<td>The Post-Cold War Program</td>
<td>97</td>
</tr>
<tr>
<td>4.3.1</td>
<td>The First North Korean Nuclear Crisis</td>
<td>105</td>
</tr>
<tr>
<td>4.3.2</td>
<td>The Second North Korean Nuclear Crisis</td>
<td>126</td>
</tr>
<tr>
<td>4.4</td>
<td>Conclusions</td>
<td>148</td>
</tr>
<tr>
<td>5</td>
<td>Iran</td>
<td>153</td>
</tr>
<tr>
<td>5.1</td>
<td>Introduction</td>
<td>153</td>
</tr>
<tr>
<td>5.2</td>
<td>The Roots of the Iranian Nuclear Program, 1957–2003</td>
<td>155</td>
</tr>
<tr>
<td>5.2.1</td>
<td>Iranian Motivations</td>
<td>155</td>
</tr>
<tr>
<td>5.2.2</td>
<td>The Origins of the Program</td>
<td>162</td>
</tr>
<tr>
<td>5.2.3</td>
<td>The Post-Revolution Program</td>
<td>164</td>
</tr>
<tr>
<td>5.3</td>
<td>Iranian Actions, US Reactions, 1979–2002</td>
<td>169</td>
</tr>
<tr>
<td>5.3.1</td>
<td>Russia and Bushehr</td>
<td>171</td>
</tr>
<tr>
<td>5.3.2</td>
<td>China</td>
<td>178</td>
</tr>
<tr>
<td>5.3.3</td>
<td>Other States</td>
<td>181</td>
</tr>
<tr>
<td>5.3.4</td>
<td>Bilateral Actions</td>
<td>182</td>
</tr>
</tbody>
</table>
5.4 Iranian Clandestine Action, 1979-2002
   5.4.1 Intelligence Estimates
   5.4.2 Domestic and Clandestine Uranium Experiments
   5.4.3 IAEA inspections
5.5 The Iranian Nuclear Crisis, 2002–2003
5.6 Conclusions

6 Ringing in Proliferation
   6.1 Introduction
   6.2 Proliferation Determinism
   6.3 New Proliferators
      6.3.1 Nuclear Networks: Leapfrogging or Falling Down?
      6.3.2 The Irrelevance of Regime Type
   6.4 Proliferation Networks
      6.4.1 The Structure of Proliferation Networks
      6.4.2 Tacit Knowledge and the Spread of Nuclear Weapons
   6.5 Past and Future Counterproliferation Efforts
   6.6 Conclusion

7 Conclusion
   7.1 Policy Implications
      7.1.1 North Korea
      7.1.2 Pakistan
      7.1.3 Iran
   7.2 Research Implications

Bibliography
Periodicals
# List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Nuclear status levels</td>
<td>43</td>
</tr>
<tr>
<td>2.2</td>
<td>Worldwide uranium deposits 2003</td>
<td>45</td>
</tr>
<tr>
<td>2.3</td>
<td>Fissile materials production methods</td>
<td>51</td>
</tr>
<tr>
<td>2.4</td>
<td>Nuclear status coding schemes</td>
<td>55</td>
</tr>
<tr>
<td>3.1</td>
<td>WEIS base categories</td>
<td>60</td>
</tr>
<tr>
<td>3.2</td>
<td>Event coding example</td>
<td>61</td>
</tr>
<tr>
<td>3.3</td>
<td>Hypotheses supported by vector autoregression</td>
<td>82</td>
</tr>
<tr>
<td>3.4</td>
<td>Vector autoregression results from the first North Korean crisis</td>
<td>84</td>
</tr>
<tr>
<td>3.5</td>
<td>Vector autoregression results from the second North Korean crisis</td>
<td>85</td>
</tr>
<tr>
<td>3.6</td>
<td>Event codes, names, and social and material scaling</td>
<td>86</td>
</tr>
<tr>
<td>4.1</td>
<td>DPRK HEU program timeline</td>
<td>99</td>
</tr>
<tr>
<td>4.2</td>
<td>DPRK nuclear/Pu timeline</td>
<td>103</td>
</tr>
<tr>
<td>4.3</td>
<td>DPRK: hypotheses supported by qualitative analysis</td>
<td>148</td>
</tr>
<tr>
<td>5.1</td>
<td>Iran Nuclear program timeline</td>
<td>165</td>
</tr>
<tr>
<td>5.2</td>
<td>Iran Pu program timeline</td>
<td>166</td>
</tr>
<tr>
<td>5.3</td>
<td>Iran HEU Program Timeline</td>
<td>167</td>
</tr>
<tr>
<td>5.4</td>
<td>Iranian nuclear facilities</td>
<td>170</td>
</tr>
</tbody>
</table>
List of Figures

2.1 Causes of proliferation demand .............................................. 22
2.2 Sources of proliferation supply ............................................. 23
2.3 Relationships between hypotheses ........................................ 30
2.4 Fissile materials production flowchart .................................. 47
3.1 Quantitative methodology flowchart ..................................... 58
3.2 Interpretations of vector autoregression coefficients ................. 67
3.3 Sample cumulative impulse-response functions ........................ 70
3.4 Comparison of Bush I, Clinton, and Bush II US–DPRK event frequencies 72
3.6 US and DPRK social action, 1991–2003 .................................. 75
3.7 First North Korean crisis weekly US–DPRK social and material action . 77
3.8 First North Korean crisis vector autoregression results ............... 78
3.9 Second North Korean crisis weekly US–DPRK social and material action . 79
3.10 Second North Korean crisis vector autoregression results ........... 80
4.1 DPRK materials production flowchart .................................... 96
5.1 Iranian government structure and relations ............................ 158
5.2 Iran materials production flowchart ...................................... 168
6.1 Network structure and state intentions .................................. 203
6.2 Simple network structures .................................................. 218
6.3 Second-tier ballistic missile proliferation, 1974–2002 .................. 219
Chapter 1

Introduction:

Post-Cold War Nuclear Aspirants

“States like these, and their terrorist allies, constitute an axis of evil, arming to threaten the peace of the world. By seeking weapons of mass destruction, these regimes pose a grave and growing danger.”—President George W. Bush[1]

“We may totally despise [North Korean leader] Kim Jong Il. We may loathe him. But the fact is if you truly want to end their nuclear capability, then you can’t casually refer to him as a pigmy and you can’t casually refer to the country as an ‘axis of evil,’”—Representative Curt Weldon (R-Pa.)[2]

Over the past four years, events have underscored not only the evolving nature of the proliferation problem but also an increased need for an understanding of what kinds of policies are most likely to slow, halt, and reverse proliferation. North Korea dramatically pulled out of the nuclear non-proliferation treaty (NPT); Iraq was invaded on counterproliferation grounds; Libya dismantled its non-conventional weapons programs; the Abdul Qadeer (A.Q.) Khan nuclear proliferation network was discovered; and Iran’s extensive nuclear facilities were revealed[3] As the sole remaining superpower, the United States

[2]Quoted in Ruppe 2005
[3]On North Korea’s withdrawal, see Pollack 2003; on Iraq’s capabilities, see Duelfer 2005; on Libya, see IAEA Board of Governors 2004c; on the A.Q. Khan network, see Kampani 2004; on Iran, see IAEA Board of Governors 2004a
uniquely possesses both the capabilities to hold countries’ military, economic, and diplomatic interests at risk and the ability to offer the benefits of foregoing nuclear arsenals—such as security guarantees, technical assistance, economic aid, and integration into the world system. Since the end of the Cold War and the discovery in 1991 of Iraq’s clandestine nuclear program, the United States has taken an increasingly active role in attempting to prevent the spread of nuclear weapons, using a wide variety of strategies in an attempt to roll back nascent nuclear programs. Which US post-Cold War counterproliferation strategies towards nuclear aspirants have been most successful and why? I argue that contrary to realist arguments that assert the causal dominance of military power, social incentives have significant effects on proliferants; symbolic gestures such as allowing aspirants to retain some civilian nuclear technologies and political incentives like offering full diplomatic recognition are crucial for the success of counterproliferation strategies. These measures can help freeze a program in the short term through allowing proliferants to save face and roll it back in the longer term by changing the structural incentives that lead states to seek nuclear weapons.

A near-consensus among policymakers and academics has been reached that halting proliferation of nuclear weapons should be a top priority. Even advocates of limited nuclear proliferation due to its potential stabilizing effects do not claim that proliferation by one state is good for other states, or even that all countries are equally good candidates for wielding nuclear weapons.\textsuperscript{4,5} The potential disadvantages of nuclear weapons programs both for the proliferant and for the rest of the world are well-documented.\textsuperscript{4,5} Regardless of the intentions or capabilities of aspiring nuclear weapons states, each new nuclear program can become a potential source of weapons, materials, and technologies to be stolen, purchased, or transferred to third parties through clandestine supply networks. The growth of these nuclear networks over time could eventually expand beyond the international community’s ability to control the spread of nuclear weapons, with potentially catastrophic results.

\textsuperscript{4}Mearsheimer 1990, Sagan and Waltz 2003, Waltz 1990, 1993
\textsuperscript{5}On the high financial cost of nuclear weapons, see Schwartz 1998; on the environmental cost, see Makhijani et al. 1995; on the dangers of accidental use and other potential hazards, see Sagan 1993, Sagan and Waltz 2003, Busch 2004
No consensus exists on how to deal with proliferation. Traditional counterproliferation tools such as economic sanctions and the threat of military force are both costly and minimally effective. Still, some argue that when a country is suspected of possessing non-conventional weapons, the preemptive threat or use of military force is necessary, justified, and effective. In September 2002, preemption was enshrined as a part of American counterproliferation policy in the National Security Strategy of the United States of America. In March 2003, the United States and its allies invaded Iraq, embarking on the first war to be fought for counterproliferation goals. Although non-conventional weapons were never found in Iraq, the war did little to settle the debate over whether the threat or use of preemption is a successful counterproliferation strategy. While some argue that such threats or actions establish credibility for US threats of regime change in other countries, pointing to Libya’s announcement in December 2003 that it was giving up its weapons programs, others counter that regime change policies can cause the acceleration of nuclear programs in states such as North Korea and Iran and has undermined the ability of the US to take military actions elsewhere.

In essence, this debate is split between two camps of realists: those who argue that military threats such as preemption can stop adversaries from developing weapons systems, and those who claim that such threats spur on development and cause arms races. Some theorists argue that states are quite likely to adopt bandwagoning-like behavior—giving in to a stronger power—and thus argue that strategies that incorporate military threats can be effective. Other theorists argue that balancing behavior—where adversaries try to compensate for imbalances of power through alliances or through increasing their own military strength—is more likely.

Both camps are wrong. The logic of bandwagoning argues that states will capitulate to stronger powers, but this is unlikely when states are trying to balance against specific threats. The logic of balancing argues that states will try to avoid being dominated, but this is unlikely when states are trying to avoid specific threats. Therefore, neither bandwagoning nor balancing is likely to be effective in preventing proliferation.
when presented with a threat or a display of force. Yet the North Korean and Iranian responses to the invasion of Iraq make it clear that such displays can often spur on programs. Realists who argue that balancing behavior is the most common response to military threats are correct, but for the wrong reasons; balancing is not inevitable, but rather occurs when such threats lack a method for the target to back down while saving face and incorporate no mechanisms for ensuring long-term stability. I argue that when the social (symbolic and diplomatic) incentives that realists neglect in their analysis are offered, states will agree to freeze or roll back their nuclear programs. These incentives can allow for saving face in the short term, increasing the chance of success. Moreover, over the long term, such offers can potentially transform the proliferant’s underlying structural reasons for proliferating, which is crucial for addressing core motivations for proliferation and locking in nuclear rollback.

These measures have been used successfully in the past. For example, during the 1993–1995 North Korean nuclear crisis, a combination of sticks and carrots brought North Korea to the negotiating table with the United States. In October 1994, the two sides signed the Agreed Framework, which offered North Korea two light-water reactors as well as diplomatic and economic relations in exchange for the cessation of North Korea’s nuclear weapons program, then thought to be limited to plutonium production. It collapsed in October 2002 after the United States accused North Korea of operating a clandestine uranium enrichment program, triggering a crisis. The degree of success of the Agreed Framework and the lessons that should be drawn from it regarding the use of positive inducements in the future is still debated. As I argue in Chapter 4, the Agreed Framework did succeed in part since it included short-term face-saving measures that enabled North Korea to freeze its program. However, the longer-term social measures needed to transform North Korea’s structural motivations were never implemented; instead, the relationship with the United States deteriorated during the administration of George W. Bush in part due to a cessation of bilateral contacts and a series of vague threats and social snubs.

Benefits and sanctions directed at potential proliferants are not the only tools available to policymakers. While those strategies are aimed at changing a proliferator’s mind, other strategies focus on denying a proliferator the necessary technologies and materials needed
for proliferation by cutting off nuclear supply networks. For example, since the 1979 Iranian revolution, the United States has sought to thwart Iran’s nuclear ambitions primarily through restricting its access to nuclear technology. The US has successfully used social and economic measures—without resorting to military threats—to convince many suppliers to reject contracts with Iran. Since the August 2002 discovery of the Natanz uranium centrifuge facility in Iran, the United States has stuck by its policies toward Iran, threatening to report Iran to the Security Council and seeking to cancel nuclear cooperation between Russia and Iran. I contend in Chapter 5 that while such efforts have postponed nuclear acquisition by Iran, the lack of a complementary strategy to suppress Iranian demand for nuclear technology has undermined the effectiveness of US strategy.

Many US attempts to limit the supply of nuclear technology have been successful; however, these attempts have been partially undercut by clandestine nuclear supply networks. Libya’s December 2003 announcement that they were giving up their non-conventional weapons programs helped to reveal the extent of the clandestine proliferation network run by A.Q. Khan. Khan’s network gave significant assistance to the Iranian, North Korean, and Libyan uranium enrichment programs. However, this assistance has been hampered by the difficulty of transmitting tacit knowledge regarding how to build and operate enrichment facilities effectively. While some efforts have been made to shut down the network, a lack of cooperation between the US and the IAEA has hampered efforts; consequently, it still lingers on, as do the North Korean and Iranian crises. I argue in Chapter 6 that in order to prevent the future growth of such networks, existing and potential nuclear technology hubs must be shut down using a wide range of incentives.

1.1 Defining the Question

With the continuing challenge presented by these crises, it is vital to determine what policies powerful actors—in particular, the United States—should follow in order to clamp down on both the demand for nuclear weapons in these states and the supply of nuclear technologies to them. In this dissertation, I evaluate the success of US post-Cold War counterproliferation policies towards new nuclear aspirants. I define the “post-Cold War era,” in
CHAPTER 1. INTRODUCTION

nuclear proliferation terms, to be 1991 to the present, although I trace the development of proliferators’ programs from their inception in my case studies. I concentrate on this time period and on the United States for two reasons: first, during this time period the United States is unique in its ability to credibly follow through on threats of sanctions or promises of benefits to target states; second, the revelations in the aftermath of the 1990-1991 Persian Gulf War regarding the extent of Iraq’s clandestine program re-invigorated nonproliferation policy in the United States and helped spawn the concept of counterproliferation.

Counterproliferation was introduced as a component of US strategy in December 1993, with Secretary of Defense Les Aspin’s Counterproliferation Initiative. It was initially conceptualized as a strategy to deter or pre-empt the military use of nuclear, chemical, or biological weapons by developing new military capabilities. However, by February 1994, counterproliferation was reduced to activities by the Department of Defense to support nonproliferation, including minimization of damage to US forces by nuclear, chemical, or biological weapons.\[12\] This decline was reversed in December 2002, when the Bush administration anchored its National Strategy to Combat Weapons of Mass Destruction on three “pillars”: “Counterproliferation to Combat WMD Use,” “Strengthened Nonproliferation to Combat WMD Proliferation,” and “Consequence Management to Respond to WMD Use.” As part of counterproliferation, the National Strategy includes interdiction and “preemptive measures.”\[13\]

Since counterproliferation has been promoted to a central part of US doctrine, it is important to examine its place in policy. During the original debate over the relative roles and definitions of nonproliferation and counterproliferation, preventive diplomacy was suggested to be a potential component of counterproliferation;\[14\] similarly, the Bush administration defines denial to be part of counterproliferation strategy. I use a broad definition of counterproliferation as a whole by including measures to convince states with nuclear programs to give them up (preventive diplomacy, or demand-side strategies) as well as measures to prevent them from acquiring them (denial, or supply-side strategies). The term is also appropriate for strategies that seek to counter programs already in motion, while

\[12\] Sokolski 2001, 87-100.
\[14\] Muller and Reiss 1995.
the broader term nonproliferation is more appropriate for the complete set of activities to prevent such programs from arising in the first place.

Counterproliferation strategies against states that already have active nuclear programs (nuclear aspirants) are examples of compellent strategies. Convincing a country to stop doing something (compellence) is considered to be much more difficult than convincing a country not to do something in the first place (deterrence)\[^{15}\] Forcing countries to give up existing nuclear programs is difficult due to the creation of entrenched bureaucratic interests and the desire not to be seen capitulating to outside pressure (losing face) as well as the sunk costs of the program\[^{16}\]. Once weapons have been developed, compellence becomes even more difficult, since countries then must be convinced to give up the benefits of having a nuclear arsenal; the problem becomes disarmament, rather than rollback.

The nonproliferation regime has a significant weakness that is also a hidden strength for rollback strategies. Under the Nuclear Non-Proliferation Treaty (NPT), states are permitted to develop extensive civilian nuclear infrastructures, often with assistance from other states and the International Atomic Energy Agency (IAEA). States can develop an infrastructure that allows them to come very close to a nuclear weapons program; for example, due to their advanced civilian nuclear programs, Japan and Germany could develop nuclear weapons fairly quickly. However, other states are not as concerned about these programs due to Japan and Germany’s social relationships with their neighbors. By comparison, Iran’s ambitions to develop a complete nuclear fuel cycle cause concerns due to its antagonistic relationships with its neighbors. This creates a tension between Iran, which argues that it is simply exercising its rights as a non-nuclear weapons state to develop nuclear technology under the NPT, and states that believe that Iran is developing its civilian infrastructure as a cover for a nuclear weapons program.

Yet this weakness is also a strength: when negotiating to give up a nuclear weapons program, a state can keep from ‘losing face’ by drawing on the norms of the NPT and demanding civilian nuclear technology instead as a symbolic substitute. If a state is developing nuclear weapons for reasons of prestige or status, this can provide a partial substitute,

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\[^{15}\] Schelling 1980, 195-199.

\[^{16}\] See Art 2003 on the current state of the compellence literature.
making compellence (where a target must stop doing something) easier to achieve by essentially turning it into deterrence (where a target simply has to not do something in the first place); the former proliferant can claim to have been pursuing a civilian nuclear program. This blurriness also allows for states to adopt ‘hedging’ strategies wherein they develop some nuclear expertise without explicitly attempting to develop nuclear weapons. Without an ambiguous middle state, countries would have to decide between no program at all or a strong nuclear weapons effort, which would likely have lead to an increase in the number of nuclear weapons states.

States do not make a single, unambiguous decision to go nuclear or not; programs develop over a long period of time, and can be stopped or rolled back at any stage short of overt testing. Many states have developed dual-use nuclear research programs without making an specific decision to go for nuclear weapons. Putting states into categories of pursuing or not-pursuing is therefore problematic; intermediate levels of hedging have to be defined along a continuum. I discuss methods for coding these different levels in Chapter 2. Proliferators’ programs can be frozen at any point along this continuum; while freezing some states in an intermediate stage may not be the best outcome, it is better than dealing with a nuclear weapons state. Over time, the underlying motivations for a given country to pursue nuclear weapons technology can be reduced. Dealing with a state like Iran that wishes to have a nuclear capability requires a combined strategy of slowing Iran’s nuclear program in the short term through various measures while satisfying its structural motivations to develop a nuclear capability by improving its relations with its neighbors and elevating its international status.

1.2 Case Selection

I examine US counterproliferation policy towards states that were suspected of having a nuclear weapons program at the end of the Cold War but had not yet assembled devices: rollback of programs in progress, rather than disarmament of relatively well-developed programs. Several states beyond the first set of six nuclear weapons states (the United States, 

17See Levite 2002 on hedging and for a list of past and present hedgers; see also Singh and Way 2004
1.2. CASE SELECTION

the Soviet Union, the United Kingdom, France, China, and Israel) had already acquired weapons by the early 1990s. Two states had already developed nuclear devices, but had not yet tested them as of the beginning of my period of inquiry (India and Pakistan). Three states inherited weapons from the Soviet Union in 1992, but gave them up in the mid-1990s (Ukraine, Belarus, and Kazakhstan). One state (South Africa) had built, then dismantled its nuclear weapons, by the early 1990s. Many other programs began and ended before the end of the Cold War without producing weapons.

Out of the four major clandestine programs that were in development at the end of the Cold War (North Korea, Iran, Iraq, and Libya), Iran and North Korea have made the most progress towards a nuclear capability. North Korea is generally believed to have assembled at least one nuclear device (although the evidence for this is speculative); Iran is much further behind, but has managed to build several substantial facilities that are necessary for the production of nuclear weapons. Iraq essentially abandoned its nuclear ambitions after the 1991 Persian Gulf war; the minor activities that occurred during the 1990s are already well-documented. By contrast, little is currently known about the negotiations Libya conducted with the United States and Great Britain that led it to give up its nuclear ambitions in December 2003. However, its program had made very little progress up to that point. Consequently, I focus on Iran and North Korea, tracing the histories of their programs up to the end of the Cold War, then examining more in-depth US attempts after 1991 to roll back these programs. As individual case studies, I end my analysis at the end of 2003, since both crises have been relatively stable since then; North Korea has been participating in the six-party talks, and Iran has frozen their uranium enrichment program. What is known about the Libyan program and a discussion of current events in Iran and North Korea is briefly considered as a part of my analysis of proliferation networks in Chapter 6. I consider the implications of my analysis for studying other cases in my concluding chapter.

These two cases should be easy cases for realism and hard cases for social incentives;
both of these states have many military-related reasons to pursue a nuclear arsenal. North Korea is geographically surrounded by two nuclear powers (Russia and China) and two latent countries (Japan and South Korea), and has US troops deployed on its border. Iran also lives in a nuclear neighborhood, bordering Pakistan and being in close range of Russia, India, and Israel. Although one potential future nuclear threat (Iraq) has subsided, Iran now has troops from the United States on two sides (Afghanistan and Iraq). Both states thus have significant military incentives to pursue nuclear programs and should be reticent to give them up in exchange for social incentives.

The histories of these states’ nuclear programs are much more than single data points. US strategies towards both states have swung between engagement, coercion, containment, and isolation over time, considering them merely “states of concern” in some eras, and members of an “axis of evil” in others.\(^\text{23}\) Similarly, the North Korean and Iranian programs have progressed in fits and starts. The North Korean plutonium program has moved through at least three distinct phases: slow progress until 1994, completely frozen until 2002, then progressing quickly since then. Its uranium program has also gone through phases, from initial acquisition of parts and plans in the late 1990s to seeking parts on a massive scale in 2002. Within each of these phases, North Korea has taken steps both toward and away from a nuclear capability. The Iranian program has encountered many technical difficulties and setbacks, and made little progress on any full-scale facilities until the late 1990s, although its progress has been more constant (if much slower) than North Korea’s.

These two cases are different on many levels. US strategies toward North Korea have been primarily involved direct negotiation and threats, while strategies toward Iran have been more indirect, attempting to cut off imports of nuclear technology from other countries. Comparison is therefore primarily within-case rather than cross-case. True process-tracing whereby the individual steps and decision-making procedures within each country are causally connected is very difficult for these cases due to a general lack of transparency in either case, so for the most part I rely on within-case congruence procedures, comparing

\(^{23}\) Albright 2000; Bush 2002.
1.3. OVERVIEW

outcomes of different strategies in various combinations employed by the US with theoretical predictions.\textsuperscript{24} North Korea and Iran are also difficult cases since neither case is anywhere near being resolved—yet the lack of resolution is what makes them so important to study, since lessons learned from each case can be applied directly. Predictions based on past experience can be tested as these crises continue to unfold.

My third study does not examine a particular country, but rather compares how the A.Q. Khan network has affected the progress of three second-tier proliferators: North Korea, Iran, and Iraq. The A.Q. Khan network was originally a procurement front for Pakistan. However, A.Q. Khan progressively sold plans, then parts, then entire manufacturing facilities for uranium enrichment, to Iran, North Korea, and Libya. Whether this network has significantly affected development times and how best to dismantle and prevent future networks is debated along the same general lines as proliferation policies towards individual countries; i.e., should military force be threatened or used or should incentives be offered? I examine the structure of the network and the progress of the recipients of nuclear technology from it in order to derive recommendations for general supply-side strategies, folding in my recommendations for demand-side strategies from my individual case studies.

1.3 Overview

In this dissertation, I analytically divide “carrots and sticks” (benefits and sanctions) into social (e.g., those that affect a state’s prestige, social status, or diplomatic standing), economic (e.g., sanctions or aid), and military (e.g., force deployments or cutbacks) types in order to determine what combination of social, economic, and military incentives and disincentives succeeds. Some argue that military concerns are most central to states’ decisions to pursue nuclear weapons;\textsuperscript{25} others claim that economic concerns are vitally important;\textsuperscript{26} Still others contend that social status and recognition are the key determinants of proliferation.\textsuperscript{27}

\textsuperscript{24} George and Bennett 2005, Ch.8-9.
\textsuperscript{25} Paul 2000; Mearsheimer 1990.
\textsuperscript{26} Drezner 1999; Solingen 1994b.
\textsuperscript{27} Chafetz et al. 1996; Grillot and Long 2000.
I argue that none of these answers is sufficient to account for either individual nuclear moves made by proliferants or net proliferation outcomes. Strategies involving the use of material tools (e.g. military deterrent threats, economic aid) alone are not only unsuccessful but are actually counterproductive. Social leverage must be used in concert with these traditional tools and in the right way in order to provide the proper balance of incentives and disincentives to slow proliferation. In particular, while clear, coherent, and credible material threats (whether economic or military) can contribute towards a short-term slowdown or a freeze on nuclear activities, concurrent social overtures are necessary to ensure that freeze holds. Over the longer term, the underlying structural motivations for proliferation (in particular, social relations with neighbors) must be altered in order to prevent backsliding.

Several processes alter the relationship between US strategies and proliferator actions, including domestic politics, feedback loops, and third-party interventions. Domestic politics, either within an executive administration or between executive and legislative branches, can play a significant role in undermining these strategies. Lack of a coherent message within an executive branch or across branches of government can signal a lack of commitment on the part of an administration. This lack of commitment, in turn, can undermine both short-term and long-term deals. Domestic political interactions within the target country can also play an important role; the strengthening or weakening of pro-nuclear advocates in a target state due to external actions can tip the balance in either direction. Actions taken by the US are amplified by feedback loops; often the reactions of proliferators to US strategies necessitate a further US response, which can lead to further actions by a proliferator, and so forth. These can undermine strategies by leading to a downward spiral of threats, or can support them if friendly gestures become reciprocated over time. Finally, US strategies do not operate in an international vacuum; coordination or a lack thereof with third parties—other states, international organizations, or non-state actors—can be crucial to the success or failure of a policy.

These results are in line with the literature on compellence; credible threats combined with positive inducements that allow a target to “save face” are considered to be crucial to success, while domestic political considerations and lack of agreement between the relevant
international actors can undermine compellence. However, my work goes beyond these findings by highlighting the role played by social action in determining success or failure, identifying what kinds of benefits in the nuclear case are likely to enable a state to save face in the short term (symbolic continuation of a civilian nuclear infrastructure) and what gestures are necessary to ensure the longer-term success of a nuclear deal (transformation of social relationships). The symbolic social benefits of a long-term deal such as integration into the world system or gaining prestige through retaining nuclear infrastructure are just as crucial to success as accompanying material incentives.

In addition to examining strategies towards individual states, I also look at the larger issue of how to slow proliferation across the entire international system. I contend that in order to defeat supply networks and minimize the probability of further proliferation systemwide, counterproliferation efforts must be focused on the hubs of supply networks rather than being dispersed in an attempt to cover all countries. Due to knowledge restrictions, nuclear supply networks are shaped like star networks, and are thus highly vulnerable to being dissolved through dismantling the central nodes. Together, these insights into the roles of social incentives and network structure are important additions to the proliferation literature.

The remainder of my dissertation is divided into six chapters. In Chapter 2, I establish connections between abstract theories of why states act the way they do and concrete explanations for why states might seek or be persuaded to forego nuclear weapons. Military capabilities (realism), economic needs (liberalism), and social desires (constructivism) provide both motivations for nuclear proliferation and opportunities for states to counter these motivations. The US can counter these motivations through intervening with appropriate incentives and disincentives—threats of force or nonaggression pacts, economic sanctions or financial assistance, and diplomatic isolation or international integration, respectively. I generate six hypotheses from these theories regarding the effects of US actions on proliferators and their supply networks. I also generate four hypotheses regarding intervening variables and processes: Domestic politics in either the US or in target states may interfere with the effects of these strategies; feedback loops can amplify them; building a consensus

\[28\textit{George and Simons 1994; Art 2003} \]
among the relevant third parties can be crucial to success; strategies that target a proliferator’s short-term incentives or tackle the long-term structural causes of proliferation may have varying success rates.

I also outline in Chapter 2 how I determine the progress of proliferators. Measuring the extent of proliferation has always been a difficult task. Intelligence estimates of the progress of proliferators’ programs have often been wrong, either underestimating or overestimating progress. Fortunately, due to the presence of IAEA inspectors and satellite imaging, it is possible to estimate the progress of the DPRK and Iran toward or away from the nuclear brink. I ground my measurement of the status of proliferators’ programs, necessary for evaluating the success of US counterproliferation strategies, in a short technical overview of the facilities needed to produce fissile materials for a nuclear weapon, which I then use in later chapters to chart their progress. I also discuss how I code different levels of nuclear activity and compare these codings with other systems.

In order to test hypotheses generated from these abstract theories, I employ a quantitative test in Chapter 3 to look at direct interaction patterns (i.e., those not mediated by third parties) between the US and proliferators. US counterproliferation strategies and DPRK responses were primarily bilateral during the two US-DPRK crises (1993–1995 and 2002–2003), alternating between mutual threats and negotiation. By contrast, strategies and responses with Iran have been primarily multilateral; Iran constantly sought new suppliers for nuclear technology, while the US attempted to block them. Consequently, in Chapter 3 I limit my analysis of the patterns of direct interaction to US-DPRK actions, looking for consistent reciprocity or rejection, the existence of feedback loops, and policy inertia.

In Chapter 4 I expand on the general findings from Chapter 3, analyzing the two US-DPRK crises in-depth. Starting with a brief history of the DPRK’s nuclear program before the end of the Cold War and as a review of North Korea’s motivations for developing nuclear weapons, I examine the patterns of interaction that preceded each step the DPRK took toward or away from the nuclear brink for these two crises to see how the DPRK responded to US actions: military threats, economic sanctions, diplomatic snubs, and so forth. I trace the evolution of relations between these two countries, evaluating the role

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29 Meyer 1984; Jo and Gartzke 2003; Singh and Way 2004
that domestic politics played in their interactions, how short- and long-term strategies interacted, how feedback affected the trajectory of crises, and how third parties complicated this relationship. A combination of material threats and social incentives led North Korea to the bargaining table in the first North Korean crisis; however, since the Agreed Framework failed to transform North Korea’s fundamental motivations for proliferation (and, most importantly, its relationship with the United States), it could not withstand the combination of North Korean cheating and a change of administration in the United States; nor could a second agreement be made due to a lack of both positive social relations during the second crisis and credible threats of economic or military sanctions.

While Chapters 3 and 4 concern primarily demand-side strategies and direct interactions between the DPRK and the United States, Chapters 5 and 6 analyze supply-side strategies towards Iran’s nuclear program and the A.Q. Khan network respectively. Since interactions concerning Iran’s nuclear program have been primarily indirect, with US strategies concentrating on supply rather than demand, I focus on Iran’s attempts to acquire nuclear technology from third parties and evaluate US strategies to curtail these attempts in Chapter 5. After a brief overview of the genesis of Iran’s program during the rule of the shah, I review Iran’s motives for proliferation and give a comprehensive overview of Iran’s program from 1979 to 2003, tracing the progress of the Iranian program over time in parallel with US attempts to stop it through convincing other countries to curtail their assistance. Although the United States was successful in slowing the program, too much diplomatic capital was spent on slowing Iranian progress on their power generation program, while too little was spent attempting to deal directly with Iran and decrease Iran’s demand for nuclear weapons.

Chapter 6 takes a broader look at proliferation networks, connecting together the demand-side (how determined are states?) and supply-side (how easily can they acquire nuclear technology?) questions. I outline two perspectives on how proliferation networks should be dismantled: proliferation determinism and proliferation pragmatism. These perspectives parallel the debates over what motivates states to proliferate. Proliferation determinism holds that states are dead-set on proliferating, and can easily obtain nuclear technology through dense, decentralized supplier networks; consequently, aggressive, system-wide
policies like regime change are necessary to stop proliferation. Proliferation pragmatism, by contrast, argues that states can be convinced to give up their programs, and that supply networks are only partially effective since they are constrained to hub-and-spoke structures by the difficulty of transmitting or generating tacit knowledge about nuclear technology; thus, policies that focus specifically on convincing hubs to shut down are best. I argue that the pragmatic perspective more accurately describes the state of the world, drawing on previous chapters as well as contemporary evidence that even the most hard-core current proliferators can be convinced to give up their programs; in parallel, I chart the structures of contemporary second-tier proliferation transactions to demonstrate that their structures resemble star networks and review evidence that they are constrained by knowledge requirements.

In my final chapter, I summarize my findings with respect to North Korea, Iran, and the A.Q. Khan nuclear proliferation network and make future predictions based on different scenarios for future US strategies. Drawing on both within-case and cross-case evidence, I give policy recommendations for the three current and potential new hubs of nuclear technology (North Korea, Iran, and Pakistan), arguing that in order to stop current and future proliferation, these states must be integrated into the nonproliferation regime through grand bargains that draw upon face-saving social incentives and transform their underlying structural motivations; without such measures, proliferation becomes much more likely. I also explore the research implications of my findings for past cases of proliferation. Based on my argument, a re-analysis of other states’ past and current strategies will reveal a greatly expanded role for social incentives as both a driver of proliferation and a tool for halting it.
Chapter 2

Theory and Method

2.1 Introduction

To evaluate my claim that social incentives are key to counterproliferation strategies in both the short and long term, in this chapter I construct a theoretical framework and outline my qualitative methodology. In this framework, I integrate realist, liberal, and constructivist theories with spiral and deterrent models to generate hypotheses regarding how potential proliferants and nuclear technology suppliers will react to military, economic, and social sanctions and benefits. I also discuss three potential intervening processes and variables (domestic politics, feedback loops, and multi-country interactions) as well as the short-term and long-term effects of different strategies. I finish by briefly outlining how I qualitatively evaluate these hypotheses through the congruence method, comparing the predictions of these theories with outcomes, then give a technical overview of the different steps involved in generating nuclear materials as a basis for measuring the progress of proliferators.

A combination of different structural factors must align for states to begin pursuing nuclear weapons: military security, economic feasibility, and social status combine to create a demand for nuclear weapons. These three structural conditions are posited as major drivers of state motivations by theories of international relations: respectively, realism (military), liberalism (economic), and constructivism (social). Additionally, in order to undertake a program, a state must have a potential supply of nuclear technology, either produced indigenously or imported from abroad. While international relations theory says less about
supply than demand, the same motivating forces can be used to make predictions about the behavior of supplier states.

Due to the profound impact of nuclear weapons on international relations, states strongly resist other states’ nuclear weapons programs. An answer to the question of which US post-Cold War strategies towards nuclear aspirants have been most successful and why requires consideration of short- and long-term patterns of interaction with other states as well as relatively static factors. Since a nuclear weapons program is a long-term, dynamic endeavor that takes place over several years, other states usually have a significant period of time to attempt to dissuade potential proliferators or block their suppliers through threats of various types of sanctions or promises of benefits.

Ultimately strategies to deal with proliferation must deal with the fundamental structural causes that sustain a nuclear program in order to be successful; individual actions that temporarily diminish demand or stop a particular transaction in a supply network can only delay, not eliminate, a nuclear program. Powerful agents (such as the US in the international system) can not only change short-term incentives but can also affect these long-term proliferation drivers by altering a state’s security, economic, or social environment. Some US efforts are short-term and involve single actions, such as preventing a shipment of parts or making a single threat to report a state to the Security Council, while others are longer-term and attack the core structures that determine supply and demand—for example, promising long-term economic aid or trade concessions in exchange for disarmament or convincing a supplier to join and adhere to export control regimes.

Several intervening processes can significantly moderate or amplify these counterproliferation strategies. First, tit-for-tat spirals, whether beneficial or harmful, can develop between the United States and a proliferator. Sometimes these feedback loops can help strategies succeed through building trust, while in other circumstances they can lead to escalating conflict. Second, domestic politics may keep the United States from successfully implementing a strategy or may prevent a foreign government from accepting an offered deal. Third, the policies of other states and international organizations in the international system can play an important role; although some actions can be taken unilaterally (such as some military threats), others require cooperation to work effectively (like economic
I use different methods to analyze US strategies in different cases, depending on whether
the primary interaction pattern between the US and a given proliferant is direct or indirect.
In the case of North Korea, where US actions have been primarily bilateral and focused on
demand for nuclear weapons, I use quantitative methodology (discussed in Chapter 3) to
establish general patterns of interaction between North Korea and the United States and to
provide a plausibility probe for my arguments regarding social incentives and the role of
feedback, then qualitatively analyze interactions in much greater detail in Chapter 4. With
Iran and the A.Q. Khan network, where US strategies have focused on the supply network
rather than demand, I rely on qualitative analysis of interactions and technical analysis of
the progress that different proliferators have made in Chapters 5 and 6.

I divide this chapter into two sections. In the first section, I set up three theories of the
sources of state action derived from realism, liberalism, and constructivism, which predict
that military, economic, and social relations respectively motivate states. I review how these
theories have been implemented in the nuclear proliferation literature to explain why states
seek nuclear weapons. I then pair each of these theories up with variants of the deterrent
and spiral models to generate hypotheses about how states will react to US actions (e.g., re-
sponding to military threats with increased or decreased nuclear activity), both with respect
to states that desire nuclear weapons and those that supply nuclear technology. I also gen-
erate hypotheses reflecting the effects of feedback loops, domestic politics, multi-country
interactions, and attempts to address both short-term transitory and long-term structural
motivations.

In the second half of the chapter, I discuss how I evaluate different hypotheses in my
qualitative analysis. This includes an overview of various indicators of a state’s progress
towards a nuclear weapon, as well as a technical overview of the facilities and materials
needed to produce fissile materials. My quantitative methodology is discussed in Chapter 3.
2.2 Theory

I frame the question of why states seek nuclear weapons in terms of the more general question of why states act the way they do (and what other states might do to affect those decisions). Three general answers are prominent in the international relations literature: a realist answer in which processes and outcomes are determined by the balance of military power, a liberal answer that emphasizes the role of economic motivations, and a constructivist answer that posits social (prestige, status, and role) factors as the major determinants of state action. This debate is additionally split between those who argue that international mechanisms and processes dominate state decisions, and others who maintain that decisions are mainly affected by domestic political considerations.

The realist perspective I use here draws on the material-based theories of Kenneth Waltz and John Mearsheimer, who postulate that the military balance of power drives state interactions. Some variants of realism incorporate variables such as perceptions of threat, relying on a combination of social perceptions and material reality to explain interactions. While including threat perception is a good step towards producing more useful theories, it analytically mixes together two theoretically distinct components; consequently, I base my military hypotheses on the more parsimonious theories of Waltz and Mearsheimer. By contrast, liberal accounts of international politics tend to focus upon economic rather than military motivations. Sometimes these accounts take domestic political constituencies as the fundamental actors, while other times they view countries as unitary actors. Like realism, variants of liberalism often mix in ideational factors; consequently, I use a material variant of liberalism that excludes ideational and social factors in order to maintain analytic separation. Finally, I include a social constructivist perspective along the lines of Alexander Wendt’s social theory, which takes social relationships (e.g. prestige, roles, and status) as major motivating factors for states, shares the realist and liberal assumptions of the state

as the basic unit of analysis, and adopts a weak rationality assumption. Other more critical variants of constructivism are difficult to compare with realist and liberal theories since they often do not share these same basic assumptions.

The distinctions between these theories of state action are mirrored by explanations of why states seek or can be dissuaded from seeking nuclear weapons: most of the literature focuses on military, economic, or social motivations at the international or domestic levels. Different overviews of nuclear proliferation divide incentives and actors in different ways. For example, Scott Sagan compares three models: security, domestic politics, and norms, in which the first focuses on military motivations, the second domestic coalitions of various sorts that form to support or oppose weapons development, and the third prestige, whether derived from acquiring or getting rid of nuclear weapons. Similarly, T.V. Paul discusses power, interests, and norms, primarily focusing on states’ relative positions in these three areas while relatively neglecting domestic politics. Both underplay the role of economics; Etel Solingen provides a counterweight, arguing that economic interests of domestic constituencies are an important factor. Lacking from most of these arguments is a solid theoretical conception of the effect of social relations on nuclear weapons development; Suzette Grillot and others have argued that role conceptions and identity play a major role in ending nuclear weapons programs.

Quantitative studies focus on the more easily-measurable aspects of these theories. Stephen Meyer divides incentives into three categories: political power-prestige, military-security, and domestic politics, then measures these using fifteen indicators (four disincentives, seven incentives, and four that could be either). Dong-Joon Jo and Erik Gartzke divide their incentives along Sagan’s three models, while Sonali Singh and Christopher Way divide incentives between internal (regime type and liberalization-related incentives) and external (security threats and guarantees) determinants. These studies also include supply-side factors that may limit proliferation, a subject that is given less attention in the

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6 Wendt 1999.
7 Sagan 1996/97.
8 Paul 2000.
9 Solingen 1994b.
11 See Meyer 1984 44-74; Jo and Gartzke 2003 14-17; and Singh and Way 2004 862-865.
qualitative literature. Meyer developed a set of fourteen indicators that would contribute towards a domestic capability, divided into factors that influence mining and processing of nuclear materials, construction and operation of nuclear facilities, and weapons fabrication. A subset of Meyer’s indicators were extended through 1992 by Jo and Gartzke. Singh and Way also discuss technological determinants using more general indicators, which are coded into three variables: GDP, a general industrial threshold, and specific industrial capabilities.\footnote{See Meyer 1984, Appendix B; Jo and Gartzke 2003, 5-7; and Singh and Way 2004, 867-869.}

More empirically-focused accounts often include all of these factors without seeking to analytically separate them into individual accounts.\footnote{Reiss and Litwak 1994; Campbell et al. 2004.} Some accounts include cognitive and psychological perspectives.\footnote{Ogilvie-White 1996, 51-53.} I exclude these from my analysis due to a lack of data that would permit observing these mechanisms in operation in my main cases (North Korea and Iran). Rather then dividing the literature by specific causes, I separate theories of proliferation analytically by theory and level of analysis. I divide states’ core structural motivations for proliferation into three areas: their relative military, economic, and social positions in the international system, paralleling realist, constructivist, and liberal motivations; see Figure 2.1.

Figure 2.1: Causes of proliferation demand

Theories of how different factors influence the supply of nuclear technologies are not as well developed as theories of demand for nuclear weapons. For example, quantitative

\[ \text{Military Position} \rightarrow \text{Economic Position} \rightarrow \text{Social Position} \rightarrow \text{Nuclear Demand} \]
2.2. THEORY

studies of nuclear weapons development use indicators that reflect national resources, and do not include the potential for technology transfers from other states. Many of the initial nuclear weapons programs attempted to rely on primarily internal, domestic sources of knowledge, technology, and resources and were thus structured as top-down “hierarchies.” More recent programs, however, have relied on imports of all three components either in an attempt to cut development times or simply because one or more of these necessary components were not available domestically. Recent nuclear programs thus are structured more like networks than hierarchies, although the technical characteristics of nuclear proliferation have prevented a full-blown market from arising. With these nuclear aspirants, domestic capabilities and international proliferation networks are combined to create a supply of nuclear technologies; these two influences are diagrammed in Figure 2.2.

![Diagram of sources of proliferation supply]

Instead of treating incentives for state action and factors that influence supply networks as inherent conditions as most studies do, I treat them as dynamic variables that can be manipulated by other actors. For example, if a state seeks nuclear weapons for international prestige, other states could seek to ensure that the state would gain more prestige from disarming rather than from proliferating. Similarly, if a state supplies particular technologies to a proliferator, third parties can offer economic compensation for ending such transactions. I construct (and differentiate) theories by specifying for each whether military, economic, or social strategies are considered most effective.

I adopt a weak rationality assumption as a base for all three theories: the effects of

\footnote{On the market/hierarchy distinction, see Williamson 1985 on network forms of transactions, see Powell 1990; Podolny and Page 1998}
counterproliferation strategies depend upon calculations regarding the payoffs to proliferants of different actions. This is a weak assumption rather than a strong one since I make no assumptions regarding what motivates states. I offer strict interpretations of each theory not as an attempt to “straw-man” the underlying theories, but rather as analytical divisions. Many realist accounts have been criticized for surreptitiously bringing in additional factors in order to explain phenomena similarly, many liberal accounts include factors other than material calculations into their theories. I use a more parsimonious version of these theories by excluding ideational factors, which are included in my social theory. I construct these theories in a non-exclusive manner, exploring the interactions between the different effects of strategies rather than attempting to pit them against each other. Indeed, when incentives are bundled together, they can have greater effects than the sum of individual parts; a military threat combined with an offer of social benefits may succeed if combined together where they would fail if applied in sequence. I include both the immediate, short-term effects of a given action as well as the longer-term, structural consequences of an action or series of actions.

Theory 1 (Realism) is based on a narrow interpretation of structural realist logic: states seek military security. Threat perception is not important; calculation of raw military capabilities, mediated by geographical reality, determines state actions. Other actions are only important insofar as they have effects on military capabilities. Realism argues that security is the main concern of states; I use the term “military” rather than “security” since the latter term often bundles in social characteristics.

**T1:** States are influenced by their relative military structural positions; actors can influence states by threatening, promising, or enacting military sanctions or benefits in the short term, or by changing the relative military position of a target state in the long term.

Examples of short-term actions that could alter payoffs include the temporary addition, removal, or repositioning of military forces that could threaten a country, or scheduling or canceling military exercises. Longer-term actions include nonaggression agreements if

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16 Legro and Moravcsik 1999
17 The classic account of structural realism remains Waltz 1979 for a more recent, less abstract exposition that includes geographical factors, see Mearsheimer 2001. However, it is worth noting that Waltz’s materialism is implicit rather than explicit. Fearon and Wendt 2003 59.
they include steps that make military conquest more difficult or repeated short-term actions that accumulate into a significant change in the local balance of military power.

Theory 2 (Liberalism) is similar to Theory 1, but is based on economic motivations rather than military ones. Calculation of the economic benefit to be gained from taking an action determines state actions. Economic actions are important in and of themselves, rather than as a means to military power. Liberalism does not argue that military security is not important at all, but rather that security needs are easily satisfied, leading most states to be primarily focused on absolute economic gains rather than relative security relationships.

**T2**: *States are influenced by their relative economic structural positions; actors can influence states by threatening, promising, or enacting economic sanctions or benefits in the short term, or by changing the relative economic position of a target state in the long term.*

Temporary economic benefits such as one-time aid, payments, or waivers of sanctions change short-term payoffs; the imposing or lifting of sanctions or trade barriers in a permanent manner or incorporation into trade organizations can alter a country’s longer-term economic position in the international system.

Theory 3 (Constructivism) takes place on the same analytical level as the first two theories in that it assumes that the relevant actors are unitary states. However, it is not material (military or economic) benefits and sanctions that determine outcomes, but social ones. States seek forms of social recognition (direct ties, prestige, status, favored roles) in the international system; these can be proffered or taken away by socially powerful actors. Social interaction intended to alter the behavior of others—or socialization—has been a recently rediscovered theme in international relations, whether through institutions[^18] or through state-to-state interaction[^19]. Much of this work is rooted in social psychology[^20]. States seek to avoid embarrassment, losing face, declining prestige, or condemnation. Social recognition can be formal (diplomatic representation, IGO membership, etc.) or informal (official visits, insults, praise, etc.)

T3: States are influenced by their relative social structural positions; actors can influence states by threatening, promising, or enacting social sanctions or benefits in the short term, or by changing the relative social position of a target state in the long term.

Short-term social sanctions and benefits include insults and compliments, positive or negative comments directed at other countries, one-time visits by prestigious actors, and so forth. Changes in social structural position include permanent alterations of rhetoric targeting the other country and its place in the system, opening or closing of diplomatic relations, and invitation into or expulsion from prestigious institutions.

While these theories specify what kinds of incentives are likely to be important and the types of actions that are likely to matter, they do not tell us how a proliferant country will respond to promises of potential benefits or threats of sanctions; that is, likely strategies that proliferants may adopt in response to these incentives or disincentives. Moreover, actors may in turn respond to actions by proliferants, potentially leading to feedback loops. To produce testable hypotheses, I combine the three theories above with two different models of strategic interaction related to the spiral model and the deterrence model.²¹

In the classic spiral model (the security dilemma), one country fears a military buildup by another country and increases its military spending, which then causes the second country to increase their military spending, leading to the first country to make further increases, and so forth. This model can also be applied to spirals involving social action rather than material action (e.g., escalation of rhetoric), or even to crossover between social and material actions (e.g., escalation of rhetoric leading to an arms race). The strategy that underpins the spiral model is reciprocation, or tit-for-tat; when both sides practice it, positive feedback results and individual actions can cause non-linear effects.

The deterrence model posits the opposite relationship: a threat by a first actor deters a second actor from taking an action that they would have taken otherwise. A similar model is compellence, where a first actor threatens to take action unless a second actor backs down. Compellence is generally considered to be more difficult than deterrence, since it requires

²¹The classic treatment of the spiral and deterrent models is Jervis 1976, 1978. Recent game theoretical treatments include Glaser 1997, Kydd 1997, Kydd 2000, Zagare and Kilgour 1998. The work of Zagare and Kilgour is especially noteworthy for exploring the conditions under which the same game can lead to either spiral or deterrent feedback.
the target to publicly be seen to take an action. Consequently, it may require a method of “saving face” to succeed with compellence.\textsuperscript{22} The literature on compellence finds that coupling threats with positive inducements increases the chance of success dramatically.\textsuperscript{23} Similar to the spiral model, there can be crossover between social and material actions: e.g. a show of force could lead to an apology.

The first three hypotheses that can be generated from the above theories and models combine the three types of theoretical motivations for action (material, economic, or social) with the two potential models of dyadic interaction (a: reciprocity or b: anti-reciprocity). The next four hypotheses deal with intervening mechanisms that may alter nuclear activity or outcomes. The last three deal with how material, economic, and social pressures can be used to restrict the supply of nuclear technology.

\textit{H1a/b: Military Incentives/Disincentives: By promising military benefits/threatening military sanctions, the demand for a nuclear program will decrease.}

\textit{H2a/b: Economic Incentives/Disincentives: By promising economic benefits/threatening economic sanctions, the demand for a nuclear program will decrease.}

\textit{H3a/b: Social Incentives/Disincentives: By promising social benefits/threatening social sanctions, the demand for a nuclear program will decrease.}

These hypotheses assume unitary state actors. This assumption is contested by some scholars, who assert that domestic politics plays a significant—even dominant—role in international relations. Therefore I include a second level of analysis by considering how domestic politics can affect strategies via two conduits. First, domestic politics may matter in the target state if the strategies need to target the right domestic coalition in the opposing country in order to have an effect. Second, it matters in the source state if strategies can be undermined by actors (veto players) who have the ability to independently alter the balance of sanctions and benefits. My notion of domestic politics in the target state is related to the notion of two-level games,\textsuperscript{24} and standard coalitional politics; my formulation of domestic politics in the source state is very close to the notion of veto players.\textsuperscript{25} However, past

\begin{itemize}
\item Schelling 1980, 195-199.
\item Art 2003.
\item Putnam 1988.
\item Kastner and Rector 2003, Tsebelis 1999.
\end{itemize}
treatments of veto players have focused on economics rather than security or social issues.

Any of the actions listed above for the first three theories could be altered by domestic politics. Taking a more threatening military posture could strengthen a coalition in the target state that included the military lifting sanctions or increasing a particular type of aid might weaken groups in a target coalition that depended on scarcity or a lack of competition; strident rhetoric by prominent members of a government in a source state may undermine an otherwise positive diplomatic message. The literature on compellence highlights the role of domestic political considerations in undermining agreements reached at the international level.

**H4a: Veto Players:** If veto players take actions to undermine any of the above strategies, the strategies will fail to decrease nuclear activity.

**H4b: Coalition Politics:** If the benefits or sanctions affect the wrong coalition, they will fail to decrease nuclear activity.

Hypothesis 5 takes into account another type of mediating process: feedback loops that amplify initial actions if the reactions of the target state lead the source state to take further actions (and so on). This process is an intrinsic part of the spiral model; although the typical application of the spiral model is to downward spirals, it can be applied to upward spirals as well, in which countries take reciprocal beneficial measures (e.g., confidence-building measures).

**H5: Positive Feedback:** Actions will exhibit positive feedback; initial moves will lead to escalating interaction, increasing the effects of those actions.

With all of these theories, strategies can have both short-term, interaction-level effects that cause immediate responses through single actions and longer-term, structural effects either through repeated actions (accumulation) or through less-reversible, more significant actions (ratcheting). I draw here upon structuration theory: while structures shape the choices of agents, agents reproduce and alter structure through their actions. Powerful agents like the United States are more likely to be able to affect such structures. Whether

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26 On this argument, see Vasquez 1993 for one such mechanism.
strategies that aim to deal with short-term (H6a) or long-term (H6b) effects succeed depends on whether the proliferant is motivated by temporary or structural causes.

**H6a/b: Interaction/Structure:** Strategies that address short-term temporary/long-term structural causes will decrease nuclear activity.

Although the United States can act alone in the international system, it rarely does so; proliferation is a phenomenon that affects many states, and nascent nuclear programs often lead to loose coalitions of states that oppose proliferation. However, the US may have an disproportionate influence; actions of other states may be relatively unimportant in some cases, and crucial to success in others. The coercive diplomacy (compellence) literature finds that a lack of agreement between the relevant international actors can undermine deals. Hypothesis H7 thus posits that multilateral cooperation or at least alignment is needed.

**H7: Multiparty Interaction:** Successful counterproliferation strategies depend on cooperation among multiple actors.

The military, economic, and social strategies that are applied to proliferators can also be used to attempt to convince suppliers to cease spreading nuclear technologies. Hypotheses H8–H10 mirror hypotheses H1–H3, but apply to suppliers (if any) rather than proliferators. Contemporary, second-tier proliferators tend to rely on external sources of technology. Domestic capabilities could also be limited through military strikes or through offering concessions in exchange for self-restraint on the part of a proliferator along the lines of North Korea’s plutonium freeze from 1994 to 2003 or Iran’s uranium enrichment freeze from 2003.

**H8a/b: Military Incentives/Disincentives (towards suppliers):** By promising military benefits/threatening military sanctions, the supply of nuclear technology will decrease.

**H9a/b: Economic Incentives/Disincentives (towards suppliers):** By promising economic benefits/threatening economic sanctions, the supply of nuclear technology will decrease.

**H10a/b: Social Incentives/Disincentives (towards suppliers):** By promising social benefits/threatening social sanctions, the supply of nuclear technology will decrease.

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Supply may additionally be limited by other factors, such as the availability of particular technologies, and whether these technologies require special types of knowledge to build and/or operate. Such factors also play a key role in affecting the structure of transactions.

These hypotheses are not mutually exclusive. For example, it may be the case that both threats of sanctions and promises of benefits cause decreased proliferation; that both social incentives and military disincentives have significant effects on proliferation; and that both short-term and long-term effects are important. The relationships between these hypotheses (except H4 and H7, since they involve interaction at levels below and above this diagram) are summarized in Figure 2.3.

Figure 2.3: Relationships between hypotheses

All of the theories that I test in this work assume that actors have goal-directed behavior; that is to say, what is known as rational action. I make only a bare rationality assumption here; that is, I assume that actors have some basic set of goals that they pursue, but make no assumptions regarding what those goals might be. Rather, I seek to discover these goals
2.2. THEORY

These theories differ on one important dimension: whether actions are taken as a result of material (military and economic) or social incentives and disincentives. In this work, I examine whether actions and reactions are primarily affected by changes in potential or actual material benefits such as increased (or decreased) aid or trade or an altered balance of military forces, or whether they are affected by changes in potential or actual social relations such as diplomatic recognition or cutting of ties, declarations of positive or negative affect, increased or decreased high-level contacts, and so forth.

The division I make here between material and social benefits moves the debate over rationalist and constructivist approaches from a theoretical debate as to whether these theories are complementary, contradictory, or comparable to a direct (if non-exclusive) empirical debate. I take a middle position in this debate by adopting a nonexclusive approach to testing rationalist and constructivist theories in that both material and social action could affect outcomes; evidence for one is not evidence against the other, although evidence could demonstrate that one affects outcomes and the other does not. I see these theories not as incompatible, but rather as operating together in connected ways.

Incentives and disincentives can be material or social. Material actions consist of direct and indirect actions or threats to the economic or military status of a state (theoretically, I separate material actions into economic and military components, but group them as “material” actions where they can or must be treated symmetrically). Social actions consist of direct and indirect actions, threats, or promises regarding social ties, prestige, status, or role. Incentives or disincentives need not be intentionally directed towards a target, but must simply be interpreted by the target as directed at it. A test of a national missile defense system, for example, may not be directed per se at any given state, but certain states will be likely to view it as a material threat related to their missile programs (and therefore to their nuclear programs by association). Actions provide incentives and disincentives, either through threats and promises or through providing social, economic, or military benefits or sanctions directly. I therefore treat actions and incentives/disincentives as loosely synonymous.

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More specifically, social actions refer to actions that act upon social characteristics of individuals, including direct or indirect relationships (ties), location within social hierarchies (prestige or status), and social function relative to particular others (role). States place value on social actions by other states, and respond to social actions accordingly, just as they place value on and respond to economic or military actions. In international relations, these characteristics include direct, formal relations between countries, common membership in international organizations, flow of people, ideas, or information between countries, role relationships between states such as developing-developed, first-third world, major-minor powers, central-marginalized countries, successful-failed states, democracies-autocracies, and so forth. Prominent in the nuclear debate are discourses about powerful authority (hegemon or sheriff) and marginalized dissenters (rogue, hermit, pariah, outlaw, or outcast). Although many of these roles imply military, economic, or domestic political characteristics, these are also social role relationships with associated norms and expectations, and are often considered to be of value independent of actual military strength, economic standing or domestic political structures. Social actions such as insults or praise, upgrading or downgrading of diplomatic or other status, assistance or blocking of membership, shunning or welcoming, and blaming or crediting for actions operate upon these social characteristics, affecting the social characteristics of not only the countries involved directly, but the wider system. I do not rely on a particular theory of why such social characteristics might be important, but rather focus on whether states act as if social status is important. Arguments over why states seek social recognition and status (e.g. state identity has intrinsic worth to the state as a corporate actor, international social status is a method for regimes to stay in power) are important, but outside the scope of this work; I simply seek to determine whether states place a high value social status or not in the context of nuclear weapons.

Material actions also include social components; signing a trade agreement, joining a security arrangement, increasing economic aid, and joint military operations all alter social characteristics as well as the material balance in the international system. Moreover, often actions that seem to have material impacts actually only have social effects. For example, non-credible deterrent threats (when recognized as such by the intended target) make no
material difference if the target believes they won’t be carried out. Yet they still have the
effect of expressing negative affect towards the target, which may lead to a negative reaction
by the target.

Two potential arguments may be raised over the way I divide material and social ac-
tions. On one side, it might be argued that what I’ve characterized as social action is simply
information that each side would use to update the likelihood of a given material benefit or
sanction occurring, reducing social action to probability manipulation. On the other hand,
if social action isn’t intrinsically valuable, then it shouldn’t affect probabilities either, since
then talk wouldn’t just be cheap, but free. At the other extreme, all action can be seen as
interpreted socially; the actual material benefit or sanction matters less than the meaning
communicated by such actions.

I argue that most actions have both social and material effects. The first school of
thought would treat (for example) economic sanctions and benefits as affecting calculations
in a symmetrical way, ignoring the immense difference in affect between these two actions
independent of the practical effects of these two actions. Actors will react asymmetrically
to these two actions, both with respect to the immediate decision and longer-term relations,
even if the material utility of the two offers is the same, due to the social message that is
contained in sanctions.\footnote{If the utility function is symmetrical across zero, which it may not be; for example, prospect theory
argues that your value for something depends upon whether you are in the domain of gains or losses. See Levy 1994 for an overview of prospect theory in international relations.}

This is not to argue that actions don’t lead to states updating their beliefs about an
event occurring (although the issue of whether states update in a rational Bayesian man-
ner is potentially problematic from a psychological standpoint). Rather, actions—social or
material—have effects beyond simple belief manipulation about probabilities. Actions not
only communicate information, but transform relationships. In standard rationalist frame-
worx (e.g., signaling games), the ‘types’ of different actors are set; through strategic in-
teraction, actors seek to reveal what type a potential opponent is. Yet interactions can alter
relationships and therefore the types of different actors. The transformation of an enemy
into an ally (or vice versa) requires an interpretation of social action as more than simple
probability updating.
Conversely, even if all material action is socially mediated, a “base material” component will still impinge upon social action, in that changes in material status will make certain social actions more or less effective or possible. Additionally, while it is certainly true that material actions are always mediated by social interpretations of those actions, it is also the case that the social meaning of actions can be relatively constant across actors and stable across time periods.

Another potential objection is that if most actions have both material and social components, it will be impossible to determine whether it is the material component or the social component of an action that is compelling. While this is certainly true for a single action, by looking at patterns of actions over time that vary significantly with respect to their material and social components, it is possible to determine which of these components seems to be driving reactions. Over time, different actions will express different variations on social and material benefits—I may present you with an award recognizing your accomplishments in front of a large crowd on one occasion, I may do the same with a cash award on another occasion, or I may just give you the cash award on a third occasion. The difference between your reactions to these three might demonstrate whether you were reacting to the material or the social reward in these three cases.

2.3 Method

These hypotheses generate multiple variables. The main variables of interest are the military, economic, and social strategies of the US toward proliferators (H1-3) or their supply networks (H8-10). Due to feedback loops (H5) and the potential for US strategies to alter long-term, structural causes of proliferation demand and supply (H6), no variable is truly independent, intervening, or dependent (See Figure 2.3); however, for the purposes of this section, I refer to the underlying causes of proliferation as independent, US actions.

\[33\] The restriction of assuming that interpretations of effects are constant across actors and time is only necessary for the quantitative part of my method.
as conditioning, and proliferator actions as dependent.\footnote{I follow Steven Van Evera’s lexicon here; conditioning variables are ones that modify the relationship between independent and dependent variables. Van Evera 1997, 8-12.} I specify two sets of deep, underlying causes for proliferation demand and supply as my independent variables: first, the proliferant’s military, economic, and social structural positions in the international system are the primary determinants of proliferation demand (see Figure 2.1); second, the supply of nuclear technology to a proliferant, which is determined by a proliferant’s domestic capabilities combined with nuclear supply networks (see Figure 2.2).

US actions can moderate or intensify how these fundamental underlying quantities effect supply or demand (and thus act as an conditioning variable even though it is the study variable or primary variable of interest). For example, if a potential proliferator suffers from a military gap in capabilities with its neighbors, the US might offer military aid as a measure to keep proliferation demand below the threshold necessary to sustain a nuclear program. Similarly, the US might intercept a shipment of crucial nuclear technology from a third party, preventing a proliferator from having the necessary supplies for maintaining its program. Alternatively, the US could take actions that more permanently altered the causes of demand and supply (H6), by making it a state an ally and bringing it under its nuclear umbrella or by shutting down major contributors to a state’s weapons program. Additional variables operate at different levels of analysis; the domestic structures of the US and the proliferants (H4) and the actions of third parties (H7) can also potentially affect nuclear outcomes. Feedback loops (H5) are a process rather than a variable, but nonetheless have an effect on outcomes.

My dependent variables are the actions taken by a proliferant with respect to its nuclear program, which I divide into three different types of actions: those concerned with producing plutonium, those concerned with producing highly enriched uranium, and those concerned with treaty and norm adherence independent of the first two. I discuss measurement of my dependent variables in the next section.

I analyze actions from two complementary perspectives. From a quantitative perspective, I consider the effects of individual actions that imply incentives or disincentives (sanctions or benefits) on general actions by proliferant countries; my primary tool for analysis
from this perspective is content analysis combined with vector autoregression to determine the correlations between different types of actions. This method of analysis doesn’t distinguish between economic and military incentives and disincentives due to methodological restrictions; however, I do distinguish between these in my qualitative section. Although I do not consider the effects of strategies specifically on nuclear actions in my quantitative section, the results of the quantitative study allow me to identify periods of high-intensity interaction, establish general strategic interaction patterns, and discern points at which these patterns change for further examination in my qualitative section. While a quantitative study could in theory also be done regarding the networks connecting multiple actors together, such an analysis is far beyond the scope of this study. See Chapter 3 for an explanation of my quantitative methodology.

Quantitative analysis can only suggest correlations between different types of actions; determining whether the causal relationships actually exist and why they exist require more in-depth analysis of the events in question. Moreover, it can only test a limited number of my hypotheses. I qualitatively examine the history of interactions between the US and a proliferant previous to and during nuclear crises to see how interaction patterns were formed.

Since US strategies toward North Korea have been primarily involved direct negotiation and threats while strategies toward Iran have been more indirect, my comparison is therefore primarily within-case rather than cross-case. True process-tracing whereby the individual steps and decision-making procedures within each country are causally connected is very difficult for these cases due to a general lack of transparency in either case, so for the most part I rely on within-case congruence procedures, comparing outcomes of different strategies in various combinations employed by the US with theoretical predictions.\footnote{George and Bennett 2005, Ch.8-9.}

Evidence can offer support for or against various hypotheses. Hypotheses H1–H3 and H8–H10 deal with whether incentives or disincentives of different types are likely
2.3. METHOD

to decrease proliferation when directed towards proliferators and their suppliers respectively. Each of these hypotheses is paired with its obverse (e.g. H3a/b, Social Incentives/Disincentives). However, evidence for, say, promises of social incentives is not evidence against threats of social disincentives; rather, the two are evaluated by different scenarios. If the United States offers social incentives and proliferation increases, this is evidence against social incentives, but not evidence against social disincentives, since the two are not symmetrical; demonstrating that praise does not work is no indication as to whether insults will.

During crises, I break down the timeline into discrete periods that begin and end with nuclear actions taken by the proliferant where possible (e.g. threats of treaty withdrawal, taking additional steps in the plutonium or uranium pathways, or inviting nuclear inspections—see below). I trace the individual actions taken during each of these smaller periods in order to discern what events led up to nuclear actions. I distinguish between my different hypotheses by looking see if military, economic, or social actions were taken by the US previous to an individual nuclear action; what the proliferant’s justification (or supplier’s justification in the case of H8–H10) for that action at the time was; whether this justification is plausible or not given the context; and whether it seemed to be affected by US actions or not. I also examine how discourse changes over time between the two sides as an indication of how each side perceived the other’s actions, especially during periods in which very few overt nuclear activities were occurring. I consider the effects of actions more broadly, looking at multiple actors and interactions over time, seeking to explain changes in patterns of interaction and the outcomes that result from these changes. For example, North Korea responded to US threats in from March 1993 through May 1994 by threatening to withdraw from the NPT, but in June 1994, they responded by agreeing to negotiate; I examine intervening events in-depth to answer why these interactions changed.

While all actions to some extent are likely to affect a proliferant’s calculations, the clearest evidence for connections between actions and reactions comes when concrete offers are made by the US or by the proliferant. Therefore in addition to general actions by the US, I also examine whether the US or the proliferant made specific military (H1), economic (H2), or social (H3) offers regarding the proliferant’s actions, and whether the
those offers were accepted by the opposite side. I examine these offers in-depth in order to parse out what types of benefits or sanctions these offers constitute.

However, important shifts in policy on either side are not necessarily reflected immediately by nuclear actions. Decisions made regarding nuclear actions can precede such actions by quite some time (although this applies more to material actions - e.g. refueling the reactor, reprocessing fuel rods - than to threats to do so, or to social actions such as accepting or rejecting a treaty). Consequently, parallel to actual nuclear actions, I track changes in discourse by both the US and the proliferant, examining whether and when changes in language occur, as well as what the effects of these changes in language seem to be. Such changes are far from "cheap talk"—they are usually calculated decisions intended to socially communicate information, often changes in underlying policy. Even when not intended to communicate information to an international audience, since states often treat statements that deviate from existing patterns of behavior as significant, such statements have independent causal force even if made unintentionally.

For hypotheses H4–H7, I group series of actions together for analysis. For domestic veto players (H4a), I determine the main thrust of US policy by determining what the general strategy that a majority of the principal players in the executive branch are following, then see if actions taken by other players seem to have direct effects on the proliferant’s policy. For coalition politics (where possible), I examine whether groups in proliferant’s country have different reactions to US policies and whether these different reactions have significant effects on policy (H4b). I also look to see if action-reaction cycles exist wherein several actions by alternating sides are causally connected together through positive or negative feedback (H5). I also look for major shifts in a proliferant’s nuclear status and examine whether these shifts seem to be related to the effects of interactions, or whether they result from structural changes in the proliferant’s military, economic, or social position in the international system (H6). I examine the role that other actors played in each crisis and whether these roles seemed to affect nuclear outcomes (H7). Finally, I evaluate whether military, economic, or social actions taken towards the suppliers (H8–10) were most successful.
2.4 Evidence

Proliferation cannot and should not be viewed as an end-state. Rather, it is a process by which countries make decisions to move closer to or away from different thresholds for proliferating. Countries will not necessarily stay solidly in one state or another, as internal and external conditions that fuel or suppress proliferation change over time. Nuclear weapons programs are long-term, difficult enterprises that often occupy an ambiguous middle ground between proliferation and non-proliferation. Consequently, the question is not whether a state has nuclear weapons or not, but whether for each state the amount of time that it would take for that state to develop nuclear weapons requires action given that state’s relationship with the rest of the world. Germany and Japan are certainly less than a year away from being able to develop a nuclear weapon; however, for the most part, other states are not concerned about this ability, since these countries seem to have little or no intent to develop weapons and have at least adequate relations with their neighbors. Yet due to the current state of Iranian relations with many states in the region and throughout the world, it is unacceptable to the US and many other states for Iran to be as close as Japan and Germany to developing nuclear weapons. To keep Iran and other states below a comfortable threshold requires continual effort. Success, therefore, is relative. The question is not whether Iran’s program is in one state or another, but whether the measures taken are slowing or halting the rate of progress such that in the longer term a state can be reached that the US and other states can live with. Therefore ability, intent, and relations must all be taken into account.

Judging the importance of a country taking a particular step requires some background knowledge of the industrial, knowledge, and organizational requirements for pursuing a nuclear capability. Knowledge of these requirements allows for an evaluation of the rate of progress. The rate at which a given country proceeds can indicate the amount of effort (proportional to technical capabilities) being put into a nuclear program. This effort, in turn, may reflect how difficult it may be to convince a country to refrain from development of such a capability. Knowledge of these requirements can also allow for better evaluation of estimates of a state’s ability to proliferate within a certain time period. Measuring the
current state and direction of a country’s program can indicate to an extent both ability and intent.

I break nuclear actions into three categories: those having to do with plutonium-related programs (Pu), highly enriched uranium (HEU) programs, and those related to treaty and norm adherence. Other nuclear-related activities, such as development of delivery systems, are difficult to discern from other military activities, and so are not included. I then code a country’s overall nuclear status based on the types of activities occurring in these three areas. I describe below the technical steps that nuclear programs must follow as a reference for my qualitative narrative.

A military program can often hide underneath the cover of a civilian program, since many of the same technologies are needed for both types of programs. At the same time, the line between a military and a civilian program can often be blurred due to the fact that many nuclear technologies are dual-use. However, given the current costs of power generation, the portions of the nuclear fuel cycle that are most usable for a military program are economically unjustifiable. Consequently, building these facilities often indicates a nuclear hedging strategy by a state. A civilian nuclear-power program can be separated into three parts. The first part is the “front end” wherein uranium is processed, potentially enriched, and turned into fuel elements for a power-production plant. The controversial part of the “front end” is the enrichment portion, since enrichment facilities can be used to create weapons-usable materials instead of fuel for a nuclear power plant. Given the current oversupply of uranium enrichment facilities in the world, the construction of an enrichment facility is unlikely to be economically justifiable, especially given the US-Russian HEU blend-down agreement. The middle portion of a civilian program simply involves irradiation of the fuel rods to create electricity. The “back end” involves disposal of the used fuel rods. However, at this point these rods can be reprocessed to separate out the plutonium generated in the process of producing power, as detailed in the next section. While some countries intend to use separated plutonium to generate additional electricity, the fuel costs of reprocessing are an order of magnitude greater than a fuel cycle without
reprocessing. Consequently, the development of the front-end or back-end of a fuel cycle is often seen as an early-warning sign of a nuclear weapons program. The selection of certain technologies can also indicate a nuclear program, including building of facilities with few civilian uses such as medium-sized gas-cooled or heavy-water reactors, production of weapons-usable materials such as highly-enriched uranium, weaponization-related testing such as explosive-lens testing, and so forth.

Treaty adherence, as opposed to construction of facilities, is conceptual rather than material. Treaty-related actions include allowing in (or kicking out) inspectors, signing or ratifying treaties, threatening to leave or violate a treaty, delivering reports to the IAEA as required of nuclear materials or activities a country has undertaken, and so forth. While some of the actions detailed below must be discovered through good intelligence, treaty adherence is generally a public matter, as are threats regarding taking additional steps towards nuclear weapons status.

Many different factors have to be aligned in order for a nuclear weapons program to succeed. Moreover, more gradations exist in the possible status of nuclear states than simply on or off. Quantitative studies of nuclear proliferation by Meyer, Jo and Gartzke, and Singh and Way have adopted different methods of coding nuclear activity. Meyer simply coded whether a state had made a “decision” to seek nuclear weapons or not, and did not examine whether states succeeded or not. Jo and Gartzke formalized this as whether the “highest decision maker in a given state authorized [or ended] a nuclear weapons program” for official programs and the year in which “nuclear activities increase noticeably” for clandestine programs. They also added acquisition data for the dates on which “each state was ready to quickly assemble nuclear components into nuclear weapons.” Singh and Way measure nuclear status along a continuum with four “degrees of nuclearness:” no interest, exploration, pursuit, and assembly. The first degree is simply no interest in nuclear weapons. The second degree is exploration, which is “demonstrated by political authorization to explore the option or by linking research to defense agencies that would oversee any potential weapons development.” To qualify as pursuing nuclear weapons, states must take steps such as “a political decision by cabinet-level officials, movement toward weaponization,

\[\text{Bunn et al. 2003}\]
or development of single-use, dedicated technology.” Finally, similar to Jo and Gartzke, Singh and Way qualify states as having fully acquired weapons if they either test or possess a “functional nuclear weapon.”\textsuperscript{38} See Table \textsuperscript{2.4} at the end of the chapter for a comparison of these three codings.

Like Singh and Way, I view proliferation as a continuum rather than as a binary state, coding programs based on the type of strategies that a state adopts regarding nuclear weapons. I code overall nuclear status as changing only if the combination of several different factors increases above or decreases below certain thresholds (see Table \textsuperscript{2.1}). Rather than looking for official exploration policies as Singh and Way do, I include building capabilities as a part of my first threshold between no acquisition and a “hedging” strategy.\textsuperscript{39} Hedging strategies include building a nuclear infrastructure and possibly attempting to gain the ability to legally acquire fissile materials without actually building or testing weapons. This captures the inherent capabilities that countries with large separated stockpiles of weapons-usable materials such as Japan and Germany or uranium enrichment facilities such as Brazil and Argentina have while still being able to judge intention separately through completeness of treaty adherence. Further divisions could be made within this category based on the amount of material or the completeness of the facilities.

I define a second threshold between nuclear hedging and nuclear acquisition wherein a country conducts weaponization-related tests, acquires technology clandestinely with no clear application to a civilian nuclear cycle, or threatens withdrawal from the non-proliferation treaty or related treaties. Finally, I include a third threshold between nuclear acquisition and nuclear weapons state wherein a country demonstrates nuclear status by testing a weapon and declaring nuclear weapons state status. I differ from Singh and Way as well as Jo and Gartzke on the coding of this threshold as well since (overt) testing seems to be a clear ‘red line’ that makes disarmament much more difficult; in the four clear cases of acquisition and rollback (South Africa, Ukraine, Kazakhstan, and Belarus), overt testing was avoided. These thresholds can be partially breached; for example, a country may declare itself a nuclear weapons state without testing (or vice versa), placing it in a borderline

\textsuperscript{38} See Meyer \textsuperscript{1984}, Appendix A; Jo and Gartzke \textsuperscript{2003} 3, 28-33; and Singh and Way \textsuperscript{2004} 866-867

\textsuperscript{39} Levite \textsuperscript{2002}
2.5. THE TECHNOLOGY OF PROLIFERATION

state.

Table 2.1: Nuclear status levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Nuclear Status</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No nuclear program</td>
<td>Nuclear activity restricted to middle of nuclear cycle</td>
</tr>
<tr>
<td>1</td>
<td>Nuclear hedging</td>
<td>Ability to produce weapons Usable materials program, partial treaty adherence</td>
</tr>
<tr>
<td>2</td>
<td>Nuclear acquisition</td>
<td>Weaponization-related testing (e.g. explosive lens testing),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>increased clandestine activities, treaty violation/withdrawal</td>
</tr>
<tr>
<td>3</td>
<td>Nuclear weapons state</td>
<td>Nuclear tests, declaration of status</td>
</tr>
</tbody>
</table>

This defines two levels of nuclear indicators: interaction-level individual actions (threats regarding treaty status or taking additional steps towards acquiring nuclear materials) and macro-level nuclear status, which can be derived from an analysis of what nuclear actions seem to indicate are the current goals of the nuclear program. In my qualitative analysis, I examine both the conditions under which these individual actions are taken and the timing of general shifts in nuclear status.

The largest organizational and technical hurdle in producing nuclear weapons that is relatively easily observable is the production of fissile materials. Massive facilities are not required to convert fissile materials into nuclear weapons, although considerable engineering problems must still be overcome for weaponization. Consequently, it is much easier to measure the status of a proliferator between no nuclear program at all and nuclear hedging than it is between hedging and acquisition.

2.5 The Technology of Proliferation

To judge a proliferator’s progress within and across different nuclear status levels, I give an overview in this section of the steps required to acquire fissile materials sufficient for a nuclear weapon, from the supply of raw uranium to a finished core of a nuclear weapon. First a proliferator must acquire a supply of raw uranium to produce fissile materials. The acquisition of raw uranium has often been used as an indicator of potential nuclear weapons interest, since the worldwide market for nuclear power plant fuel is experiencing a glut.
Although it later turned out to be incorrect, intelligence that Iraq was seeking uranium in Africa was one of many pieces of information that pointed to a possible nuclear weapons program.

Although in theory many different materials can be used in a nuclear device, in practice two particular isotopes are used: the plutonium-239 ($^{239}\text{Pu}$) and uranium-235 ($^{235}\text{U}$). Neither of these isotopes is found separated in abundance naturally; they must be produced from natural uranium, which is usually found with a $^{235}\text{U}$ concentration of 0.71%; the remainder of the uranium is primarily made of the non-fissile (under most circumstances) isotope $^{238}\text{U}$. Natural uranium is found in deposits around the world; as of 2003, the IAEA World Distribution of Uranium Deposits Database listed 49 countries with significant deposits; see Table 2.2. This does not include North Korea’s deposits, which are large but uncertain, and estimated to be between 200 and 300 thousand tons of uranium.

Uranium ore must be extracted from the ground and milled to convert the ore into uranium ore concentrate, or yellowcake ($\text{U}_3\text{O}_8$). The $\text{U}_3\text{O}_8$ is then converted to uranium dioxide ($\text{UO}_2$), using (among other chemical compounds) nitric acid and tri-butyl phosphate (TBP). The latter is part of the PUREX (Plutonium and URanium EXtraction) process used to extract plutonium and uranium from spent fuel; importation of TBP is often seen as an indication of a nuclear program. If a country is using heavy-water reactors (HWRs, see below), the $\text{UO}_2$ can be used directly as fuel. Otherwise, for either a plutonium-production or a uranium-enrichment program, the $\text{UO}_2$ must be first turned into uranium tetrafluoride ($\text{UF}_4$) using anhydrous hydrogen fluoride (AHF). Like TBP, imports of large quantities of AHF are often taken as a sign that a country is developing a nuclear program. At this point the natural $\text{UF}_4$ can either be converted into uranium metal (U) to be used as fuel in a graphite-moderated reactor to produce plutonium or converted into uranium hexafluoride ($\text{UF}_6$) and enriched. These two routes to a nuclear weapon are pictured in Figure 2.4, with the plutonium route on the left and the highly enriched uranium route on the right.

---

For other isotopes and their bare-sphere critical masses, see Committee on International Security and Arms Control 2005, 222. Bare-sphere critical masses overestimate the amount of fissile material required by about a factor of two to three, since a weapon designer would most likely use a tamper to keep neutrons from escaping.

Hayes 2004.

This diagram omits intermediate stages for clarity, while preserving the essential elements for detection and evaluation of a program. See Benedict et al. 1981, Ch.5 for an exhaustive account; see Paternoster 1992.
### Table 2.2: Worldwide uranium deposits 2003

<table>
<thead>
<tr>
<th>Country</th>
<th>Deposit (tons U)</th>
<th>Country</th>
<th>Deposit (tons U)</th>
</tr>
</thead>
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<tr>
<td>Algeria</td>
<td>23200</td>
<td>Kyrgyzstan</td>
<td>6050</td>
</tr>
<tr>
<td>Argentina</td>
<td>19795</td>
<td>Madagascar</td>
<td>10100</td>
</tr>
<tr>
<td>Australia</td>
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<td>Malawi</td>
<td>11700</td>
</tr>
<tr>
<td>Bolivia</td>
<td>500</td>
<td>Mexico</td>
<td>61630</td>
</tr>
<tr>
<td>Brazil</td>
<td>190400</td>
<td>Mongolia</td>
<td>51770</td>
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<tr>
<td>Bulgaria</td>
<td>57560</td>
<td>Morocco</td>
<td>132000</td>
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<tr>
<td>Cameroon</td>
<td>5000</td>
<td>Namibia</td>
<td>221460</td>
</tr>
<tr>
<td>Canada</td>
<td>751330</td>
<td>Niger</td>
<td>259382</td>
</tr>
<tr>
<td>Central African Republic</td>
<td>16000</td>
<td>Pakistan</td>
<td>1000</td>
</tr>
<tr>
<td>China</td>
<td>43500</td>
<td>Peru</td>
<td>21500</td>
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<tr>
<td>Congo</td>
<td>29500</td>
<td>Poland</td>
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<tr>
<td>Czech Republic</td>
<td>232500</td>
<td>Portugal</td>
<td>2900</td>
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<tr>
<td>Denmark</td>
<td>27000</td>
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<td>Finland</td>
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<td>302730</td>
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<td>Slovenia</td>
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<td>240485</td>
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<tr>
<td>Hungary</td>
<td>32800</td>
<td>Sweden</td>
<td>79000</td>
</tr>
<tr>
<td>India</td>
<td>13300</td>
<td>Tajikistan</td>
<td>1400</td>
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<td>Indonesia</td>
<td>6910</td>
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<td>Iran, Islamic Republic of</td>
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<td>147940</td>
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<td>Italy</td>
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<tr>
<td>Kazakhstan</td>
<td>903575</td>
<td>Zimbabwe</td>
<td>2000</td>
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<tr>
<td>Korea, Republic of</td>
<td>14800</td>
<td>Total</td>
<td>7598112</td>
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</table>

*Table does not include countries listed in database, but with zero deposits (Chile, Jordan, Serbia and Montenegro, Turkmenistan, and Vietnam). The database includes only those deposits with Reasonable Assured Resources of not less than of 500 tonnes U and a minimum average grade of 0.03% U to avoid unnecessary clustering and to be more useful for resource assessment.*

amounts of uranium in each box assume the attempted production of a “first” plutonium or uranium implosion weapon in one year; however, the higher uranium requirements of the plutonium route are offset by the fact that the fuel could be left in for a longer period of time in order to produce additional plutonium.

2.5.1 The Plutonium Route

A military program that involves plutonium-based weapons needs to pass through several stages. Many or all of the preliminary stages involve activities that are also legitimate in civilian nuclear programs. Uranium must be mined, refined, (sometimes) enriched, and cast into fuel rods. These rods are then irradiated in a reactor; some reactors are more proliferation-prone than others due to the ratio of isotopes of plutonium they produce. The rods are removed and reprocessed to remove the plutonium, which is recovered as an oxide. The oxide can be turned into a metal suitable for casting into pits for warheads. Many of these steps are detectable even at long distances. For example, a reactor’s cooling tower (if it has one) will release plumes of steam that are visible from satellites on clear days; a reprocessing plant will release Krypton-85, a radioactive gas that can be sampled from the air if weather patterns are right. Below I cover the basic technical details required to understand and estimate a state’s progress towards a plutonium capability.

For plutonium-production reactors, natural (0.71% $^{235}$U) uranium is usually used. Natural uranium dioxide ($UO_2$) can be used directly as a fuel in heavy-water reactors (HWRs), or it can be converted into uranium metal for use in graphite-moderated reactors; typically, these can be either cooled with water (light water-cooled graphite reactors, or LWGRs) or with gas (gas-cooled reactors, or GCRs). See Table 2.3 for a list of reactor types and amount of plutonium produced in the nuclear weapons states. More exotic reactor types can also be used, but these three types have been used most heavily by proliferants. Heavy water-moderated reactors require much less fuel for the same energy (and plutonium) production due the tendency of heavy water to absorb fewer neutrons and to slow neutrons more efficiently than graphite by a combined factor of about 7.5. Nonetheless, the abundance of graphite and the scarcity and expense of heavy water has led several countries to
2.5. THE TECHNOLOGY OF PROLIFERATION

Figure 2.4: Fissile materials production flowchart

Key:
- $\text{U}_3\text{O}_8$ = Uranium concentrate (yellowcake)
- $\text{UO}_2$ = Uranium dioxide
- $\text{U}$ = Uranium metal
- $\text{UF}_4$ = Uranium tetrafluoride
- $\text{UF}_6$ = Uranium hexafluoride
- GCR = Gas-cooled (CO$_2$) graphite-moderated reactor
- Pu = Plutonium
- SWU = Separative Work Unit

Enrichment

Compound

Amount

90%

U

90%

20kg

59.4t

50t

61.7t

69.1t

6.5t

6.5t

50t

30kg

5kg

20kg

Pu core

U core

Casting

Reproc 0% loss

GCR Fuel 25 MWt

GCR 60%CF

$\text{UO}_2$

$\text{U}_3\text{O}_8$

$\text{UF}_4$

$\text{UF}_6$

Pu

U

Pu core

Casting

U core
use graphite as a moderator. See Table 2.3 for a list of reactors used by past proliferants. Figure 2.4 assumes a GCR similar to that constructed by North Korea, which requires about 50 tons of natural uranium metal (U) fuel for a full load. After irradiation, the fuel is left to cool for a few months, then is reprocessed to recover the produced plutonium. A 25 MWt (Megawatts of thermal energy) reactor running with a 60% capacity factor[^43] would produce about 5 kilograms of plutonium per year. After a cooling-off period of a few months, the fuel can be unloaded from the reactor and reprocessed using the PUREX process, in which compounds similar to those used in uranium conversion (including TBP) are used to separate the plutonium and uranium remaining in the fuel rods from the fission products[^44] If there were no losses in reprocessing[^45] a proliferant could recover about 5 kilograms of plutonium.

While the standard figure used for calculating the amount of plutonium required per weapon is around five kilograms, six is often used as a more conservative estimate for a weapon design by a new proliferator. The Trinity test and the Nagasaki bomb both used about six kilograms of plutonium[^46] a “first weapon” can require up to eight kilograms[^47] The IAEA has defined a “significant quantity” of plutonium to be eight kilograms. However, the same design used for Trinity and Nagasaki would still produce a yield of 1 kiloton if half the amount of plutonium were used (3 kg[^48]) and “modern” weapons in the US arsenal use between 3 and 4 kilograms[^49] Whether a new nuclear state would be satisfied with a 1 kiloton weapon is another question; India and Pakistan claimed yields for their tests well above Western estimates for the actual yield[^50] leading to claims that the devices had “fizzled.” While a 1 kiloton yield is certainly considerable, the desire of the Indian and Pakistani governments to claim higher yields instead of simply claiming the actual lower

[^43]: Capacity factor is the fraction of actual power produced in a period over the full potential power in a period if it were run at 100% of power 100% of the time; a 60% capacity factor could be, for example, 60% power 100% of the time or 80% power 75% of the time.
[^44]: See Benedict et al. 1981 Ch.10 for a complete account, as well as alternate reprocessing methods.
[^45]: Some losses always occur; a new nuclear program may lose an appreciable fraction when first operating—perhaps as high as 30% initially, dropping off over time. See Albright et al. 1997, 305.
[^50]: Albright 1998.
yield indicates that states may at least initially shoot for larger-yield weapons using more plutonium rather than smaller-yield weapons using less, especially if prestige motivations are stronger than military ones.

Another issue with plutonium production is the purity of the plutonium recovered through chemical separation. Along with $^{239}$Pu, other isotopes of plutonium are also created. “Weapons-grade” plutonium contains 93% or higher $^{239}$Pu, although this label is somewhat misleading. Due to its higher neutron emission rate, a high concentration of $^{240}$Pu and other isotopes makes nuclear weapon design more difficult, since excess neutrons may cause a weapon made out of a substantial fraction of isotopes other than $^{239}$Pu pre-detonate. This reduces the yield substantially, perhaps to one or a few kilotons for a bomb similar to the Nagasaki design using “reactor-grade” (82% or lower $^{239}$Pu) plutonium. Again, although this is still a substantial yield, this may be an undesirable characteristic for a new nuclear state, although it does not eliminate the possibility of a state using reactor-grade plutonium. The 25 MWt graphite-moderated reactor in Figure 2.4 produces “weapons-grade” plutonium through a burnup of 1000 MWd/t, since our reactor has 50 t of fuel, it would take 2000 days at 100% capacity before it degraded the plutonium quality to sub-weapons-grade. A 25 MWt heavy-water reactor, which only requires about 6 2/3 t of fuel, would do so after only 265 days; however, many heavy-water reactors are built so that they can be unloaded while operating.

Although small research reactors (<10 MWt) can be used to produce plutonium, reactors intended for producing weapons-grade plutonium are often much larger (30-50 MWt or higher), while power-production reactors generally are 1000 MWt or greater (and are normally referred to by the amount of energy produced, usually around a third of the thermal output; e.g., about 1000 megawatts of electric power, or MWe, for a 3000 MWt reactor). In operation, plutonium-production and power-production reactors operate continuously, while research reactors operate intermittently. Power-production reactors generally are operated over long periods of time, while the core in plutonium-production reactors is changed frequently. The operation of a plant with a steam tower can be monitored simply

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51 Committee on International Security and Arms Control 1994, 32-33.
52 Albright et al. 1997, 463.
by observing the tower via satellite photos, while plants that use rivers or other bodies of water for cooling can be monitored by measuring temperature changes in the water from a sufficiently close distance.

Separation can be remotely detected by sensing of \( ^{85} \text{Kr} \), a radioactive gas that is produced through fission of \( ^{235} \text{U} \) and released during the PUREX process. This measure is sufficiently reliable to be used as a secondary check against other estimates of total plutonium production (as it was for estimates of Soviet production during the Cold War)\(^5\). Reprocessing facilities are often large, and require much heavier shielding for workers than simple facilities for production of isotopes for medical or industrial use. Additionally, the dissolution of metals in nitric acid results in red-brown fumes potentially observable from a facility\(^4\).

### 2.5.2 The Uranium Route

A military HEU program involves a different set of technologies than a plutonium program. After mining, refining, and conversion to \( \text{UF}_4 \), uranium tetrafluoride must be converted to uranium hexafluoride before being enriched in centrifuges (or through other methods), converted back to uranium metal, then cast into pits. Uranium has two main isotopes: \( ^{235} \text{U} \), the fissile part, and \( ^{238} \text{U} \), a (relatively) non-fissile part. Weapons-grade uranium consists mostly of \( ^{235} \text{U} \). Depending on the efficiency of the centrifuges, hundreds are required; however, they can fit into a relatively small area, and so are more difficult to detect than larger facilities such as a large reprocessing plant or a reactor cooling tower. Many centrifuge parts, however, are under export controls, and so much of the information that is discovered about HEU programs comes from the interception of the materials needed for fabrication of centrifuges. The dissolution of A.Q. Khan’s nuclear network has also produced a great deal of information. Similar to plutonium programs, a few basic technical details are required to understand and estimate a state’s progress toward a uranium capability.

After uranium mining, refining, and conversion, the \( \text{UF}_4 \) is combined with fluorine to convert it to \( \text{UF}_6 \), which is a gas at relatively low temperatures \( (57^\circ \text{C}) \). It can then be

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\(^4\) Paternoster 1992, 8.
enriched using any one of a variety of methods. While early uranium enrichment programs used gas diffusion (GD) and/or electromagnetic separation (EMIS), most modern programs use centrifuge technology due to its lower cost and power requirements; see Table 2.3 for production figures and technologies used by the major weapons states. All enrichment methods use the small mass difference between $^{235}\text{U}$ and $^{238}\text{U}$. Gas diffusion works by passing UF$_6$ through small holes; molecules with $^{235}\text{U}$ pass through these holes at a slightly higher rate than those containing $^{238}\text{U}$. Centrifuges spin the gas; the heavier $^{238}\text{U}$ molecules tend to gather near the walls of the spinning centrifuge, and are discarded. Electromagnetic separation accelerates the molecules in an arc, with the lighter $^{235}\text{U}$ molecules...
tending to move towards larger radii. Other techniques more rarely used in production of fissile materials (and never proven commercially viable) include aerodynamic enrichment (used by South Africa for its weapons program), laser enrichment, and chemical separation. In addition to the nuclear weapons states, Iraq pursued a number of technologies, including EMIS, chemical separation, gas diffusion, and gas centrifuges; Iran has primarily experimented with laser and centrifuge enrichment technologies; and North Korea is only known to have centrifuge technologies. Apart from the states listed in Table 2.3, the Netherlands, Germany, Japan, Argentina and Brazil all have enrichment technology; all but the latter two have operating commercial enrichment plants in use for power-production reactor fuel.  

The standard measure of the ability of an enrichment technology to separate $^{235}$U from $^{238}$U is the Separative Work Unit (SWU). Calculating the number of SWU needed for a given application depends on the amount and initial enrichment of the feed, the amount and enrichment of the final product, and the enrichment of the depleted uranium in the tails. The higher the initial enrichment, the lower the final enrichment, and the higher the enrichment of the depleted uranium, the fewer SWUs are needed. Assuming an initial enrichment of 6.5 tons of 0.71% $^{235}$U, a tails enrichment (called an assay) of 0.3%, and extraction of 30 kg of 90% $^{235}$U, approximately 4000 SWU are needed, as is pictured in Figure 2.4. A given machine is measured in SWU per year; for example, the P-1 centrifuges distributed by the A.Q. Khan network produce about 2 SWU per year.  

For light-water-moderated and cooled power-production reactors the fuel must be enriched, often up to 5% $^{235}$U. It must be enriched to at least 30% to be reasonably usable in an implosion weapon (requiring 100 kg with a tamper), although implosion weapons usually contain uranium enriched to 90%, known as ‘weapons grade’ uranium (WGU). In Figure 2.4, the path to a uranium weapon—including enrichment—is pictured on the right. The standard figure used for calculating the amount of weapons-grade uranium used per weapon is between 15 and 30 kilograms for an implosion weapon. The IAEA standard for a “significant quantity” of weapons-grade uranium is 25 kilograms; the Iraqi design

56 ↑ Hibbs 2005.  
57 ↑ Glaser 2002, 75.  
required about 18 kilograms\textsuperscript{59} and the solid-core Chinese design transferred to Pakistan and Libya (and likely Iran and North Korea) would require no more than 15 kilograms. However, 20 kilograms is often used as an estimate, since a new nuclear state might desire higher yield and reliability\textsuperscript{60}. For a simpler, gun-type design, about 60 kg is required; South Africa’s design was 55 kg\textsuperscript{61} while the Hiroshima bomb contained 60 kg\textsuperscript{62}.

Uranium enrichment facilities using gas diffusion are usually quite large, while those employing centrifuges can be relatively small. Detection of these facilities therefore depends upon observing imports of certain crucial materials and parts from other countries. For example, high-strength aluminum, maraging steel, or carbon fiber are required for the centrifuge rotors and the vacuum vessel around the rotors; the bearings often use cobalt; and frequency converters are used to drive the rotors at the proper speeds. Detection of the actual facility in operation is very difficult, since centrifuges have low power requirements.

\section*{2.6 Sources}

For my qualitative analysis, my history is based initially on the Nuclear Threat Initiative’s nuclear timelines, which contain thousands of events related to several different proliferants\textsuperscript{63}. I check the NTI timelines against independent sources for important periods to ensure that they are not systematically biased and that I am not missing crucial interactions among the United States, proliferant countries, and third parties.

Nuclear programs are commonly clandestine and difficult to obtain accurate information on. States go to great lengths to keep these programs secret within their own countries as well as abroad. Consequently, accurate information on the status of nuclear programs is extremely difficult to acquire, and is often contested. Even when evidence is not contested, interpretations of the meaning of a particular piece of knowledge often are. I attempt to balance several different sources, using more reputable information where available: IAEA

\begin{footnotesize}
\begin{itemize}
\item \textsuperscript{59} Albright and Hibbs 1992.
\item \textsuperscript{60} Albright \textit{et al.} 1997, 276.
\item \textsuperscript{61} Albright \textit{et al.} 1997, 386.
\item \textsuperscript{62} Garwin 1997.
\item \textsuperscript{63} Nuclear Threat Initiative 2005.
\end{itemize}
\end{footnotesize}
reports, assessments made by technical experts (e.g., David Albright), articles from reputable journals (e.g., *Bulletin of Atomic Scientists, Arms Control Today, The Nonproliferation Review*), and information from industry periodicals (e.g., *Nucleonics Week, Nuclear Fuel*). However, a great deal information is only available from general periodicals. I try to adjudicate between conflicting pieces of evidence and conflicting narratives by comparing individual pieces of information to a coherent larger narrative. The evidence is often mixed, so I supply as much information as possible to let the reader make an independent decision.

Consequently, I supply exhaustive citation information in order to document the original articles where possible. While standard citation styles recommend full citations for periodicals in footnotes and exclusion from the bibliography, when author-date citations are also included in the footnotes this produces an unreadable mess. I therefore have separated periodicals from the remainder of the bibliography and indicate whether a citation is in the regular bibliography or in the periodical bibliography by placing periodical citations in italics (e.g. *Hibbs 2000a* versus Albright 1998). When available, URLs are provided for the bibliography for ease of reference; most periodicals are available from Lexis-Nexis.
Table 2.4: Nuclear status coding schemes

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<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>USA</td>
<td>1942–</td>
<td>1942–</td>
<td>1945–</td>
</tr>
<tr>
<td>Russia</td>
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<td>1943–</td>
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<tr>
<td>UK</td>
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<td>1941–</td>
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<tr>
<td>India(2)</td>
<td>1972–</td>
<td>1972–</td>
<td>1974–</td>
</tr>
</tbody>
</table>

Active Programs

| Iran(1)                    | 1974–1978         |                           |                           |
| Iran(2)                    | 1984–             | 1984–                     | 1985–                     |

Exploratory Programs

| Switzerland                |                   | 1946–1969                 |
| Yugoslavia(1)              |                   | 1954–1965                 |
| Yugoslavia(2)              |                   | 1974–1988                 |
| Australia                  |                   | 1956–1973                 |
| Taiwan(2)                  |                   | 1987–1988                 |
| Algeria                    |                   | 1983–                     |
| Romania                    |                   | 1985–1993                 |
Chapter 3

Social Action, What Reaction?
A Quantitative Analysis of US–DPRK interactions

3.1 Introduction

In the previous chapter, I outlined the three underlying theories I test in this work (realism, liberalism, and constructivism) and generated hypotheses regarding interactions between the United States and proliferators. In this chapter, I undertake a quantitative test of a subset of these hypotheses: specifically, those relating to direct, bilateral interactions with a proliferator (North Korea): H1–H3 (the effects of military, economic, and social incentives) and H5 (feedback loops). Analyzing event data through vector autoregression, I investigate interactions between the United States and North Korea during the most active parts of the two North Korean nuclear crises (1993–1995 and 2002–2003). North Korea generally followed a consistent policy of reciprocation during the latter half of the first crisis, but switched to a strategy of consistent rejection during the second crisis; in both of these time periods, positive feedback loops existed, amplifying US actions. However, the nature of these feedback loops changed significantly from the first crisis to the second; in the first crisis, this feedback reflected reciprocal moves that improved relations, while in the second,
it represented a series of rejected diplomatic moves that exacerbated the crisis.

In order to quantitatively test my hypotheses on interaction patterns between actors, several steps must be followed, as seen in Figure 3.1. On the left-hand side of this figure are the seven steps of my method; on the right is an example for each step. First, a data source must be selected for events. I use a database of state-to-state interactions that spans from 1991 through 2003 drawn from Reuters news articles; to take an example, one entry from this database records Madeleine Albright’s trip to North Korea on October 23, 2000. Second, the events must turned into event codes using content analysis, which turns text from news sources into events of the form source-verb-target. In this example, the sentence

![Figure 3.1: Quantitative methodology flowchart](image)

<table>
<thead>
<tr>
<th>Step</th>
<th>Event</th>
<th>Example</th>
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</thead>
<tbody>
<tr>
<td>1. Events</td>
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<td>2. Event Codes</td>
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<td>3. Event Scaling</td>
<td>Social: +2.07 Material: 0</td>
<td></td>
</tr>
<tr>
<td>5. Vector Autoregression</td>
<td>( \text{PROSOC}<em>t = 0.79 \times \text{USASOC}</em>{t-1} )</td>
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<td>6. Interpretation</td>
<td>US Social action reciprocated by DPRK</td>
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</tr>
<tr>
<td>7. Hypothesis Testing</td>
<td>Supports H3a: Social Benefits</td>
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</tbody>
</table>
“Madeleine Albright flies to North Korea” has Madeleine Albright as the source actor, flies as the action verb, and North Korea as the target actor; computer-generated content analysis software can identify with high accuracy these events. In this case, it would identify that a US governmental agent traveled to meet (code 320) with the North Korean government. Third, action verbs are then be converted into values on a continuous scale; for example, on a scale of social value—used in this chapter—from -4 (extreme hostility or intense negative affect conveyed) to +4 (extreme friendliness or intense positive affect conveyed), travel to meet has a value of +2.07. Fourth, the events must be summed over some time period, in this case each day; consequently, the day that Albright traveled to North Korea would have a net social value of +2.07 if no other actions occurred that day. Fifth, vector autoregression is then used to identify relationships between actions; e.g., whether social actions lead to other social actions. The result for the second half of the first North Korean nuclear crisis is that a US social action of value 1 is reciprocated by a North Korean social action of value +0.79, so Albright’s visit would be reciprocated by a social action of value +1.64 (e.g., code 935, Request mediation). Finally, these coefficients must be interpreted and used to test hypotheses; since US social actions were reciprocated by the DPRK, and since during this period US actions were primarily positive, this result supports hypothesis H3a (Social Incentives). Note that this offers no proof for or against hypothesis H3b (Social Disincentives). If US social actions had been negative during this period, this result would instead offer evidence against hypothesis H3b (Social Disincentives), since in that case the coefficient meant that social sanctions by the US had led to belligerent social action on North Korea’s part rather than backing down.

In this chapter, I describe in-depth each step of this method, then use it to test hypotheses relating to US–North Korean relations. I first outline how news articles are turned into source-verb-target events in my datasets. I then describe the scales that are used to convert these events into positive and negative social and material (grouping economic and military) values. I next turn to data analysis, describing how vector autoregression works and how I select periods and lag lengths to analyze in these datasets, as well as how I use vector autoregression to test hypotheses. I then analyze data for US-DPRK interactions and present my results, concluding with implications for my qualitative analysis.
3.2 Quantitative Methodology

3.2.1 Data Coding

The first step in data analysis is to take events and code them into a set number of categories. Several different systems exist for coding international events between actors. One of the most established comprehensive systems is the World Events Interaction Survey (WEIS). The original system divided events into 22 base categories (see Table 3.1) that were intended to cover most major world events that involved interaction between states. A descendant of this research is the IDEA (Integrated Data for Events Analysis) framework, which expands the existing 22 base categories to include economic and natural events (among others), alters the framework so as to be actor-independent (altering events that would require state actors), and extends each base category into many subcategories. The IDEA framework allows for coding of both events and actors into hierarchical categories. Each event is coded into one of the base categories, then (if possible) is coded into subcategories. Due to this recoding, I have coded each IDEA event into a four-digit number, where each base category has two zeroes added to it. For example, a threat to halt negotiations has a base category of 1700 (Threaten), a subcategory of 1720 (Sanctions threat) and a subsubcategory of 1721 (Threaten to halt negotiations). See Table 3.6.

Table 3.1: WEIS base categories

<table>
<thead>
<tr>
<th>Cat</th>
<th>Name</th>
<th>Cat</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yield</td>
<td>12</td>
<td>Accuse</td>
</tr>
<tr>
<td>2</td>
<td>Comment</td>
<td>13</td>
<td>Complain</td>
</tr>
<tr>
<td>3</td>
<td>Consult</td>
<td>14</td>
<td>Deny</td>
</tr>
<tr>
<td>4</td>
<td>Endorse</td>
<td>15</td>
<td>Demand</td>
</tr>
<tr>
<td>5</td>
<td>Promise</td>
<td>16</td>
<td>Warn</td>
</tr>
<tr>
<td>6</td>
<td>Grant</td>
<td>17</td>
<td>Threaten</td>
</tr>
<tr>
<td>7</td>
<td>Reward</td>
<td>18</td>
<td>Demonstrate</td>
</tr>
<tr>
<td>8</td>
<td>Agree</td>
<td>19</td>
<td>Sanction</td>
</tr>
<tr>
<td>9</td>
<td>Request</td>
<td>20</td>
<td>Expel</td>
</tr>
<tr>
<td>10</td>
<td>Propose</td>
<td>21</td>
<td>Seize</td>
</tr>
<tr>
<td>11</td>
<td>Reject</td>
<td>22</td>
<td>Force Use</td>
</tr>
</tbody>
</table>

\[1\] On the original WEIS project, coding, and events, see McClelland [1978].
in Section 3.B at the end of this chapter for a complete list of event codes in the IDEA framework.

With the advent of inexpensive computer time, systems were developed in order to facilitate the automated coding of news articles into events, such as the Kansas Event Data System (KEDS)

Complementing the IDEA framework is a computer program that uses similar techniques to the KEDS called the VRANet Reader

which will automatically code events into the framework. It has been demonstrated to approach the accuracy of human coders

In the VRANet Reader, each actor is coded into three separate variables. The first (Name) indicates the state or IGO an actor represents (e.g., North Korea or the UN). The second (Sector) indicates what part of government an actor represents (e.g., National Executive, Diplomat). The third (Level) indicates whether an actor is a named individual or simply a representative (e.g., US Secretary of State Colin Powell versus a spokesperson for an agency). For example, take US Secretary of State Madeleine Albright’s trip to North Korea in October of 2000. The original Reuters lead sentence is “U.S. Secretary of State Madeleine Albright said on Wednesday she would fly to North Korea in four days, becoming the only member of a U.S cabinet to visit the Stalinist state against which it fought in the 1950-53 Korean war.”

This is coded (by the VRANet Reader) as is shown in Table 3.2. Note that in this case, the event is reciprocal; every “Travel to meet” event has a corresponding “Host a meeting” event. For the quantitative analysis, I include all sectors

<table>
<thead>
<tr>
<th>Source</th>
<th>Sector</th>
<th>Level</th>
<th>Event</th>
<th>Target</th>
<th>Sector</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>National</td>
<td>Individual</td>
<td>Travel to meet (320)</td>
<td>PRK</td>
<td>Government</td>
<td>Country</td>
</tr>
<tr>
<td>PRK</td>
<td>Government</td>
<td>Country</td>
<td>Host a meeting (330)</td>
<td>USA</td>
<td>National</td>
<td>Individual</td>
</tr>
</tbody>
</table>

2For a validity assessment and overview of the KEDS parser, see Schrodt and Gerner 1994.
5Reuters News 2000.
and levels that are associated with governmental action.

For this project, I use a subset of a dataset of over 400,000 country-to-country events that has been coded by the VRANet Reader from the leading sentences of Reuters articles from 1991-2003, this dataset provides general information about the state of relations between countries during this period of time. While these do not sample based on the subject of interaction, during the two North Korean nuclear crises, interaction between the US and the DPRK was dominated by the nuclear issue.

### 3.2.2 Event Scaling

Once events are coded into different categories, it is necessary to interpret these events in such a way that would give meaning to each action. The Goldstein conflict/cooperation scale was developed for the WEIS system, mapping event codes into a single continuous scale. This scale was calibrated using survey research. The IDEA framework has a similar set of scales, divided into five different categories (instead of a single scale) for each event: locus, affect, mechanism, physical injury, and material damage. Both integer “base codes”—the consensus of principal investigators of the project—and codes based on survey data that records the average of a general survey of practitioners of a set of archetypal events are available. I use the survey data since it offers greater granularity; values are the average of the survey respondants’ answers, and so can take on any value, while the base codes are limited to integer values. I derive my metrics from two particular scales: affect, which in the survey data ranges from -4 (extreme hostility or intense negative affect conveyed) to +4 (extreme friendliness or intense positive affect conveyed) and material damage, which ranges from -6 (catastrophic destruction, with damage likely to have long-term implications) to 0 (no damage), and increases proportional to the scale, reparability, and time duration of the destruction.

I use affect as the basis for my measure of social action, and material damage as the
basis for my measure of material action. The social value of individual actions as an incentive or disincentive for behavior, while not identical with the affect communicated by an action, is sufficiently close to use affect as a proxy. Material damage gives the negative part of the scale by which material action is measured; I produce the complementary positive scale of material benefit by identifying the complements of each negative event (e.g., the material benefit for lifting economic sanctions is equal to the material damage for imposing economic sanctions). While this may not be completely accurate—more or less benefit may be achieved from lifting sanctions as may be lost due to the imposition of sanctions—this is a good approximation. Since some survey respondents were consistent outliers, out of thirty-two coders, six were dropped from material scaling and four from affect scaling. Due to the original asymmetric distribution of values for material damage, many events in the survey data have a small material damage due to a few coders marking events as having a material damage component even when the majority concluded that no material damage would occur. When creating a material damage/benefit scale, this small deviation flattens the distribution more than the corresponding affect distribution and causes it to be bimodal (two peaks at small positive and negative values rather than a single peak centered at zero). I therefore zero events where the overwhelming consensus (over 75%) among coders was that material damage was zero. See Table 3.6 at the end of this chapter for scaling for all actions.

Using event scaling assumes that the value of every action is constant across events and actors. While meaning can vary significantly, the assumption of constant meaning is sufficiently true to be a useful method for studying aggregate patterns of interaction. I use qualitative analysis of individual events to help make up for this shortcoming. To take an example of scaling, in the case of the Albright visit listed above, both traveling to a meeting (code 320) and hosting a meeting (code 330) are an indication of positive affect (+2.07 and +2.29 respectively), with no material benefit or damage implied. A threat to use force (code 1730), on the other hand, would have a negative affect (-3.92), with material damage implied (-3.68), while an easing of sanctions (code 650) would have both positive affect (2.41) and positive material benefit (1.06). In the case of threats and promises, material damage or benefit is equal to the damage done if the threat or promise was carried out.
3.2.3 Vector Autoregression (VAR)

Once news articles have been turned into events and events into quantities of interest (in
this case, social and material benefits or sanctions), a method is needed to analyze the pat-
terns of interaction in this data. I use vector autoregression to partially test hypotheses
H1–H3 (military, economic, and social incentives, although the event scaling does not cur-
rently differentiate between military and economic material action) and hypothesis H5
(feedback). I have two main actors (the United States and the proliferant), two different
types of actions (material and social), and two questions to be resolved through quantita-
tive analysis: what and how do proliferants respond to material and social actions by the
United States, and what feedback loops result from responses by the United States in turn?
This produces a low number of quantitative variables (four: US and proliferant material and
social actions) but a high degree of endogeneity, since each of these variables could affect
at least two others. For example, a social action by the US might conceivably cause social
or material reaction by North Korea; calling North Korea a “rogue state” may lead it to
respond with an insult or a threat of force. Additionally, inertia could lead to further social
actions by the US once a particular social action has been taken; taking the same example,
calling North Korea a “rogue state” may lead to this phrase being more commonly used in
the future. With a low number of variables and this great of a degree of uncertainty as to
the relationships between the variables in question, vector autoregression fits the modeling
requirements better than traditional statistical methods in political science. Moreover,
vector autoregression techniques exist to empirically determine the appropriate lag time,
rather than needing to guess how many lags might be appropriate.

These techniques have been used successfully in the past to examine rivalries and reci-
procity in the international system between great power and the relationships between

---

9Vector autoregression was pioneered in econometrics by Christopher Sims. See Sims 1980. A very
readable overview of the technique can be found in Stock and Watson 2001.

10Although the framework could be modified to separate of these two events, they are sufficiently rare that
such a separation would likely lead to poor (and excessively complicated and difficult to interpret) results.

11For arguments regarding the more widespread use of vector autoregression in political science due to the
high degree of uncertainty in relationships between variables, see Freeman et al. 1989 and Freeman et al.
1998.

12Early studies include Williams and McGinnis 1988, McGinnis and Williams 1989, Rajmaira and Ward
democracy, democratization, and interstate war. It has been used in a very similar context to this study to examine machine-coded event data in the past using the WEIS categories, the KEDS parser, and the Goldstein conflict-cooperation scale, looking at interaction patterns in the Middle East and in Bosnia. Other techniques have also been used to analyze this type of data, such as Hidden Markov Models (HMM) the IDEA principal investigators also have used HMM. However, these models are intended to detect different stages of a crisis, rather than examine direct cause-and-effect relationships between different protagonists. Social network analysis might also prove to be an effective technique for predicting patterns of interaction among multiple countries, but is beyond the scope of this project.

Vector autoregression is a simple extension of time-series regression. If, for example, we thought that North Korea’s social action at time $t$ could be predicted by the social and material actions of the United States and the social action of North Korea (due to inertia) at time $t-1$, then we would end up with an equation like:

$$PRK_{SOC_t} = c + a_1USASOC_{t-1} + a_2USAMAT_{t-1} + a_3PRK_{SOC_{t-1}} + e$$

Where USA is an action by the United States, PRK is an action by North Korea, SOC is a social action, MAT is a material action, $a_1$–$a_4$ are coefficients, $c$ is a constant, and $e$ is a stochastic error term. I derive these four variables from raw event data by adding up for each day the total of the event scaling values for all the actions in that day. For example, suppose that on one day, USA rejected a proposed settlement (Code 1113: SOC=-3.21, MAT=-0.92), and the next day PRK made two pessimistic comments (Code 0220: SOC=-1.64, MAT=0.00). Then the variables for those two days would be:

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13 Crescenzi and Enterline 1999 uses vector autoregression in a different context from other international studies: instead of studying actions, studying more general variables.
14 Both Goldstein and Pevehouse 1997 (Bosnia) and Goldstein et al. 2001 (Middle East) use very similar techniques to the ones I employ here.
15 HMM is well-established for other purposes, but is just beginning to be used for data analysis in the social sciences. See Schrodt 1999, Schrodt 2000 for pioneering work.
16 See Bond et al. 2004 on predicting conflict in Indonesia.
In this case, a regression would find that coefficients \( a_1 \) and \( a_2 \) both have an effect (i.e., would be positive); that is, material and social action by the United States cause social action in the same direction by North Korea. If North Korea had made a pessimistic statement the previous day, then coefficient \( a_3 \) would also be positive; inertia would have an effect.

Each of these four variables (USASOC, USAMAT, PRKSOC, and PRKMAT) is likely to have a causal effect on at least three of the other variables (e.g., USASOC\(_t-1\) may affect PRKSOC\(_t\), PRKMAT\(_t\), and USASOC\(_t\), but not USAMAT\(_t\)), so four equations need to be solved simultaneously, as is shown in Equation (3.1):

\[
\begin{align*}
\begin{pmatrix}
\text{USASOC}_t \\
\text{USAMAT}_t \\
\text{PRKSOC}_t \\
\text{PRKMAT}_t
\end{pmatrix} &=
\begin{pmatrix}
c_1 \\
c_2 \\
c_3 \\
c_4
\end{pmatrix} +
\begin{pmatrix}
a_{11} & a_{12} & a_{13} & a_{14} \\
a_{21} & a_{22} & a_{23} & a_{24} \\
a_{31} & a_{32} & a_{33} & a_{34} \\
a_{41} & a_{42} & a_{43} & a_{44}
\end{pmatrix} 
\begin{pmatrix}
\text{USASOC}_{t-1} \\
\text{USAMAT}_{t-1} \\
\text{PRKSOC}_{t-1} \\
\text{PRKMAT}_{t-1}
\end{pmatrix}
+ 
\begin{pmatrix}
e_1 \\
e_2 \\
e_3 \\
e_4
\end{pmatrix}
\end{align*}
\] (3.1)

Simply put, in this equation each of the variables in the regression at time \( t \) is regressed on the past values at time \( t-1 \) of each of the four variables. This produces 16 coefficients, plus four optional constants \( c_i \) (exogenous variables may also be included in the equation, but are not pictured here), plus an error term \( e_i \). These coefficients are easily interpretable; for example, \( a_{41} \) would indicate whether a social action by the United States causes a material action by the proliferant. Four coefficients correspond to four implausible causal relationships (\( a_{21} : \text{USASOC}_{t-1} \rightarrow \text{USAMAT}_t \), \( a_{12} : \text{USAMAT}_{t-1} \rightarrow \text{USASOC}_t \), \( a_{43} : \text{PRKSOC}_{t-1} \rightarrow \text{PRKMAT}_t \), and \( a_{34} : \text{PRKMAT}_{t-1} \rightarrow \text{PRKSOC}_t \)) and do not have any interpretable relationship or functional value. Consequently, they are suppressed in the regressions. Since the distribution of values for action is approximately a distribution centered around zero and since not suppressing constants would lead to an odd empirical interpretation (that states take a constant action every day regardless of circumstances),
constants are also suppressed. See Equation 3.2 and Figure 3.2 below for interpretations of the remaining 12 coefficients.

\[
\begin{pmatrix}
\text{USASOC}_t \\
\text{USAMAT}_t \\
\text{PRKSOC}_t \\
\text{PRKMAT}_t
\end{pmatrix}
= \begin{pmatrix}
\text{USA}1 - \\
- \text{USA}2 \\
\text{USA}3 \\
\text{USA}4
\end{pmatrix}
\begin{pmatrix}
- \\
\text{PRK}3 \\
\text{PRK}4 \\
\text{PRK}1
\end{pmatrix}
\begin{pmatrix}
\text{USASOC}_{t-1} \\
\text{USAMAT}_{t-1} \\
\text{PRKSOC}_{t-1} \\
\text{PRKMAT}_{t-1}
\end{pmatrix}
+ \begin{pmatrix}
e_1 \\
e_2 \\
e_3 \\
e_4
\end{pmatrix}
\] (3.2)

Figure 3.2: Interpretations of vector autoregression coefficients

These 12 coefficients define the potential interaction patterns between the United States and North Korea. Positive coefficients indicate that a change in the value of one variable in a positive or negative direction will cause another variable to change in the same direction after a time lag; negative coefficients mean that a change in one variable will lead to a future change in another variable in the opposite direction. If \(\text{USA}3\) is positive, then a positive social action by the United States (e.g., an expression of good will) will lead to a positive social action by North Korea (e.g., a willingness to enter talks). If coefficient \(\text{PRK}3\) is positive at the same time, then a feedback loop exists between social actions by the United States and social actions by North Korea; the US is likely to respond to North
Korea’s willingness to enter talks with an acceptance.

The substantive interpretation of a coefficient depends on both the coefficient and the types of actions taken; for example, if USA5 was negative, then material actions by the United States would cause North Korea to react with social actions of in the opposite direction during that period. If material threats by the United States had dominated that period, this would represent a deterrent-type relationship, where material threats lead to positive social action (backing down). This would lend support to hypotheses H1b/H2b (Military/Economic Disincentives). On the other hand, if the United States had primarily offered material benefits during that period, then the negative coefficient would mean a rejection of the agreement offered, evidence against hypothesis H1a/H2a (Military/Economic Incentives). Four of the coefficients represent inertia; for example, if USA1 was positive, then social actions by the United States would make similar future social actions by the United States more likely (even when accounting for the effects of all other variables); hence, this coefficient and PRK1 are labeled social inertia, while USA2 and PRK2 are labeled material inertia.

3.2.4 Crisis Periods and Time

In order for vector autoregression of event data to produce robust results, at least two criteria must be met: first, interaction patterns between the different actors during the period of concern must be relatively stable; second, the lags between interactions must be relatively similar in length. In order to discern particular periods to analyze, I first attempt to identify periods of high-intensity interaction during which lag times are relatively consistent. From the complete computer-coded database of events, I extract all events between the United States and North Korea. I then sum the events by calendar month, defining “crisis” periods as a series of months in which a particularly high frequency of interaction occurred. More precisely, a crisis period is defined as 1) for every month in that period, the number of events per month exceeds the average number of events per month for the entire dataset and 2) at least one month has an interaction frequency of more than one event per day. I take the resultant periods and check them against dates that have been used by other sources to

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For an alternate but similar approach to selecting periods, see Goldstein et al. 2001.
3.2. QUANTITATIVE METHODOLOGY

delimit crises.

More than one time lag may be required; the above equations only include a single lag, meaning that only yesterday’s actions have an effect on today’s actions. Only at the height of crises are action-reaction times likely to be this short; actions are often only responded to after a longer period, such as a week or a month. Additional lags would be represented by adding additional matrices of coefficients multiplied by previous values of the four variables (USASOC\textsubscript{t-2}, etc.—one for each additional day of lag). A variety of methods exist for testing the proper number of lags in a vector autoregression; I use the likelihood-ratio test implemented in Stata 8. Such a test can determine whether adding an additional lag increases prediction power; however, a choice must still be made among the multiple lag lengths that test significant, which represents a tradeoff between additional explanatory power and overfitting the model. In general, I select the number of lags for which additional lags do not alter the substantive interpretation of the model (the same coefficients are significant in the same directions) and/or do not significantly increase the explanatory power.

After performing the regression, I perform block F tests to determine Granger causality (that is, I test the variables as a group to see if past values of those variables together help predict each variable of interest).\textsuperscript{18} I determine the direction of causality by graphing cumulative impulse-response functions,\textsuperscript{19} which determine the responses of all other variables to a one-time shock in a single variable. The change in the value of the target variable after the same period as the number of lags specified is considered to be the effect of the source variable on the target variable. For example, if six lags are selected, and USASOC goes from 0 to 1 at time t (with all other variables initially set to 0), then the simulated value of PRKMAT at time t + 6 is recorded as the net effect of USASOC on PRKMAT. A sample cumulative impulse-response function graph is shown in Figure \ref{fig:3.3} taken from the second half of the first North Korean nuclear crisis. In this graph, USASOC has a positive effect on PRKSOC that increases with time; the cumulative response after 29 days to a social action by the United States of value 1 is a response by North Korea of value 0.79. By

\textsuperscript{18}“A variable x is said to Granger cause a variable y if, given the past values of y, past values of x are useful for predicting y.” Stata Corporation 2003, TS-233.

\textsuperscript{19}I follow Goldstein et al. 2001 here.
Figure 3.3: Sample cumulative impulse-response functions

1 Jun 1994—30 June 1995

Days

Response

USASOC → PRKSO

Days

Response

PRKSO → USASOC

Days

Response

USAMAT → PRKSOC

Days

Response

PRKMAT → USAMAT

Days
contrast, USAMAT has a negative effect on PRKSOI that also increases with time; the cumulative response to a material action by the United States of value 1 is a social response by North Korea of almost -7.5. The large difference in magnitude between these two effects has two causes; first, material events are much rarer than social events; second, the average material event has a much lower value than the average social event. As a result, rare material events of small value appear to have a much larger substantive impact than is actually the case.

3.3 US–DPRK Interactions

Since US interactions with North Korea were primarily bilateral during the first nuclear crisis and started out bilateral in the second crisis, US–DPRK interactions are a good testing ground for quantitative analysis. From the dataset of all country-to-country events from 1991–2003 coded by the VRAReader from the first line of Reuters news articles into the IDEA framework, I extracted all events with the United States as a source actor and the DPRK as a target actor (or vice versa), then made a secondary cut eliminating all nongovernmental interactions (e.g. those between businesses). This left 6262 events between 1 Jan 1991 and 31 May 2003. See Figure 3.4 for a comparison of the monthly frequencies of each base event category during the Bush I (1991–1992), Clinton (1993–2000), and Bush II (2001–2003) administrations (Clinton’s two terms do not differ appreciably in the distribution of events). This figure is log scaled due to the overwhelming number of comment/consult events relative to other events. Categories 02–10 (Comment–Propose) are generally positive, 11–17 (Reject–Threaten) generally negative, and 18–22 involve material sanctions (Demonstrate–Force Use). See Table 3.6 at the end of this chapter for a list of all event codes.

This graph reveals significant differences in interactions between the three administrations. Consultations, agreements, and (friendly) requests between the Clinton administration and North Korea were much more frequent than either Bush administration, while

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20While both of the 95 percent confidence level bounds for these two responses overlap zero, they are both significant at the 0.05 level. See Table 3.4 in Section 3.A.
demands and warnings were much more frequent during the second Bush administration than the first Bush or Clinton administrations, indicating significantly different dynamics for these three administrations.

After determining the distribution of events during these three administrations, I summed the social and material event scaling values each day for every event, creating my four basic variables for analysis: USAMAT, USASOC, PRKMAT, and PRKSOC (where as before, USA is the United States, PRK is North Korea, MAT is a material action, and SOC is a social action). Each of these variables is defined for every day from 1 Jan 1991–31 May 2003; a day in which no USA → PRK events occurred received a score of zero for both USA variables, and vice versa.

I then summed these daily values over each month to determine crisis periods. Applying
the above criteria (the number of events every month exceeds the average number of events per month, at least one month has an interaction frequency of more than one event per day) resulted in four crisis periods: 1 Jun 1994–31 Jan 1995, 1 Mar 1995–30 June 1995, 1 Sep 2000–30 Nov 2000, and 1 Oct 2002–31 May 2003; see Figure 3.5, which depicts the number of events per month, as well as key dates. I combined the first two crisis periods since they were separated by a single month. Note that these periods overlap fairly well with crisis periods that have been identified by other accounts: for example, the first North Korean nuclear crisis has been identified by participants as occurring from March 1993 to July 1995. The beginning of the last period corresponds with the US’s accusation that the DPRK was developing a clandestine uranium enrichment program.

As can be seen in Figure 3.5, the period from 1 Mar 1993–31 May 1994 also had a high frequency of events each month, but never had a month in which the event total exceeded one event per day. Since this period was clearly part of the first crisis, I test this period both separately and combined with the period 1 Jun 1994–30 June 1995. As I will argue in Chapter 4, although the last period ending in May 2003 coincides with the end of the data, by this point the nuclear crisis had reached a stable state. The remaining period (1 Sep 2000–31 Nov 2000) corresponds with Secretary of State Madeleine Albright’s visit to the DPRK. Due to the short period of time (as well as the general lack of overt nuclear moves in this period), I exclude this period.

These periods contain very different interaction patterns. As can be seen in Figure 3.6, the interaction from 1 June 1994–30 June 1995 (the latter half of the first crisis) mainly consisted of reciprocal positive social actions; 1 Sep 2000–30 Nov 2000 is similarly positive and reciprocal. By contrast, 1 Oct 2002–31 May 2003 demonstrates a high variance of social action, including the highest recorded total negative social action in a month by the DPRK during the entire thirteen-year span. Even before analysis, it is clear that US–DPRK dynamics changed significantly between the two crises.

\[\text{Wit et al., 2004}\]
3.3.1 The First North Korean Nuclear Crisis

The first half (1 Mar 1993–31 May 1994) of the first North Korean nuclear crisis (see the top of Figure 3.7) consisted of a mixture of positive and negative interactions, with no clear indication of periods of sustained detente or crisis. Consequently, even if autoregression were to produce significant results, the interpretation would be difficult, since it would be unclear if the positive or negative actions of the United States were causing the DPRK’s reactions. In the second half (1 Jun 1994–30 June 1995) of this crisis, most of the social and material action was positive rather than negative, as can be seen in at the bottom of Figure 3.7. In all of the figures depicting interaction between the US and North Korea, due to the low frequency of material action and the low average material scaling (see Table 3.6),
I have rescaled the material action by a factor of six to make the social and material components of approximately equal scale. The early dip in material action, followed by a peak in social action, represents the height of the crisis in June, when North Korea officially withdrew from the IAEA and the United States threatened to take it to the Security Council for economic sanctions, while making early preparations for increasing military forces. This was followed by Jimmy Carter’s visit to North Korea and the US–DPRK agreement to hold a third round of talks at the end of June, which boosted positive interaction significantly; the high positive peak in late October is due to the signing of the Agreed Framework.

Note that most material action by the US was negative during this period, with the notable exception of the signing of the Agreed Framework. However, the agreement itself (as opposed to the negotiations leading up to the agreement) would not affect the vector
autoregression analysis since only actions that are separated in time can have an effect on each other. Put another way, since the agreement was simultaneously endorsed by both sides, the US signature cannot be said to have caused the North Korean signature, or vice versa.

Using the likelihood-ratio test, I found 29 days to be an optimal lag time (see Section 3.A for details). I then conducted vector autoregressions on all four variables for the first part, the second part, and both parts together. As noted earlier, coefficients between the social and material components of the same actor were suppressed as well as all constants. However, the results were only robust for the second part, probably due to the greater intensity of interaction as well as more consistent patterns of interaction.

The results of the vector autoregression for these two time periods are summarized in Figure 3.8; a full list of coefficients are listed in Table 3.4 in Section 3.A. The only relevant result for hypothesis testing from the first half of the crisis would be the positive relationship between US material action and DPRK social action. However, since US material action during the first half of the crisis had both positive and negative directions (see the top of Figure 3.7), the implications for this result are unclear. Since the results for the first period were not very robust, I focus here on the latter half.

Two positive feedback loops stand out in the second half of this crisis; social and material actions by the US and the DPRK were mutually reciprocated with social and material actions respectively, strongly supporting hypothesis H5 (Feedback Loops). This relationship magnifies the effects of a single action by the United States. This effect is further amplified by other coefficients; both US social and material action showed significant inertia during the second period. Consequently, a single US action of any type is likely to lead to future similar US actions regardless of the response from the DPRK.

Social and material action do not exist separately, but mutually cause each other; a social action by the US leads not only to a social but a material reaction from the DPRK.

---

22 Using the entire timeframe and 27 lags, USASOC → PRKSO and USASOC → PRKMAT were significant at the 0.10 level; USAMAT → PRKMAT was significant at the 0.05 level, and inertia was found in all but PRKSO.

23 With fewer lags (14), the effects of social coefficients tended to lose significance (although with even fewer lags, they reappeared again). This may indicate variable (and possibly different) periods of time before social and material effects occur. Other effects were present at fewer lags. In addition, a PRKMAT → USASOC deterrent relationship that was present at fewer lags disappeared with 29 lags.
3.3. US–DPRK INTERACTIONS

Figure 3.7: First North Korean crisis weekly US–DPRK social and material action
CHAPTER 3. SOCIAL ACTION, WHAT REACTION?

Figure 3.8: First North Korean crisis vector autoregression results

Only results with \( p < 0.10 \) are pictured.

For example, a positive statement by the US might lead not only to a reciprocated positive statement by the DPRK but also a material bargaining concession. This supports hypothesis H3a (Social Incentives).

One important exception to these reciprocal relationships, however, is the negative coefficient between US material action and DPRK social action. Material actions by the United States deterred DPRK social actions; that is, threatening moves by the United States caused North Korea to back down on its negative social actions, e.g. rhetoric. Two examples of this coded in the dataset include a publicized plan to escalate sanctions on North Korea in June 1994\(^{24}\), which, along with the positive social action represented by former president Jimmy Carter’s visit to North Korea, led North Korea to back down; a second example occurred in September, when a battle carrier group was moved to the Sea of Japan for the first time in order to bolster negotiations with the North Koreans\(^{25}\). This supports hypotheses H1a/H2a (Military/Economic sanctions)

\(^{24}\text{Reuters News 1994b}\)
\(^{25}\text{Reuters News 1994a}\)
3.3 US–DPRK INTERACTIONS

3.3.2 The Second North Korean Nuclear Crisis

Interactions during the second nuclear crisis differed significantly from both parts of the first nuclear crisis. Weekly events between the United States and North Korea between 1 Oct 2002 and 31 May 2003 are tabulated in Figure 3.9. Like the first half of the first crisis, clear patterns are difficult to discern through visual inspection; however, the lows are much more extreme in the second crisis than first one. Most of the action is negative on both sides, with occasional attempted “olive branches” by the Bush administration, combined with attempted periodic material deterrent threats. The strongest positive peak was the meeting in late April between the United States and North Korea, while some of the most negative actions included the United States threatening economic pressure in late December and announcing repositioning of bombers in mid-March on the eve of the 2003 Iraq war on the US side; on the North Korean side, events surrounding the restarting of the North Korean nuclear reactor for plutonium production in late February were among the most
negative material actions.

For the second crisis, I found the optimal lag time to be the same (29 days), then ran the same vector autoregression as before (see Section 3.A for details). The results of the vector autoregression for this time period are summarized in Figure 3.10; the full results are listed in Table 3.5 in Section 3.A at the end of this chapter.

Figure 3.10: Second North Korean crisis vector autoregression results
1 Oct 2002–31 May 2003
Only results with \( p < 0.10 \) are pictured.

The results for the second nuclear crisis are substantially different from the first, except for the tendencies of the United States to sustain material actions through inertia and North Korean material actions to cause US material responses. Support for the hypotheses is consequently considerably weaker—and, in fact, is reversed in many cases. Feedback (hypothesis H5) no longer occurs consistently for material actions due to a lack of material reciprocation by North Korea; in fact, North Korean material action wasn’t a function of any of the other variables. Social actions still cause feedback, but in a very different manner. Due to the double negative relationship between social actions by the United States and social actions by the DPRK, H5a (positive feedback) is supported; diplomatic efforts by the United States only seemed to spur on additional negative social reactions from the DPRK, which led the United States to take further efforts. North Korean material actions
seemed to be the main driver of interaction in the second crisis; throughout the crisis, the United States reacted to North Korean provocations, rather than taking the initiative. Due to this dynamic, none of the other hypotheses are well-supported.

The second crisis does undermine support for some hypotheses, however. Like the second half of the first crisis, US action consisted primarily of negative material actions combined with mostly positive social actions. Consequently, the reversal of some of the coefficients constitutes evidence against the same hypotheses supported by the earlier crisis. The negative North Korean reaction to social overtures by the Bush Administration is evidence against hypothesis H3a (Social Incentives); similarly, H1a/H2a (Military/Economic Disincentives) were undercut by the results; US attempts to deter the North Koreans through making vague threats and moving bombers into position during March 2003 were simply ignored by the North Koreans or led to additional negative social actions.

### 3.4 Conclusion

Across the three time periods studied, both US strategies and North Korean reactions varied significantly. During the first half of the first crisis, no consistent strategy was followed by the United States; positive and negative actions towards North Korea were equally prevalent. Consequently, very few coefficients from the autoregression proved to be significant; those that were cannot be interpreted usefully and so offer neither evidence for nor against any of the hypotheses. In the second half of the first crisis, US strategy was much clearer: a consistent combination of material sanctions and social benefits resulted in strong feedback loops and a net positive reaction by the DPRK, supporting hypotheses H5 (Feedback), H1b/H2b (Military/Economic Disincentives), and H3a (Social Incentives). Feedback was supported both for social and material actions, and was further amplified by US inertia. Many of these relationships were reversed in the second nuclear crisis. The same general combined strategy of positive social action with material deterrence was followed, but with the opposite results. Social overtures were rejected, and material threats were disregarded or led to further negative actions by the DPRK. Positive feedback still occurred with respect to social actions; rejections of overtures simply led to further overtures.
Table 3.3: Hypotheses supported by vector autoregression

Yes = evidence for, No = evidence against, – = no evidence

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Mar 1993–</td>
</tr>
<tr>
<td></td>
<td>31 May 1994</td>
</tr>
<tr>
<td></td>
<td>1 Jun 1994–</td>
</tr>
<tr>
<td></td>
<td>30 June 1995</td>
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<tr>
<td></td>
<td>1 Oct 2002–</td>
</tr>
<tr>
<td></td>
<td>31 May 2003</td>
</tr>
<tr>
<td>H1a/H2a (Material Benefits)</td>
<td>–</td>
</tr>
<tr>
<td>H1b/H2b (Material Sanctions)</td>
<td>–</td>
</tr>
<tr>
<td>H3a (Social Incentives)</td>
<td>–</td>
</tr>
<tr>
<td>H3b (Social Disincentives)</td>
<td>–</td>
</tr>
<tr>
<td>H5 (Positive Feedback)</td>
<td>–</td>
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</tbody>
</table>

The results for different hypotheses during the three periods tested are summarized in Table 3.3. Note that these results only indicate whether consistent relationship patterns existed between variables during that particular period of time. Individual examples of these relationships may have existed during these periods, but if they were inconsistent with the general trends, they would not show up. These results are a very mixed picture; the only result consistent across at least two of the three time periods was positive feedback. This confirms the plausibility probe; feedback does seem to have a significant effect on outcomes. At the same time, these results presents an interesting puzzle: why did North Korea respond well to material threats and social benefits in the first crisis, but not the second? In the next chapter, I re-analyze these results by examining individual actions taken by the US and North Korea to flesh out these initial results.

While material actions were consistently reciprocated by North Korea, the dynamics of social interaction clearly changed between the first and second crises, from reciprocity to anti-reciprocity. Positive feedback was often present, amplifying individual actions. How these interaction patterns—and the change in patterns from the first crisis to the second—affected nuclear outcomes is dealt with in the next chapter.
3.A Lag Lengths and Coefficients

I tested the number of lags (the number of days to the included in the vector autoregression) by conducting likelihood-ratio tests for lags up to 49 days for the first part of this period (1 Mar 1994–31 May 1994), the second part (1 Jun 1994–30 June 1995), and both parts together to determine whether the additional parameters for each additional day added were significant. For example, for the second half, lags of 4, 6, 12, 14, 25–26, 29, 38, 40–42, and 47–49 days were significant at the 0.05 level. However, past 29 days additional lags offered diminishing returns (and similar results, and also raised concerns about overfitting the models).

Taking the period from 1 Oct 2002–31 May 2003 as the next sample, I tested the number of lags, again conducting likelihood-ratio tests for lags up to 49 days. For this period, lags of 5, 7, 18, 22–25, 28–29, 32–33, 35–40, and 42–49 days were significant at the 0.05 level. However, as with the previous sample, past 29 days additional lags offered diminishing returns. Additionally, having equal lag lengths makes direct comparison easier.

In Table 3.4, results with \( p < 0.10 \) are starred. The first four entries indicate the overall p-values for each equation, while the entries after that indicate the p-values for each independent variable separately. Note that due to the very different frequencies of social and material events, as well as the difference in dynamic scale, the direction of the coefficient is much more important than the cumulative value, which is skewed. Social responses to material actions are inflated, while material responses to social actions are suppressed.

26 Due to limitations in STATA, more than 49 lags could not be tested with this dataset.
### Table 3.4: Vector autoregression results from the first North Korean crisis

(*=p < 0.10)

#### 1 Mar 1993–31 May 1994

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Independent Variable</th>
<th>Dependent Variable</th>
<th>Cumulative Response</th>
<th>p &lt; $\chi^2$</th>
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#### 1 Jun 1994–30 June 1995

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<th>Dependent Variable</th>
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### Table 3.5: Vector autoregression results from the second North Korean crisis

(*=p < 0.10)

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<th>Dependent Variable</th>
<th>Cumulative Response</th>
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3. B Event Codes

This section lists all relevant event codes. The first column indicates the numeric code, the second the description of the code, and the last two the social and material scaling. Note that the scalings here are based on survey data for typical events in each of the categories below.\textsuperscript{27} Not every code was surveyed; any name that includes “not specified above” means that the affect and material scaling for that code was based on an average of its subcategories.

Table 3.6: Event codes, names, and social and material scaling

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<th>Material</th>
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<td>Yield to order</td>
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<td>120</td>
<td>Yield position</td>
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\textsuperscript{27}For survey guidelines, see [http://vranet.com/IDEAHistograms/ideascaling.htm](http://vranet.com/IDEAHistograms/ideascaling.htm)
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## CHAPTER 3. SOCIAL ACTION, WHAT REACTION?

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Chapter 4

North Korea

“This is an interactive game. Our relationship [with North Korea] is affected by what we do, which shouldn’t be surprising.”

4.1 Introduction

In Chapter 3, I performed a quantitative test of my hypotheses on the two North Korean crises, from 1993-1995 and 2002-2003. Both crises exhibited feedback; US actions became amplified through North Korean reactions and US counter-reactions. While in the latter half of the first crisis, a combination of material threats with social benefits led to positive responses on North Korea’s part, both of these relationships were reversed by the second crisis; both material threats and social benefits were rejected by North Korea. In this chapter, I give an overview of the background to these two crises, then chronicle each of these crises in order to explore both the relationships identified by my quantitative analysis and investigate the remainder of my hypotheses.

The US’s changing strategy towards North Korea over three administrations and the start-and-stop development of North Korea’s nuclear program combine to provide significant within-case variation on both my study variable (US strategies) and dependent variables (North Korean nuclear actions). North Korea has probably come the closest in the

\[\text{Gallucci 2004}\]
post-cold war period to reaching or exceeding the nuclear threshold among the four clandestine nuclear countries (North Korea, Iran, Iraq, and Libya), has the most advanced missile program, and has been both a major focus of US counterproliferation efforts and a main justification for a national missile defense program by every US administration since the end of the Cold War.

Although the North Korean nuclear question is far from resolved, both North Korea’s nuclear status and relations with United States have more than once reached a metastable state such that outcomes of two particular periods (12 Mar 1993–13 Jun 1995 and 4 Oct 2002–12 May 2003) are relatively well-defined. The first period begins with North Korea’s announcement that it would withdraw from the Treaty on the Non-Proliferation of Nuclear Weapons (hereafter NPT), and ends with North Korea’s agreement on the supplier of the light-water reactors under the Agreed Framework, while the second period begins with the US accusation of a clandestine highly enriched uranium (HEU) program and ends with North Korea’s “nullification” of its only remaining nuclear agreement with South Korea. Additionally, during these periods interaction between North Korea and the US has been at its most frequent and tightly coupled; consequently, I focus my analysis on these two periods, since connections between US strategies and North Korean nuclear actions are most apparent during these crises.

I argue that while evidence can be found for all three types of incentives (military, economic, and social), that military and economic sanctions only worked under very limited conditions (and fail badly under other conditions), while social incentives were useful throughout North Korea’s nuclear program. The difference between North Korea’s reactions in the first and second crises was a result of primarily two factors: a fundamental change in US–DPRK social relations, and a lack of well-defined ‘red lines’ or the international consensus needed to make material sanctions effective. Domestic politics seemed to play a limited role, at least during crises. Positive feedback loops, identified as a potentially important factor by my quantitative analysis, did occur in both crises, significantly amplifying the effects of individual actions at the height of crises. Finally, although short-term interactions did drive individual North Korean actions, only potential or actual structural changes in social position caused significant shifts in overall North Korean nuclear status.
In the following sections, I first give a brief historical overview of North Korea’s motivations for and technical progress in its nuclear program as background. I then outline a timeline of key nuclear actions taken by the DPRK from the two North Korean nuclear crises and explain how these actions affected North Korea’s overall nuclear status. Next, I examine each crisis in detail, breaking down the crises into individual nuclear actions. I chronicle the events leading up to each nuclear action, then analyze how these histories support different hypotheses. In each crisis, I review the administration’s policy towards North Korea up until the crisis itself as background and to determine the effects of past administration policy on crisis dynamics.

4.2 The North Korean Nuclear Program, 1950–2003

4.2.1 North Korean Motivations

North Korea’s motivations for starting (and continuing) its program could come from a number of different sources. A history of being threatened indirectly with nuclear weapons, its long animosity with a nuclear-armed United States, and the contemporary conventional superiority of the combined South Korean/US forces give it significant military motivations. North Korea may even believe that a nuclear deterrent is an economically optimal choice; the costs of maintaining its “million-man army” may be much higher than maintaining a small domestic nuclear infrastructure capable of producing a few nuclear weapons. Its long and partially self-imposed isolation may have lead the DPRK to seek prestige and social recognition from a nuclear weapons infrastructure. Regardless of its original motivations, the important question is what types of incentives are likely to convince North Korea to give up its nuclear program; however, the wide range of motives that North Korea has to develop such weapons suggests that there may be many different points of leverage that can be used to help convince North Korea to give up its program.

The range of possible motivations and solutions to the North Korean problem suggested by observers is equally broad. (The number of observers is also quite broad; I list a small but representative sample here). Michael Mazaar suggests that North Korea is motivated
by security concerns and legitimacy both at home and abroad; he suggests that military and
economic sanctions will likely fail, and that a combination of implied sticks and explicit
carrots is needed. Selig Harrison argues that economic motivations in particular have come
to the forefront, and would be the key to successful negotiations. Victor Cha argues for
containment-plus-engagement, where engagement is highly conditional, in order to build
a case for punishment later. Michael O’Hanlon and Mike Mochizuki advocate a wide-
ranging ‘grand bargain’ with North Korea including all varieties of incentives in exchange
for a deal that not only includes nuclear weapons but conventional forces. A wide range
of strategies is consequently advocated by scholars of North Korea.

Few, however, suggest that North Korea cannot be dealt with; studies of North Korea’s
negotiating style find that while the DPRK often uses brinkmanship and can make outra-
geous demands, they act rationally and can make deals. Domestic politics, and therefore
responsibility for the nuclear program, in the DPRK is opaque at best. Many observers ar-
gue that there are clear splits, however, between military proponents of a nuclear weapons
program and members of the foreign ministry who want to use it as a bargaining chip. An
exception to this is a few neoconservatives, who argue that North Korea is monolithic and
implacable; for example, Nicholas Eberstadt argues unconditionally for military coercion
in the form of regime change. In Chapter 6, I cover additional, more general examples of
this perspective. Both the postulated motivations for and recommended strategies against
North Korea’s nuclear program cover a wide range, with little consensus.

4.2.2 The Origins of the Program

North Korea is in the rare position of being one of a few states that have been threatened
with nuclear weapons (albeit indirectly) during an armed conflict. Korea was partitioned
into two states at the end of the Second World War; on 25 June 1950, North Korea crossed
the 38th parallel, starting the Korean War. General Douglas MacArthur requested nuclear weapons in 1950 to prevent an invasion by China; B-29 bombers were deployed to Guam in 1951 for three months with nuclear weapons. Although Eisenhower has been reported to have employed nuclear weapons in order to bring about an armistice, the authorization of transfer of nuclear weapons to military control in 1953 was not intended as a part of atomic diplomacy, although it may have had that effect. The Korean War armistice was signed on 27 July 1953 without South Korea’s signature. The US deployed nuclear weapons to South Korea starting in early 1958, and had such weapons deployed there until 1991.

North Korea’s nuclear program has existed for nearly the entire history of the country. The North Korean Atomic Energy Research Institute was established in December 1952, although basic research and experiments did not begin until the 1960s. The current Yongbyon site where the bulk of North Korea’s nuclear infrastructure sits was started in 1962, when the Soviet Union agreed to supply the DPRK with a small (2 MWt) IRT-2000 research reactor. In the 1970s, North Korea separated a small amount of plutonium from the fuel rods of this research reactor. North Korea joined the International Atomic Energy Agency (IAEA) in 1974, and placed this research reactor under safeguards in 1978.

Most of the plutonium-related facilities (pictured on the top and left-hand side of Figure 4.1) were started in the early 1980s and (with the exception of the plutonium reprocessing facility) were completed by the late 1980s. In the late 1970s, North Korea began planning to build a 5 MWe graphite-moderated reactor at Yongbyon, which went critical in the mid-1980s. It is pictured on the left-hand side of Figure 4.1. As noted in Chapter 2, graphite-moderated natural-uranium reactors are ideal for producing plutonium due to the lower fraction of neutron-emitting plutonium-240 produced; a sufficiently high fraction of plutonium-240 makes the plutonium extracted less usable for weapons design, although the fraction needed is debatable. In the mid- to late-1980s, construction was started on a second (50 MWe) graphite-moderated reactor and a plutonium reprocessing facility at the

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9 See Dingman 1988 on US nuclear strategy during the Korean War.
10 MWt refers to the raw thermal output of a reactor; MWe refers to the (potential) electricity output. See Chapter 2. Both are measured in megawatts. I refer to these reactors by the most common designations given, occasionally referring to the 5 MWe reactor as the “Yongbyon reactor.”
11 See Hibbs 1992b and Albright and O’Neill 2000 on this separation, which the North Koreans later admitted.
12 On the North Korean program from 1945–1980, see Mazarr 1995a 14-34.
Figure 4.1: DPRK materials production flowchart

Key:
- $\text{U}_3\text{O}_8$ = Uranium concentrate (yellowcake)
- $\text{UO}_2$ = Uranium dioxide
- U = Uranium metal
- $\text{UF}_4$ = Uranium tetrafluoride
- $\text{UF}_6$ = Uranium hexafluoride
- GCR = Gas-cooled (CO$_2$) graphite-moderated reactor
- Pu = Plutonium
- SWU = Separative Work Unit
same site; in 1989, construction on a third (200 MWe) graphite-moderated reactor located in another location (Taechon) also began. Additional facilities are known to exist. A re-
processing facility, also located at Yongbyon, was begun in the late 1980s, and is pictured below the 25 MWt reactor in Figure 4.1; an earlier pilot facility may have also existed. This facility was intended to have two process lines sufficiently large to reprocess spent fuel for all of North Korea’s reactors; at the time of the Agreed Framework in October 1994, one of the lines was almost complete. A fuel fabrication laboratory (which converts uranium metal into fuel for the 25 MWt reactor in Figure 4.1) is also located at Yongbyon, and became operational in the mid-1980s. Uranium mining and refinement (to $\text{U}_3\text{O}_8$), pictured at the top of Figure 4.1, is reportedly located at Pyongsan.\textsuperscript{13}

In December 1985, the Soviet Union agreed to supply four light-water nuclear power reactors if North Korea joined the Nonproliferation Treaty (NPT). North Korea signed the NPT, but failed to submit a safeguards inspection agreement with the IAEA by the extended deadline of December 1988. In 1989, the DPRK shut down the 5MWe reactor for about 70 days, removing and reprocessing some of the fuel rods and extracting the plutonium. While North Korea claims that it only removed a few damaged fuel rods and reprocessed about 90 g of plutonium, they could have extracted up to several kilograms, depending upon how many fuel rods they removed and the efficiency of the extraction process.\textsuperscript{14} In parallel, the DPRK conducted a series of high explosive tests between about 1983 and 1991;\textsuperscript{15} further tests were rumored to have occurred between 1991 and 1994.\textsuperscript{16}

### 4.2.3 The Post-Cold War Program

North Korean’s nuclear actions after 1989 can be classified into three categories: progress in their highly enriched uranium (HEU) program, their plutonium (Pu) program, and general treaty adherence. An overview of the material flows in North Korea’s program is

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\textsuperscript{13} Albright and O’Neill 2000; Bermudez Jr. 1994, 1999a, b, 2002
\textsuperscript{14} On the operating history of the 5MWe reactor and estimates of the plutonium extracted, see Albright and O’Neill 2000.
\textsuperscript{15} Nuclear Threat Initiative 2005
\textsuperscript{16} Yu 1996.
CHAPTER 4. NORTH KOREA

The DPRK has a complete plutonium cycle, from mining to reprocessing; the status of its uranium cycle is unknown. The uranium conversion (from UF$_4$ to UF$_6$) and enrichment facilities in Figure 4.1 are hypothetical; the number of centrifuges (and therefore SWU) is based on the 214 tubes intercepted in 2003, which would have provided the vacuum casings for 428 P2 type centrifuges. The UF$_6$ found in Libya is speculated to be connected to North Korea; if the UF$_6$ (and not simply the precursor uranium) did come from the DPRK, it would indicate that North Korea does have a UF$_4$ to UF$_6$ conversion facility. Such a capability is certainly within the reach of a state that has mastered the other parts of the uranium conversion cycle, although the Libyan UF$_6$ is probably not directly from North Korea; see Chapter 6.

Little is definitively known about North Korea’s HEU program; the evidence in Table 4.1 is an estimate of dates based on the available open literature. I include dates on which the HEU program seemed to make particular forms of progress (e.g. initial signing of agreements, small-scale acquisitions, seeking large numbers of parts on the market).

North Korea’s highly enriched uranium (HEU) program can be divided into several distinct phases. Most programs pass through at least three distinct phases in terms of what the program needs to acquire in order to move to the next phase. First comes an initial phase in which parts for a few individual centrifuges are acquired; these centrifuges are assembled and tested separately. The second stage involves assembling centrifuges into small (tens to a couple hundred) cascades in a pilot facility, testing connections between machines. Finally, parts for the entire facility are acquired and built.

It appears that cooperation with Pakistan on the HEU program started in the early 1990s. The full story is only beginning to partially emerge, although some dates and details are known. During the 1990s, A.Q. Khan visited North Korea a dozen times or more. When these visits occurred is not documented. Joseph Bermudez reports that cooperation began with Prime Minister Benazir Bhutts trip to North Korea in December 1993. However, an agreement was totally not formalized until later; the Congressional

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Warrick 2003
Sanger and Broad 2005a
Kessler 2005
Hersh 2003
Bermudez Jr. 2002

### Table 4.1: DPRK HEU program timeline

<table>
<thead>
<tr>
<th>Year</th>
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<th>Event</th>
</tr>
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<tr>
<td>1990s</td>
<td>A.Q. Khan visits DPRK 12+ times</td>
<td></td>
</tr>
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<td>1993</td>
<td>Dec</td>
<td>Bhutto trip to DPRK</td>
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<tr>
<td>1996</td>
<td>Mid</td>
<td>Agreement signed DPRK/Pakistan</td>
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<td>1997</td>
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<td>Cooperation starts</td>
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<td>1998</td>
<td>Jun</td>
<td>Missile transfers DPRK-Pakistan. Nuke transfers?</td>
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<td>1999</td>
<td>Early</td>
<td>Frequency converters (two) sought by DPRK</td>
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<td>1998-1999</td>
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<td>Clinton Administration learns of possible HEU projects</td>
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<td>1999-2001</td>
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<td>CIA reports DPRK seeks dual-use technologies</td>
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<td>2000/2001</td>
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<td>CIA reports DPRK begins developing HEU program</td>
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<td>2001</td>
<td>Late</td>
<td>CIA reports DPRK seeking centrifuge parts in “large quantities”</td>
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<td>2002</td>
<td></td>
<td>DPRK seeks frequency converters from Japan, pure cobalt</td>
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<td></td>
<td></td>
<td>DPRK orders 6000-grade aluminum tubes from German firm</td>
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<tr>
<td>Mid</td>
<td></td>
<td>Last exchange of equipment (one-way?)</td>
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<tr>
<td>Mid</td>
<td></td>
<td>CIA reports “clear evidence” of centrifuge facility</td>
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<td>Sep</td>
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<td>Export license for 214 6016-T6 tubes rejected</td>
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<td>Oct</td>
<td></td>
<td>DPRK “admits” to HEU program</td>
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<td>2003</td>
<td>Apr</td>
<td>214 6016-T6 tubes seized</td>
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Research Service (CRS) claims that an agreement was reached between North Korea and Pakistan in the summer of 1996. This date is in accordance with recent testimony of defectors.\(^{21}\) Actual cooperation is reported to have started in 1997\(^{22}\) although direct transfers of parts between Pakistan and North Korea tend to be dated to 1998. Transfer of missile technology from North Korea to Pakistan are known to have taken place in 1998; the Nuclear Threat Initiative (NTI) reports that an ‘Unknown number of Nodong missiles’ and ‘Several shipments of warhead canisters and missile production components’ were sent to Pakistan\(^{23}\).

The Clinton administration reportedly learned of these transfers in 1998 or 1999, according to the Congressional Research Service (CRS)\(^{24}\). CRS cites as evidence a 1999 DOE report, likely the same one reported on in the Washington Times.\(^{25}\) However, the only actual components that were cited in the Times article were two frequency converters.

\(^{21}\) Agence France Presse 2004
\(^{22}\) Bermudez Jr. 2002; Hersh 2003
\(^{23}\) Nuclear Threat Initiative 2005
\(^{24}\) Niksch 2005
\(^{25}\) Gertz 1999
This would seem to indicate that North Korea at this point was still in the first stage of their HEU program. CIA reports from the first half of 1999 through the first half of 2001 indicate renewed interest in dual-use technologies by North Korea; all reports repeated the same phrase “[North Korea] sought to procure technology worldwide that could have applications in its nuclear program, but we do not know of any procurement directly linked to the nuclear weapons program.” The CIA didn’t mention seeking components for uranium enrichment specifically until the latter half of 2001, when the it reported that “The North has been seeking centrifuge-related materials in large quantities to support a uranium enrichment program. It also obtained equipment suitable for use in uranium feed and withdrawal systems.”

However, it is possible that the uranium program began earlier. A special, untitled report by the CIA, released on November 19, 2002, stated “we assess that North Korea embarked on the effort to develop a centrifuge-based uranium enrichment program about two years ago.” This makes it difficult to determine whether the program actually started during the Clinton administration. According to Seymour Hersh, a classified report argues that in “2001 North Korean scientists began to enrich uranium in significant quantities.” However, this latter piece of evidence is at odds with the remainder of the evidence, and has not been supported by any other open sources. The last well-known transfer between Pakistan and North Korea occurred in July of 2002, although additional transfers may have been made. It is also unclear what was on each shipment and in which direction a transfer was taking place; for example, the last shipment was claimed by President Musharraf to have been surface-to-air missiles being transferred to Pakistan. Musharraf verified in 2005 that A.Q. Khan had passed “probably a dozen” centrifuges to North Korea.

Various different components for centrifuges have been sought on the market by North
4.2. THE NORTH KOREAN NUCLEAR PROGRAM, 1950–2003

Korea. Documented components include frequency converters (from Japan, used for timing)\(^3\)\(^{33}\) pure cobalt (used in bearings)\(^3\)\(^{34}\) and aluminum tubes (from, variously, Russia, China, Japan, Pakistan, and Europe)\(^3\)\(^{35}\). The latter bears special mention. Intelligence on Iraq falsely identified a shipment of 7000-grade aluminum as centrifuge tubes, even though the dimensions and finish of the tubes indicated that they were primarily suited to be used as rocket motors\(^3\)\(^{36}\).

However, the shipment of 214 6000-grade aluminum tubes that were intercepted on April 12, 2003, as a French ship sailed through the Suez Canal on their way to North Korea via China, seem to fit more closely dimensions of known centrifuges\(^3\)\(^{37}\). In particular, if cut in half, the tubes are well-suited to be used as vacuum housings for the G2/P2 centrifuge design that Pakistan is known to have stolen from Urenco. The G2 is the designation of the original Urenco design for a supercritical centrifuge with two maraging-steel rotors; the P2 is Pakistan’s version of the G2. The P1 centrifuge is not based on Urenco’s G1 design, but rather on an earlier Urenco design with four aluminum rotors that is twice as tall as the G2, but less efficient due to its lower rotor speed. This finding in 2003 contradicted earlier evidence that Pakistan had only given North Korea an earlier, aluminum-based design\(^3\)\(^{38}\).

Reports indicate that the North Koreans had sought as many as 2000 tubes in 2002. Frequency converters were sought as early as 1999\(^3\)\(^{39}\) while the dates on which North Korea sought cobalt are unknown. However, the number of frequency converters (two) sought in 1999 would indicate a very small testbed, while the number of tubes actually shipped in 2003 indicate a shift to a pilot facility. The uranium enrichment facility pictured in Figure 4.1 assumes a pilot-sized facility of 400 G2 centrifuges.

Unlike the HEU program, the plutonium program is relatively easy to observe due to satellite monitoring and the presence of IAEA inspectors during portions of the timeline. During the 1993-1995 crisis, North Korea only made two moves with respect to its plutonium program: unloading the fuel rods from the 5 MWe reactor in May-June 1994 and

\(^{33}\) Hibbs 2003b
\(^{34}\) Hibbs 2002a, b, 2003a
\(^{35}\) Squassoni 2004
\(^{36}\) Albright 2003
\(^{37}\) Warrick 2003
\(^{38}\) Hibbs 2003a
\(^{39}\) Gertz 1999
freezing its program in November 1994. Several additional moves were made in the 2002-
2003 crisis, all of them in 2003: testing the power system at its reprocessing plant on
January 15, moving the 8000 canned fuel rods out of storage at the end of January, restarting
the 5 MWe power plant at the end of February, and starting to reprocess the fuel rods.
See Table 4.2 for a complete list of plutonium-related actions.

The latter event is the source of some contention. Intelligence estimates indicate that
North Korea started reprocessing in late spring or early summer of 2003. This corroborates
the North Korean claim during talks with the United States in late April to be starting repro-
cessing. While the initial translation (by North Korea into English) of the announcement
on the KCNA website declared that they had finished reprocessing—“We are successfully
reprocessing more than 8,000 spent fuel rods at the final phase”—this was pulled from
the website later; another translation given is “We are successfully completing the final
phase, to the point of the reprocessing operation, for some 8,000 spent fuel rods.” The
former translation is currently posted on the KCNA website. However, significant levels
of Krypton-85 were not detected until July 19—and even then the location and concentra-
tions seemed to indicate a second reprocessing plant, not the Yongbyon facility. This is
consistent with an often-speculated second plant (most reprocessing facilities are preceded
by smaller pilot plants; no such plant has been declared by North Korea).

However, little hard intelligence indicates that the rods have been reprocessed. This
leaves a puzzle: if the North Koreans have not reprocessed the fuel, what did they do
with it? The magnesium cladding on the fuel makes the rods dangerous to store without
proper precautions; the joint US-North Korean effort in the 1990s to store the rods placed
them in containers filled with an inert gas. The visit in early 2004 to Yongbyon by a
small US delegation verified that the storage pools were empty. While it is possible
to store them elsewhere, this would be hazardous; therefore most estimates assume that
reprocessing finished some time in 2003; see Chapter 6 for further analysis of the likelihood
of reprocessing and the amount of plutonium extracted.

40 Korean Central News Agency 2003
41 Hecker 2004a
4.2. THE NORTH KOREAN NUCLEAR PROGRAM, 1950–2003

Treaty adherence (apart from the HEU/Pu events) is indicated by the level of compliance with treaty obligations, the DPRK’s relationship with the IAEA, and statements from North Korea regarding how they view the treaty in question; I also include declarations regarding building or testing nuclear weapons and nuclear weapons state status, as well as other key events, in Table 4.2. For example, North Korea’s announcement that they were withdrawing from the NPT on March 12, 1993, their suspension of that withdrawal on June 11, 1993, and their renewed withdrawal announcement on January 10, 2003 are all included, as are six threats to leave the NPT and one threat to withdraw from the IAEA.

Table 4.2: DPRK nuclear/Pu timeline

<table>
<thead>
<tr>
<th>Dates</th>
<th>Type</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>03/12/1993</td>
<td>Treaty</td>
<td>DPRK announces withdrawal from NPT</td>
</tr>
<tr>
<td>06/11/1993</td>
<td>Treaty</td>
<td>DPRK suspends withdrawal from NPT</td>
</tr>
<tr>
<td>09/22/1993</td>
<td>Treaty</td>
<td>DPRK threatens to leave NPT(1)</td>
</tr>
<tr>
<td>10/25/1993</td>
<td></td>
<td>IAEA cameras out of film</td>
</tr>
<tr>
<td>11/29/1993</td>
<td>Treaty</td>
<td>DPRK threatens to leave NPT(2)</td>
</tr>
<tr>
<td>01/31/1994</td>
<td>Treaty</td>
<td>DPRK threatens to leave NPT(3)</td>
</tr>
<tr>
<td>03/03/1994</td>
<td>Treaty</td>
<td>DPRK threatens to leave NPT(4)</td>
</tr>
<tr>
<td>05/12/1994</td>
<td>Pu</td>
<td>DPRK begins removing fuel rods</td>
</tr>
<tr>
<td>06/02/1994</td>
<td></td>
<td>Unloading of reactor partially destroys past Pu production history</td>
</tr>
<tr>
<td>06/05/1994</td>
<td>Treaty</td>
<td>DPRK threatens to leave NPT(5)</td>
</tr>
<tr>
<td>06/10/1994</td>
<td></td>
<td>DPRK finishes removing fuel rods</td>
</tr>
<tr>
<td>06/13/1994</td>
<td>Treaty</td>
<td>DPRK announces withdrawal from IAEA</td>
</tr>
<tr>
<td>06/16/1994</td>
<td>Treaty</td>
<td>DPRK threatens to leave NPT(6)</td>
</tr>
<tr>
<td>06/23/1994</td>
<td>Treaty</td>
<td>DPRK announces compliance with NPT</td>
</tr>
<tr>
<td>10/21/1994</td>
<td>Treaty</td>
<td>DPRK, USA sign the Agreed Framework</td>
</tr>
<tr>
<td>11/01/1994</td>
<td>Pu</td>
<td>DPRK orders cessation of Pu-related nuclear activities</td>
</tr>
<tr>
<td>12/31/2002</td>
<td>Treaty</td>
<td>DPRK kicks out inspectors, threatens to withdraw from NPT</td>
</tr>
<tr>
<td>01/10/2003</td>
<td>Treaty</td>
<td>DPRK withdraws from NPT</td>
</tr>
<tr>
<td>01/15/2003</td>
<td>Pu</td>
<td>Test of power system at reprocessing plant</td>
</tr>
<tr>
<td>01/30/2003</td>
<td>Pu</td>
<td>DPRK moves 8000 fuel rods out of storage</td>
</tr>
<tr>
<td>02/26/2003</td>
<td>Pu</td>
<td>DPRK resumes operations at 5 MWe plant</td>
</tr>
<tr>
<td>04/06/2003</td>
<td>Treaty</td>
<td>DPRK threatens to arm itself with “tremendous military deterrent”</td>
</tr>
<tr>
<td>04/24/2003</td>
<td>Pu</td>
<td>DPRK announces reprocessing fuel rods</td>
</tr>
<tr>
<td>05/12/2003</td>
<td>Treaty</td>
<td>DPRK ‘nullifies’ 1992 N-S nuclear pact</td>
</tr>
</tbody>
</table>

These three measures of nuclear status (progress in their HEU program, plutonium program, and treaty status) have moved back and forth across different nuclear thresholds
repeatedly (see Chapter 2). The first move across the threshold between hedging and acquisition occurred on March 12, 1993, when the DPRK announced their withdrawal from the NPT, triggering the first North Korean nuclear crisis. The suspension of this withdrawal on June 11 temporarily moved North Korea over to the other side of the threshold. However, the questions about continuity of safeguards in the ensuing months made North Korea’s nuclear status more questionable at the time; in retrospect, it appears that North Korea did not take any additional nuclear steps during this period of time. North Korea stepped back towards the threshold in late May of 1994 when it began unloading the Yongbyon reactor, and formally crossed it in early June when a sufficient portion of the reactor had been unloaded to partially destroy the past operating history, making it difficult to determine how much plutonium had previously been extracted from the reactor (although opinions vary as to the degree of the destruction). Its withdrawal from the IAEA on June 13 added to this step over the threshold. However, on June 23, North Korea not only announced that it would comply with its NPT obligations, but would freeze its entire nuclear program. This was further solidified with the signing of the Agreed Framework and the return of IAEA inspectors.

It is difficult to pin down when North Korea next crossed the threshold from hedging to acquisition. Although this chapter does not deal explicitly with the reasons why North Korea began or continued pursuing a highly enriched uranium program, the timing of the various pieces of evidence seems to indicate that regardless of the status of the program during the Clinton years, the program began expanding in 2001. While CIA reports from the late Clinton years seem to indicate a very small-scale program, in November 2002, they concluded that North Korea “embarked on the effort to develop a centrifuge-based uranium enrichment program about two years ago.” Since DPRK–US relations were at an all-time high in November 2000, it seems more likely that the program started a couple of months later. North Korea then began seeking centrifuge parts in large quantities throughout 2001. In 2002, North Korea sought as many as 2000 aluminum tubes—enough for 4000 G2/P2 centrifuges, or about five weapons per year. However, it is not clear when in 2002 North Korea sought these components, so putting a more precise date than 2002 for the HEU

[^4]: Central Intelligence Agency Nonproliferation Center 2002b
program is not possible. What is not ambiguous, however, is that North Korea did pass the acquisition threshold by kicking out inspectors (December 31, 2002) and withdrawing from the NPT (January 10, 2003). Further escalation, pushing towards nuclear weapons state status, occurred on April 6, 2003, when it stated that it “will have no other option but to beef up the deterrent force for war by mobilizing all the potentials.” At the end of the US–DPRK talks in late April, they announced that they already possessed nuclear weapons, and were reprocessing the plutonium in the 8000 fuel rods. Finally, North Korea announced towards the end of the first six-party talks that it planned to formally declare itself a nuclear power and test a nuclear weapon, leaving it just short of the threshold for nuclear weapons state status (having not yet publicly tested).


4.3.1 The First North Korean Nuclear Crisis

North Korea’s nuclear program in the early 1990s has been well chronicled elsewhere. Here I focus on specific actions taken by the relevant parties and North Korea’s reactions to these actions. In this section, I break up the first crisis into five periods, according to variance in North Korea’s nuclear status: 1) The first negotiations with the US in 1990 until early 1993, 2) North Korea’s withdrawal from the NPT in March of 1993 until its subsequent rejoining in June; 3) nearly a year of back-and-forth negotiation that failed to produce a solution from June 1993 until the DPRK threatened to leave the NPT in March 1994; 4) the peak of the crisis from late March to June of 1994 until North Korea’s agreement to come into compliance with the NPT; and 5) the subsequent bargaining between June and October of 1994. I end with a discussion of the Agreed Framework. Due to a lack of additional nuclear actions, I truncate my analysis here, although bargaining continued through June of 1995.

4. A large military benefit (the announcement of the US withdrawal of nuclear weapons

4 Korean Central News Agency 2003
4 Sanger 2003e
from South Korea) in 1991 paved the way for the North-South Joint Declaration on the Denuclearization of the Korean Peninsula, a signing of IAEA safeguards, and a reciprocal cancellation of the annual US-South Korean military exercises, Team Spirit. However, subsequent deadlock and a showdown with the IAEA over ‘special inspections’ resulted in North Korea announcing its withdrawal from the NPT. Temporary potential social benefits (bilateral talks) and weak military benefits (agreement on a principle of not using military force) got North Korea back to the negotiating table after North Korea’s initial withdrawal from the NPT in 1993 once the US obtained agreement from the IAEA and South Korea. However, the US was unable to hold together this temporary alignment of interests; high-level talks were suspended as both the IAEA and South Korea made demands that threatened North Korea’s social status, causing additional threats to leave the NPT; a US decision to ship Patriot missile batteries to South Korea in early 1994 added a military grievance rather than proving to be a deterrent as intended. However, after once again managing to realign other interested states (Japan, China, Russia, and South Korea) and plying North Korea with a combination of social benefits, potential economic carrots, and credible threats of economic sanctions, the US changed the dynamic of relations with North Korea in June 1994. By demonstrating that it was serious both about taking decisive action and about offering substantial benefits, the US established a pattern that continued throughout the remainder of the crisis: arguments became debates over details of the agreement rather than fundamental issues. The Agreed Framework contained both economic and social benefits; yet the social aspects of the deal (being treated as an equal, maintaining “nuclear state” status, establishing a reciprocal arrangement, obtaining a measure of the US’s good will), which altered North Korea’s social structural position, proved to be crucially important to North Korean acquiescence.

Overall, support for hypotheses is mixed. I find some support for military incentives (H1a), strong support at the height of the crisis for economic incentives and disincentives (H2a/H2b), and moderate to strong support for social incentives (H3a). I also find evidence against military, economic, and social disincentives (H1b/H2b) before the height of the crisis. Domestic politics (H4a/b) played a minor role at best. Positive feedback (H5) was prominent at the height of the crisis, but not at other times. While strategies that focused on
short-term interaction were employed, the crisis lingered on (H6a); once serious negotiation that had the potential to change structural motivations occurred, the crisis ended (H6b). Finally, interactions with other relevant actors (China, Japan, Russia, South Korea, and the IAEA) were very important (H7), since the crisis only ended once the US managed to present a credible threat while aligning the interests of these other parties.

Prelude to Withdrawal: 1990–1992

During the first Bush administration, multilateral efforts were made to bring North Korea into compliance with IAEA standards, since it had already acceded to the NPT but had not yet signed a safeguards agreement. The promise of bilateral talks and the withdrawal of US nuclear weapons from South Korea helped to secure North Korean cooperation, leading to a North-South agreement on denuclearization and a joint nuclear commission. However, problems soon surfaced with the extent of North Korea’s declaration and whether joint US-South Korean military exercises were to continue.

At the end of 1989, several nations called on North Korea to sign an IAEA safeguards agreement but North Korea insisted on demands such as the establishment of a nuclear-free zone (i.e., removal of US nuclear weapons) on the Korean Peninsula, a cessation of the annual joint US-South Korean Team Spirit exercises (began in 1976), and a no-first-use agreement by the United States. North Korean and US representatives met several times in 1990 to discuss security issues, but failed to come to any agreements. Normalization talks with Japan also foundered on the issue of IAEA safeguards. The Soviet Union halted exports of nuclear materials and equipment and work on the light-water reactors by 1991 due to North Korea’s unwillingness to sign a safeguards agreement. However, in June of 1991, North Korea announced that they would finalize the text of the safeguards agreement, since the prospect of bilateral talks with the United States had emerged. The agreement was finalized and initialed in July, but not signed or ratified.

President Bush announced the removal of all US tactical nuclear weapons from South
Korea on September 27, 1991. North Korea agreed to sign the safeguards agreement after all weapons were removed, but began simultaneously covering up its nuclear waste storage facilities. North and South Korea signed a non-aggression pact on December 12 and a “Joint Declaration on the Denuclearization of the Korean Peninsula.” In January 1992, the United States and South Korea announced cancellation of Team Spirit, and North Korea signed the IAEA safeguards agreement at the end of the month (although it was not ratified until April 1992). The first high-level talks between the United States and North Korea were held on January 21.

In March, the United States informed North Korea that sanctions would be imposed if they did not allow inspections by a deadline of June. The same month, North and South Korea agreed to hold joint inspections and held the first meeting of the Joint Nuclear Control Commission (JNCC) set up by the denuclearization agreement. In May, North Korea submitted a 150-page initial declaration of nuclear facilities and materials to the IAEA; the first inspections occurred at the end of the month. The six IAEA inspections that occurred between the initial declaration and February 1993 raised suspicions over the concealment of nuclear waste at the Yongbyon facility, additional unreported facilities, and the misreporting of the number of times and amount of plutonium that was reprocessed. Throughout the remainder of 1992, additional meetings of the JNCC failed to produce an agreement on joint inspections, although the United States expressed a willingness to allow inspections of its bases. At the end of 1992, a stalemate existed in which North Korea threatened to halt all inspections if Team Spirit wasn’t canceled, while the United States and South Korea insisted on additional inspections before canceling Team Spirit for the next year.

The prospect of social incentives (bilateral talks) with the United States pushed North Korea towards signing an agreement with the IAEA during the first Bush administration;
the announcement of withdrawal of nuclear weapons (a major military incentive) from the peninsula along with the cancellation of Team Spirit created additional goodwill and led to the resumption of North-South ties and the Denuclearization Agreement. However, the meeting with the United States and the cancellation of Team Spirit were only one-shot affair, and so had no permanent impact on North Korea; without verification, North Korea’s suspicions about the continued presence of US nuclear weapons could not be assuaged. The threat of economic sanctions in March 1992 may have helped spur on North Korea’s initial declaration.

**Early Withdrawal: January–June 1993**

North Korea’s withdrawal from the NPT on March 12, 1993, had been preceded by months of arguing with the IAEA over inspection of two undeclared but suspected nuclear waste sites, as well as frequent demands by North Korea to suspend the annual Team Spirit joint military exercise between South Korea and the United States. These two issues had been linked by both North and South Korea; North Korea threatened to withdraw from the JNCC and IAEA inspections if Team Spirit was not canceled by December 1992, while South Korea (backed by the United States) demanded that the JNCC conduct inspections before canceling Team Spirit for 1993. In January, North Korea argued that the IAEA could not inspect the two facilities in question, warning that it might jeopardize its supreme interests, language that reflected the NPT’s withdrawal clause. South Korea formally notified North Korea on January 25 that Team Spirit would continue as previously planned, and North Korea warned that it would have to cut off access by the IAEA to nuclear facilities as a result.

In February, the IAEA’s sixth inspection team was denied access to the two suspected sites, and IAEA Director Hans Blix formally asked for a “special inspection,” the first in the IAEA’s history. After being denied, the IAEA passed a resolution demanding access to the two sites in question by March 25, with a threat to send the matter to the
Security Council for sanctions if North Korea did not comply. On March 9, Team Spirit began. These combined pressures left North Korea with no way of backing down without revealing their previous concealment of plutonium; on March 12, North Korea withdrew from the NPT, moving over the threshold from nuclear hedging to nuclear acquisition. With North Korea’s withdrawal from the NPT, what had been a disagreement became a crisis. The IAEA (ineffectively) extended the deadline for compliance to March 31. Japan, South Korea, and the United States expressed support for bringing the issue to the Security Council and imposing sanctions, while China opposed any international sanctions on North Korea due to the lack of punitive measures called for by the treaty itself. North Korea reacted strongly to the idea that sanctions could be imposed. The IAEA voted to send the issue to the Security Council, over Chinese and Libyan objections. Due to China’s veto, the UN Security Council simply expressed concern over the nuclear situation on April 8.

Japan offered bilateral talks, but North Korea refused, insisting upon bilateral talks with the United States. Meanwhile, the IAEA began backing off, acquiescing to more limited inspections of North Korean nuclear facilities. North Korea then agreed on May 1 to allow an inspection team to carry out maintenance work on safeguard equipment on May 10. Simultaneously, South Korea offered to drop its opposition to US–DPRK talks if China would not veto a (sanctionless) UN Security Council resolution on North Korea.

On May 3, North Korea set out its conditions for rejoining the NPT, including a no-first-use guarantee and verification of the withdrawal of all nuclear weapons by the United States from South Korea. US and DPRK representatives met in Beijing two days later as a precursor to higher-level bilateral talks which were to start on June 2. The proposed UNSC resolution (without a sanctions clause) finally passed on May 11. The same day, however,

US Deputy Secretary of Defense William Perry announced that the United States would not consider reductions of troops until the DPRK rejoined the NPT. While North Korea voiced its objections to the UNSC resolution, it continued to pursue diplomatic avenues for reconciliation.

Prior to the beginning of negotiations, officials at the State Department separately commented that it had not ruled out sanctions, and that the United States would be willing to address legitimate security concerns that North Korea had. After four rounds of talks, on June 11, a joint statement was made by the North Korean and US delegations agreeing to continued dialogue and US security assurances. In exchange, North Korea suspended its withdrawal from the NPT. The next day, the US made an additional unilateral statement saying that it would regard additional reprocessing, a break in the continuity of safeguards, or withdrawal from the NPT as inconsistent with US efforts to resolve the nuclear issue. These standards later became important “red lines” in US-DPRK relations.

The IAEA (and especially its director Hans Blix), having been embarrassed in Iraq, took a hard line towards North Korea and refused to compromise, threatening to refer the DPRK to the UN Security Council for sanctions. Simultaneously, South Korea’s unwillingness to cancel Team Spirit for a second year in a row without inspection of the same two sites that the IAEA wanted to inspect gave North Korea additional justifications. Both military and social threats preceded North Korea’s decision to step over the line. While the Team Spirit exercises may have seemed relatively routine and innocuous to South Korea and the United States, North Korea took them very seriously, mobilizing its army each time the exercises were carried out. North Korea claimed that the Team Spirit exercises were a prelude to an invasion, while the hard line that the IAEA and South Korea were taking with respect to inspections didn’t leave North Korea any ability to ‘save face’ since it would have been caught lying about its plutonium extraction. The threat of economic sanctions was an unlikely cause of withdrawal, since with China on the Security Council, the probability of sanctions was low without multilateral support. Yet this does not explain why North Korea

71 South Korean News Agency (Seoul) 1993c.
73 Sigal 1998, 64.
74 On the importance of “saving face” and this particular decision, see Mazarr 1995b and Oberdorfer 2001.
chose to take this step in 1993 as opposed to any other year; it seems likely that although the military threat contributed, it was the social implications of being caught lying and losing face that made North Korea decide to adopt brinkmanship as an option. Consequently, these events offer evidence against military and social disincentives, and to a lesser extent against economic disincentives.

A combination of several elements enabled the deal with North Korea to return to the NPT. A complex multi-party deal was struck (China agreed not to veto a UNSC resolution on North Korea in exchange for South Korea’s acquiescence to the United States conducting bilateral talks with North Korea). This opened up a bargaining space which was then exploited by the United States, which offered social and military benefits (bilateral talks that would treat North Korea as an equal; a willingness to address security concerns), while keeping the threat of disincentives (the possibility for future economic sanctions). Along with the IAEA’s retreat on inspections, these tactics managed to get North Korea to suspend its withdrawal from the NPT.

The intrinsic value of the social benefits of simply being able to participate high-level talks with the United States—a consistent theme throughout both crises—became apparent when North Korea rejected bilateral talks with Japan during this part of the crisis and demanded talks with the United States instead. In fact, the only concessions made by the United States in exchange for the suspension were an agreement to high-level talks (a social benefit) and a (non-binding) military agreement to the principle of “assurances against the threat and use of force, including nuclear weapons.” Against North Korea. Economic sanctions were not mentioned in the joint statement. It is unclear how effective (additional) economic sanctions against the DPRK would have been in any case, unless applied multilaterally, since the United States had no less than five different sets of sanctions on North Korea already in place. Without Chinese support, such threats had no effect other than to incite backlash from the DPRK. These events thus support military and social benefits and a small amount of support for economic disincentives.
Waiting for Results: June 1993–March 1994

From June 1993 to March 1994, multi-party interactions continued. The IAEA variously pushed for additional inspections or acquiesced to whatever North Korea was willing to give them; South Korea demanded off and on to have talks with North Korea as a precondition for high-level US-North Korean talks; China continued to refuse to allow any resolution that included sanctions pass the UNSC; Team Spirit was continually up for grabs, being scheduled, postponed, canceled, and rescheduled. North Korea threatened to leave the NPT again whenever South Korean dialogue became an issue, the IAEA rejected a deal bartered by the United States, or Team Spirit seemed ready to go ahead. The deployment of Patriot missiles became a potent issue, first with North Korea becoming incensed over their deployment, then with South Korea demanding their deployment once the United States began considering them more of a liability than an asset.

The June 11 agreement was far from the end of the crisis. North Korea refused to negotiate with the IAEA until after talks with US scheduled for mid-July had ended\textsuperscript{77} At the conclusion of the talks, a joint statement was released which promised to explore replacement of the proliferation-prone gas-graphite reactors North Korea currently had\textsuperscript{78} Meanwhile, South Korea continued to threaten North Korea with a possible imposition of sanctions by the United Nations\textsuperscript{79} IAEA inspectors returned to North Korea on August 3, but again were not allowed to visit the two suspected nuclear waste sites\textsuperscript{80} South Korea attempted to hold out an olive branch and propose resuming the JNCC talks, which North Korea rejected (unless Team Spirit were to be cancelled)\textsuperscript{81} The US, in turn, told North Korea in mid-September that it would not resume high-level bilateral talks until North Korea resumed dialogue with both South Korea and the IAEA (working-level talks had continued in the meantime). In response, North Korea threatened to withdraw again from the NPT on September 22\textsuperscript{82} At the general meeting of the IAEA on September 27, Blix put North Korea’s refusal to

\textsuperscript{77} South Korean News Agency (Seoul) 1993a
\textsuperscript{78} DPRK/USA 1993.
\textsuperscript{79} Japan Economic Newswire 1993i
\textsuperscript{80} Japan Economic Newswire 1993b
\textsuperscript{81} Agence France Presse 1993a
\textsuperscript{82} Associated Press 1993.
allow inspections at the top of the IAEA’s agenda; meanwhile, the commander of U.S. and allied forces in South Korea warned North Korea against developing nuclear weapons. In response, North Korea accused the IAEA of not being impartial. The IAEA then passed a resolution calling upon North Korea to cooperate, which was duly rejected by North Korea, which again emphasized the need for bilateral talks with the United States. Blix warned that assurance that North Korea was not diverting nuclear materials was diminishing. However, on October 2, North Korea proposed working-level talks with South Korea. The US held secret talks with North Korea on October 19, offering diplomatic recognition and the suspension of Team Spirit if North Korea accepted IAEA inspections before the end of October. On October 25, the nuclear monitoring equipment in North Korea ran out of film.

South Korea denied two days later that there were discussions with the United States regarding canceling Team Spirit (they later agreed in a November meeting to postpone the decision). the IAEA moved back towards its previous hard-line policy on November 2 by refusing to send an inspection team unless North Korea permitted inspections of all sites and the next day Secretary of Defense Les Aspin added back two requirements for further talks with North Korea: opening the two suspect sites and opening dialogue with South Korea. North Korea counter-offered on November 11 with a ‘package deal’ that excluded South Korean dialogue; South Korea rejected it the next day. However, the United States and South Korea agreed privately on an unspecified ‘new approach’ towards North Korea on the 23rd. North Korea threatened to leave the NPT again on November 29.

North Korea’s threat on November 29 was followed by releasing a new list of six demands on December 2. the same day, Blix warned that the IAEA’s ability to confirm

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83 Agence France Presse 1993e
84 Hibbs 1993c
85 Agence France Presse 1993b
86 Agence France Presse 1993c
87 Japan Economic Newswire 1993c
88 Japan Economic Newswire 1993h
89 Lewis 1993
90 Japan Economic Newswire 1993a
91 Agence France Presse 1993d
92 Burns 1993
93 United Press International 1993b
94 United Press International 1993a
North Korean compliance continues to degrade. North Korea agreed the next day to allow
the IAEA to replace film and batteries in the cameras.\textsuperscript{95} However, this offer was rejected
by the United States and the IAEA as inadequate. Meetings continued between US and
North Korea in which the United States demanded access for the IAEA at the two suspect
facilities, and North Korea insisted upon the United States accepting its previous limited
offer. On December 27, the United States escalated by announcing that it would seek in-
ternational economic sanctions if North Korea continued to refuse access by the IAEA to
all of its facilities.\textsuperscript{96} However, talks continued, and an agreement was announced between
the DPRK and the United States in early January 1994 on inspections to maintain continui-
ty of safeguards. However, the IAEA rejected one-time inspections as unacceptable, and
the United States denied making such a concession without consultation with the IAEA.\textsuperscript{97}
Despite several working-level bilateral discussions, no agreement was reached.

Talk of potential economic sanctions continued to circulate without raising the usual
amount of North Korean ire. However, the announcement on January 26 that Patriot mis-
siles would be deployed in South Korea escalated the conflict further, which was promptly
protested by North Korea, who \textit{threatened again five days later that they might withdraw from the NPT},
warning that it was prepared to renege on all promises if the deployment continued.\textsuperscript{98}

The next day, the U.S. Senate called on the Clinton administration to take a more ag-
gressive stance towards North Korea.\textsuperscript{99} The DPRK responded the following day by stating
that it would not accept any pressure tactics from Washington\textsuperscript{100} then followed up the next
day by officially informing the IAEA that it rejected nuclear safeguards inspections.

The US then appealed to China to put added pressure on North Korea, warning that
the other permanent members of the Security Council would press for economic sanctions
if North Korea did not cooperate.\textsuperscript{101} North Korea responded on February 12 by claiming
that sanctions would viewed as a declaration of war (a frequent North Korean theme), but

\textsuperscript{95} Hibbs 1993b
\textsuperscript{96} Schweid 1993a
\textsuperscript{97} Greenhouse 1994b
\textsuperscript{98} United Press International 1994a
\textsuperscript{99} Abrams 1994
\textsuperscript{100} United Press International 1994b
\textsuperscript{101} Lewis 1994c
agreed to allow IAEA inspectors to inspect the seven already-declared nuclear facilities. However, North Korea refused to issue visas to the IAEA inspectors until a third round of high-level talks was scheduled, then added the demand that the annual Team Spirit exercise must be officially suspended, which then led the United States to break off the talks again on the 24th, yet on the 26th, the United States and North Korea agreed that inspections would begin on the first of March, while the third round of high-level talks would begin on March 21. On March 2, the United States and South Korea announced cancellation of Team Spirit, and the inspectors arrived on March 3.

However, since South Korea insisted on North-South talks being part of the deal, the high-level talks were postponed the IAEA inspectors left on the 15th without having been able to inspect all seven sites fully, after which the United States canceled the talks and resumed planning for Team Spirit. On March 19, a North Korean representative remarked in a meeting at the DMZ that Seoul could be turned into a “sea of fire,” which three days later caused the South Korean military to be placed on high alert. Two days later after the sea of fire remark, North Korea again threatened to pull out of the NPT if the IAEA were to refer the North Korean issue to the Security Council and Team Spirit were to go as planned.

Of the four threats to leave the NPT between June 1993 and March 1994, two offer evidence against hypothesis H3b (Social Disincentives), two H1b (Military Disincentives), and one H2b (Economic Disincentives). The first threat came after a refusal by the United States to resume high-level talks; the second after the United States demanded inspections of the two suspect sites and for North Korea to talk to South Korea; the third is after the announced deployment of Patriot missiles; and the fourth is after the United States decided to ask the UN to prepare economic sanctions and the resumption of Team Spirit. The
first two are reactions after social sanctions were threatened (canceling high-level talks; inspections of the sites that would cause North Korea to lose face), the third after a military threat (the Patriots), and the fourth after a combination of an economic sanctions threat and the resumption of Team Spirit. Although the Patriot missile batteries would have decreased North Korea’s military ability to threaten South Korea, it is not clear how much of an offensive military threat they would have posed. Again, with China blocking economic sanctions, evidence against H2a (Economic Disincentives) exists, but is not very strong. The one positive nuclear move (allowing IAEA inspectors) came after a promise to suspend Team Spirit and for high-level talks to begin, supporting H3a (Social Incentives) and H1a (Military Incentives).

**Deterrence: March–June 1994**

During the height of the crisis, North Korea repeatedly threatened to leave the NPT while first warning of, then carrying out, the discharge of fuel rods from their nuclear reactor. However, North Korea never stepped over the ‘red lines’ that the United States had set nearly a year before: reprocessing, safeguards, and NPT membership. The US successfully managed to put together a consensus on action against the DPRK and followed through on its earlier threats to cancel talks if any of the red lines were violated. This led to North Korean acquiescence once former president Jimmy Carter traveled to North Korea to present a deal to North Korean president Kim Il Sung.

The same day that North Korea made its threat to pull out of the NPT, Clinton announced that the Patriot missiles would arrive in South Korea in about 30 days, and the United States presented a draft resolution to the Security Council calling for North Korea to accept additional inspections (but without including sanctions). On March 29, China objected to the part of the resolution suggesting that the Security Council would take further action if the inspections did not occur; a version without this clause was issued as a UNSC presidential statement on the 31st. Two days later, Secretary of Defense William Perry stated that North Korea was lying about its nuclear program, and mentioned that direct
military action was still an option with dealing with North Korea\[113\] The next day, North Korea condemned the UN resolution\[114\] These negative reactions were then balanced by positive steps. On April 15, South Korea withdrew its demand for an exchange of special envoys as a precondition for high-level US-North Korean talks\[115\] on April 20, Perry announced that Team Spirit would be postponed until at least November\[116\] However, these concessions were too late and had no apparent effect; North Korea announced on April 19 that it would be shortly be refueling its reactor, while refusing to let the IAEA sample the removed rods\[117\]

On May 2, the United States announced that they would abort all talks if North Korea removed the fuel rods without IAEA inspectors\[118\] the IAEA followed the next day, saying that it would be compelled to take the issue to the Security Council\[119\] On May 3rd, North Korea rejected the IAEA’s demand\[120\] Working talks continued with the United States nonetheless, although the United States threatened again to break off all talks\[121\] North Korea announced on May 12 that they would begin discharging the reactor immediately, and began removing the rods on the 14th\[122\]

The next day, the Clinton administration threatened to seek sanctions if North Korea removed the fuel from the rods in accordance with the “red lines” set almost a year before; Perry declared the situation to be a crisis two days later\[123\] IAEA inspectors were allowed to complete inspections of the plutonium reprocessing plant and replace film and batteries on monitoring equipment, then reported that fuel was being removed from the reactor, but was not being diverted\[124\] Since North Korea wasn’t diverting the fuel, the United States decided to resume high-level talks on the 20th\[125\] while the IAEA sent a second team to
discuss implementation of safeguards on the 24th; however, North Korea rejected IAEA and US demands to set aside 300 rods for sampling later. By the 27th, North Korea had removed almost half of the fuel in the reactor core without tracking the location of the rods, partially destroying the past history of burnup in the reactor core. The UNSC passed a resolution on the 30th also urging that rods be set aside. The next day, Blix announced that North Korea was no longer officially in compliance with safeguards due to the removal of too many fuel rods without sampling. On June 2nd, IAEA inspectors stated that they could no longer verify that North Korea had not diverted plutonium.

The same day, Russia warned North Korea that it could not expect protection from sanctions or war. The next day, North Korea reiterated that it would view economic sanctions as a declaration of war. On the 4th, The US, Japan, and South Korea called on the Council to urgently consider economic sanctions, while North Korea threatened again on the 5th to leave the NPT.

North Korea then backed down, claiming that the rods could still be measured, and offered to guarantee IAEA inspections in exchange for a third round of bilateral talks. However, the United States replied on the 8th that North Korea had passed the “point of no return” due to North Korea’s destruction of the evidence necessary to determine whether spent fuel had been diverted. The same day, South Korea came out in favor of economic sanctions, despite the potential ramifications of such a move. Two days later, North Korea announced they had finished discharging the fuel rods, Russia agreed to cooperate on a resolution calling for economic sanctions, and the IAEA suspended technical aid to North Korea; China also warned North Korea that they might not be able to veto a sanctions resolution in the Security Council.

Assistant Secretary of State Robert Gallucci threatened
on the 12th to implement escalating sanctions. On the 13th, North Korea withdrew from the IAEA, and reiterated that sanctions would be viewed as a declaration of war.

Two days later, the United States presented the four other permanent members of the Security Council with a resolution calling for sanctions on North Korea. However, Russia reversed its position the next day on sanctions since the United States had failed to consult with Russia sufficiently before presenting the resolution. On the 16th, North Korea again threatened to leave the NPT.

During the same period of time, a second diplomatic track opened. On June 9th, former President Jimmy Carter announced the next day that he would travel to North Korea. He arrived on June 15th; the next day, he met with President Kim Il Sung, who agreed to allow IAEA inspectors to remain at the reactor and to allow upkeep of monitoring equipment. However, North Korea had already been backing down; Carter’s trip simply just sealed the deal after Kim elected to have the more prestigious Carter visit instead of the two US Senators that the Clinton administration was prepared to send. US safeguards experts also proposed alternative techniques to measure the plutonium in the 8000 fuel rods that had been withdrawn from the Yongbyon reactor, and Clinton announced the United States’ willingness to reopen high-level talks if the nuclear weapons program was frozen. On the 23rd, North Korea not only announced that it would comply with its NPT obligations, but would freeze its entire nuclear program.

Once North Korea realized that it would not get support from at least one of its patrons (Russia) in early June, it started backing down, but did not go sufficiently far to placate the United States. Once it became clear that South Korea was willing to suffer the consequences of sanctions and that North Korea would not receive any support from China, either, North Korea began looking for a way out. The US carried through effectively with
its threats: once North Korea refused to set aside a sufficient number of rods, they aborted the talks. However, the success of this deterrent depended upon successful US diplomacy with the other involved parties; by getting China, Russia and South Korea on board, the deterrent threat became credible to implement, since North Korea could no longer expect to escape the sanctions through threatening South Korea or circumventing the sanctions through Chinese and Russian support. North Korea escalated by threatening to leave the NPT every time that sanctions were threatened; however, once it became clear that sanctions would actually be implemented, they backed down. By having a way to save face through former President Jimmy Carter’s visit to North Korea, North Korea was able to take advantage of the offered social benefits instead of having to suffer the highly probable economic sanction, supporting hypothesis H2b (Economic Disincentives); additionally, the positive response of North Korea to Jimmy Carter’s visit and the North Koreans’ willingness to freeze its nuclear program in exchange for the United States suspending its sanctions drive and high-level talks lends additional support to H3a (Social Incentives). Finally, hypothesis H5 (Positive Feedback) is supported by the reciprocation of threats and accusations between North Korea and the United States in the month before Carter’s visit. Neither military hypothesis (H1a/b) is strongly supported; military threats (such as Perry’s comments) did not seem to provoke a particular reaction from North Korea, although they could have contributed to North Korea’s decision, lending some support to H1b (Military Disincentives).

**Bargaining: June–October 1994**

In the bargaining that followed the June climax to the crisis, the United States continued to successfully keep third parties (primarily the IAEA and South Korea) in line with promises to respect their interests while negotiating with North Korea. It is unclear whether the military threat posed by the US carrier battle group that was moved during this phase actually improved the US bargaining position, but it did not have the negative effect that such moves had had in the past. Otherwise, reciprocal positive social and material moves continued between North Korea and the United States, concluding with the signing of the Agreed Framework and the verification of the freeze of North Korea’s nuclear program.
The day after North Korea announced that it would freeze its nuclear program, a low-level working group met and settled on an agenda and a date (July 8) for further talks.\footnote{145} South Korea announced three days later that a presidential summit would occur between the two Koreas on the 25th of July.\footnote{146} The opening day of talks with the United States, Kim Il Sung died; negotiations were postponed until the 5th of August, and the presidential summit with South Korea was indefinitely postponed.\footnote{147} On July 11, North Korea announced that IAEA inspectors would remain, the fuel rods would not be reprocessed, and the reactor would not be refueled, in accordance with the United States’ three red lines.\footnote{148} The US Senate passed an amendment four days later to prohibit aid to North Korea unless the president certified that North Korea was not seeking nuclear weapons, a move that later became an impediment to implementation of the Agreed Framework.\footnote{149} The third round of high-level talks finally occurred from August 5-12; by the end of the meeting, the basic outline of the Agreed Framework was in place and was codified as an Agreed Statement, as was an agreement to meet again on September 23.\footnote{150} However, disputes still remained over the timing of the inspection of the two suspect nuclear waste sites. On August 18, the White House announced that inspections would be required before light water reactor parts would be supplied; this demand was rejected two days later by North Korea.\footnote{151}

South Korea insisted on playing a larger role in the crisis on September 6, and was assured by the United States that the resumption of substantive dialogue with North Korea would be a requirement of any deal.\footnote{152} Working-level talks with the United States on the 10th were followed by North Korea expressing a willingness to work with the IAEA, whose personnel had recently been permitted to inspect two additional facilities.\footnote{153} The IAEA then reported that inspections in March and May 1994 had indicated that no reprocessing had taken place recently in those facilities.\footnote{154}
The locus of the disputes then shifted to who would supply the reactors to North Korea; while North Korea insisted upon being able to choose a supplier, the countries paying for the reactor insisted upon choosing the suppliers. A US carrier battle group was deployed to the Sea of Japan on September 22, a day before the second session of the third round of talks began in Geneva, in order to bolster the United States’ bargaining position. After a brief suspension at the end of the month, talks resumed on October 5. North Korea warned South Korea and the IAEA not to add additional requirements to the talks; two days later, South Korea’s president criticized the US approach to negotiations. The US sent a draft compromise five days later that did not contain South Korea’s demand for special inspections of the two sites before nuclear technology would be supplied; however, the United States privately assured South Korea that their position would be defended in any eventual agreement.

The Agreed Framework was signed on October 21. Its key provisions included an international consortium that would replace North Korea’s graphite reactors with light water models, provision of 500,000 tons of heavy fuel oil annually until the reactors came online, efforts to normalize economic and political relations, canning of the 8000 fuel rods withdrawn from the reactor (with North Korea to remaining in possession), IAEA monitoring of the freeze, and North Korea’s continued membership of the NPT. In parallel, the United States and South Korea announced suspension of Team Spirit. On November 1, North Korea ordered the cessation of construction of their 50 MWe and 200 MWe reactors, operations at the 5 MWe reactor, and operations at other nuclear facilities; IAEA inspectors verified these actions on November 23.

At first glance, the Agreed Framework would seem to be primarily about exchanges of economic goods: two light water reactors and monthly supplies of fuel oil in exchange for a nuclear weapons program. Yet each of the elements of the Agreed Framework vindicates the perspective that social benefits were just as, if not more important than, the economic
During the negotiations, the Clinton administration repeatedly offered fossil-fuel based energy plants of equivalent or greater power that could be built more quickly and would be more compatible with North Korea’s shaky electric grid, yet North Korea insisted upon nuclear technology, since they wanted to be seen as a modern nuclear state. The fuel oil was more symbolic than anything else; it provided about 2.5% of North Korea’s total energy consumption. Instead, North Korea used the frequency of deliveries of fuel oil as a symbolic measurement of the US commitment to the Agreed Framework. Frequent complaints about the lateness of deliveries were due to this symbolic nature; since North Korea buffered the supply of fuel oil, late deliveries did not actually affect power generation, but rather just relations between the United States and the DPRK (North Korea has storage approximately equal to the amount shipped every year; at the end of 2001, this reserve was nearly full). The prospective lifting of economic sanctions would have been worth little, at least initially; the sanctions had existed for so long that North Korea had structurally adapted to these sanctions. Moreover, North Korea had little to offer the United States in terms of trade. The normalization of political relations had been important to North Korea throughout the crisis, and in fact constituted North Korea’s major short-term demand; North Korea attached intrinsic value to being treated as an equal by the United States, and formalizing such social relations had become a major goal. Finally, the Agreed Framework held that the United States would provide “formal assurances to the DPRK against the threat or use of nuclear weapons by the United States.” While this is a stronger statement than the nuclear guarantee given the year before, it still falls short of a formalized treaty; furthermore, without any kind of confidence-building measures that increase transparency, it fails to make military conquest any more difficult.

The events surrounding bargaining during this period (and the Agreed Framework itself) supported several hypotheses. The reciprocal positive actions taken by both sides led to the freezing of North Korea’s plutonium program, and support hypothesis H5 (Positive

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162 Interviews with Bill Perry and John Lewis confirmed the symbolic nature of many of the provisions of the Agreed Framework. Lewis 2004; Perry 2004.
163 Manyin and Jun 2003.
Feedback). The offer of economic and social goods that constituted the Agreed Framework supports both hypotheses H2a (Economic Incentives) and H3a (Social Incentives), and more weakly H1a (Military Incentives).

Summary

Of all the hypotheses, H3a (Social Incentives) has the most support during the first crisis. The initial decision to leave the NPT in order to save face and the decision to suspend withdrawal once high-level talks were offered were both related to social actions. Half of North Korea’s threats to leave the NPT followed negative social actions (offering evidence against H3b, Social Disincentives), while positive moves (such as letting in IAEA inspectors) followed positive social moves. The combination of a visit by a prestigious actor (Carter), plus a return to high-level talks were related to the initial freeze of North Korea’s nuclear program. Finally, the terms of the Agreed Framework itself were heavily laden with social benefits regarding international status and direct relations with the United States.

Hypothesis H2b (Economic Disincentives) was supported primarily by the events during the height of the crisis, when for the first time economic sanctions became a real possibility, although previously in the crisis there was significant evidence against it. Hypothesis H2a (Economic Incentives) was also supported by the Agreed Framework terms. Hypothesis H1a (Military Incentives) seemed primarily relevant in terms of Team Spirit; whenever it was cancelled, the North Koreans responded well; whenever it was rescheduled, they protested loudly. Additionally, the Patriot missiles turned out to provoke a negative reaction instead of being a deterrent as intended, providing further evidence against H1b (Military Disincentives). Assurances that the United States would not use nuclear weapons were also valued, although the actual military value of such assurances is doubtful.

Domestic politics (H4a/b) seemed to play a minor role, although due to a lack of North Korean openness, it is difficult to tell whether actions were influenced by changing balances of power between different groups within North Korea. Up until the Agreed Framework, the Clinton administration was relatively free to pursue its goals; however, shortly after the Framework was signed, control of both the House and the Senate passed into opposition hands, placing severe constraints on the administration (however, this falls outside the time
periods covered in this study.)

There is also the question as to whether interaction (H6a) or structure (H6b) played a greater role. Although interactions throughout the crisis were linked with nuclear moves by North Korea, the crisis did not reach a stable state until the United States offered significant benefits that, given time, would alter North Korea’s social position in the international system through obtaining US diplomatic recognition, thereby not being treated as a marginalized state any longer. So while interaction was important in terms of short-term nuclear actions, a longer-term freeze required significant alteration to North Korea’s social position. The economic benefits, by contrast, were unlikely to be significant enough to alter North Korea’s overall economic position.

Finally, there was significant support for hypothesis H7 (Multiparty Interaction). Without Chinese, Russian, and South Korean support, the threat of sanctions would not have been nearly as effective. Additionally, demands by South Korea or the IAEA on North Korea frequently exacerbated the crisis.

4.3.2 The Second North Korean Nuclear Crisis

I discuss the second nuclear crisis in a slightly different manner from the first, in part because a definitive account of this crisis has yet to be published. Although the actual crisis did not begin until October of 2002, I argue that the actions of the Bush administration prior to that date were crucial to establishing the patterns that played out in the crisis. I divide my analysis into three parts: The first twelve months, during which the Bush administration first conducted a comprehensive review of North Korean policy, then attempted to widen the scope of talks with North Korea to include other issues; the period from the inclusion of North Korea in the “axis of evil” until the proper beginning of the crisis in October 2002; and the crisis itself, until it reached an equilibrium in May of 2003. For each of the first two parts, nuclear moves with clear dates are relatively rare, although the evidence that does exist in public accounts does indicate that the North Koreans accelerated their HEU program during this time. Consequently, instead of tracking nuclear actions, I track changes in North Korean discourse as a function of US policies in order to trace how North

Korean responses to US statements and actions during this period.

The deterioration of the US–DPRK relationship began in early 2001, when the social benefits (in particular, high-level talks) that had been granted the North Korean government by the Clinton administration through the Agreed Framework were severely decreased. Upon entering into office, the administration cut off these high-level ties until they formulated a comprehensive plan for dealing with the DPRK, increasing North Korean suspicions as to US intentions. Later demands for a widened agenda to include conventional weapons and humanitarian issues led North Korea to reject further talks. The inclusion of North Korea in the “Axis of Evil,” the Nuclear Posture Review, and the National Security Strategy in 2002 then led North Korea to invert its responses from reciprocation of actions (positive or negative) to continual rejection. Subsequent overtures by the Bush administration to talk and attempts to deter North Korean action were consequently met with continued rejection and further acceleration of North Korea’s nuclear program. Attempted military deterrence in the form of sending bombers to Guam and repositioning US forces failed to alter North Korea’s trajectory; attempted economic sanctions without aligning other parties to the conflict also failed, leading to a nuclear stalemate, with North Korea remaining just at the nuclear weapons state threshold, having declared its possession of nuclear weapons but not having tested.

Like the first crisis, support for hypotheses is again mixed. I find some mostly evidence against hypotheses formerly supported; in particular, military, and economic disincentives (H1b/H2b) were both ineffective during the period (October 2002–May 2003) in which the Bush administration attempted to employ these strategies. Domestic politics (H4a/b) again played a minor role at best. Positive feedback (H5) was prominent throughout, although with different effects during different parts of the crisis; insults were repeatedly traded before the onset of the actual crisis, while during the actual crisis it primarily took the form of escalating military and economic moves: while the United States made threats of economic sanctions and implied military moves, North Korea ramped up its production of fissile materials and made vague threats of retaliation. The shift in the US-North Korean social relationship appeared to motivate the North Korean shift in strategies, implying that structural motivations (H6b) were at work. Finally, interactions with other relevant actors
(H7) played little role due to the determination of both the United States and North Korea not to negotiate.

**The Calm before the Storm: January 2001–January 2002**

The new administration expressed doubt very quickly both about the Agreed Framework and North Korea itself, freezing ties with North Korea while they completed a policy review. At the same time, multinational efforts were also in disarray, although these problems were inherited from the Clinton administration. Although no military or economic threats were made by the Bush administration during the first twelve months, several social snubs were made with respect to both North and South Korea, which led to corresponding complaints by North Korea, collateral damage with respect to North-South relations, and increased suspicion among the North Koreans as to the intentions of the Bush administration. In particular, personal statements made about Kim Jong Il led to increased North Korean suspicions. Since relations were at a positive peak with North Korea at the end of the Clinton administration, it is possible that the development of the HEU program cited by the CIA was more closely connected with the early statements of the Bush administration regarding North Korea. Although these events cannot be directly connected to US policy, the timing is suggestive.

Once the policy review was completed, the United States sought to resume talks with North Korea with an expanded agenda to include troop deployments. At the same time, North Korea began demanding compensation for lost electricity due to the delayed completion of the nuclear power plants under the Agreed Framework. While the two sides were at loggerheads, North Korea’s HEU program continued to develop.

The Agreed Framework was already in trouble when the Bush administration entered office; several potential appointees for the Bush administration were known to be “highly critical of the 1994 deal.”[^166] In particular, both Deputy Secretary of Defense Paul Wolfowitz and National Security Advisor Condoleezza Rice were in favor of a transition to

[^166]: Hibbs, 2000b
thermal energy sources rather than nuclear power plants, despite the previously voiced opposition in March and June 2000 to thermal plants by the South Koreans\textsuperscript{167} the North Korean determination to be seen as a nuclear-capable state, and the opposition of the director-general of the Korean Peninsula Energy Development Organization (KEDO)\textsuperscript{168} Still, the United States continued to suggest thermal plants as a substitute for nuclear technology until late June 2001. Even Secretary of State Colin Powell suggested that the administration might seek to modify the accord\textsuperscript{169} although on other occasions Powell, Assistant Secretary of State for East Asian and Pacific Affairs James Kelly, and State Department spokesman Richard Boucher all said that they expected to fully implement the Agreed Framework. The North Koreans objected to what they saw as a hard-line approach from the very beginning, singling out the “foreign and national security policy team” as the source of this approach; they also objected to the US commitment to a national missile defense “to cope with the ‘missile threat’ from the DPRK, calling it a ‘rogue state.’”\textsuperscript{170}

The Bush administration started a complete policy review on North Korea in January 2001, although various details of the policy leaked out during the process very early on\textsuperscript{171} The central tenet of the new deal that the Bush administration was to offer North Korea was to further expand negotiations to include conventional forces and humanitarian issues as well as missiles and nuclear weapons. Two weeks before the review was finished, another important detail was leaked: the United States would seek to accelerate safeguards inspections\textsuperscript{172}

With the new administration in office, the oppositional stance that Congress had taken against deals with North Korea intensified; in early March, both Democrat and Republican lawmakers delivered letters to the Bush administration asking for a reconsideration of its existing commitment to the Agreed Framework. This mistrust was shared by Bush himself; at a press conference with South Korean president Kim Dae Jung on March 7, Bush said, “I do have some skepticism about the leader of North Korea. We’re not certain as to whether

\textsuperscript{167}Choson Ilbo 2000
\textsuperscript{168}Shin 2001
\textsuperscript{169}Barber 2001
\textsuperscript{170}Korean Central News Agency 2001b
\textsuperscript{171}Japan Economic Newswire 2001b
\textsuperscript{172}Hwang 2001
or not they’re keeping all terms of all agreements.”\textsuperscript{173} Shortly after this comment, the fifth in a series of inter-ministerial talks between North and South Korea were postponed on March 13; this postponement was suspected at the time to have been caused by Bush’s remark.\textsuperscript{174}

By the time that President Bush announced the conclusion of his policy review, most of the relevant details had already been leaked. For several months after the review, administration officials declared that they were ready for talks “without preconditions,” but insisted upon a broadening of the agenda to include conventional arms talks and unspecified “humanitarian issues,” and pushed for early implementation of the IAEA safeguards. In the first official US–DPRK meeting since the Bush administration entered office, Special Envoy Jack Pritchard outlined this new policy and requested a meeting with the North Korean Vice Foreign Minister.\textsuperscript{175}

The North Korean response on June 18 was to continue to insist that the main issue to be discussed between the two sides was compensation for the lack of electricity due to the delay and reactors. North Korea continued throughout the summer to argue that determining the agenda of the talks before meeting was equivalent to putting preconditions on talks, and contrary to equal treatment: “It is the universally recognized elementary requirement that dialogue between sovereign states should be conducted on a fair and equal footing.”\textsuperscript{176}

Additionally, Bush’s criticism of Kim Jong Il continued even after the policy review, calling him “untrustworthy” because “he makes his own people go hungry;”\textsuperscript{177} which prompted further criticism from North Korea reiterating the theme of equality: “The DPRK holds its dignity and sovereignty dearest, and never allows any infringement upon them. It will surely make the U.S. pay for such impudent behavior intended to infringe upon its dignity and sovereignty. If the U.S. wants dialogue with the DPRK, it should approach the dialogue on a fair and equal basis and make a political decision to renounce its hostile
policy toward the DPRK.” Redeployments of aircraft from the USS Kitty Hawk to South Korean air bases prior to deploying the carrier to the Indian Ocean in support of operations in Afghanistan were also met with criticism. This was followed by a vague threat when Bush warned North Korea “not to think that because we happen to be engaged in Afghanistan we will not be prepared and ready to fulfill our end of our agreement with the South Korean government.” He also stated that “I’ve been disappointed in Kim Jong Il not rising to the occasion, being so suspicious, so secretive.” North Korea duly returned the criticism:

“He went the length of speaking ill of its supreme leadership, saying it is too doubtful and shrouded in secrecy and it refuses to keep the promise and he is a person quite not understandable. Putting aside the political motive of his utterance, Bush’s remark cannot but be interpreted as an imprudent statement unbecoming for the president of a “superpower.” It is a senseless attitude away from even elementary diplomatic etiquette for the head of state of the U.S. to speak ill of the leader of other country, who is stranger to him, for no reason. It is universally known that it was none other than Bush who began casting a string of doubts, saying he feels skeptical about the North Korean leader as soon as he assumed the presidential office and it was again his administration which put the DPRK-U.S. dialogue which was under way to a stalemate.”

The escalation of rhetoric on both sides deteriorated relations rapidly. The new administration’s return to the “rogue state” rhetoric of contrasted sharply with the Clinton administration’s rhetoric regarding “states of concern” that had just been introduced the previous June. While the review was under way, official contacts were broken off, which was also seen as suspicious by the North Koreans. The North Koreans saw the “phased access” and “conditional and strict reciprocity” advocated by some members of the Bush
administration as requiring North Korea to act before offering any benefits, as opposed to the simultaneity prescribed by the Agreed Framework. Since the North Koreans saw the ambiguity of the situation created by the postponement of safeguards inspections as an important bargaining chip, and regarded the protocol defining when such inspections could be done as sacrosanct, the new demand to move IAEA inspections forward only increased North Korean suspicions. Ambiguity surrounding the number of fuel rods that had been reprocessed previously was probably their most valuable remaining bargaining chip. Through Bush’s personal criticism of Kim Jong Il, the conflict became personalized and deepened mistrust. Even Bush apparently later admitted that this remark had been a diplomatic misstep; Senator Joseph Biden said in an interview that “Bush ‘was clearly aware’ that his March comments about Kim were ‘a blunder’ and that the president never intended to disrupt relations.”

The end of the policy review and its subsequent announcement further chilled relations with North Korea. The main result of announcing the end of the review was a change in administration attitude, since the North Koreans had already mostly adjusted their expectations to the outcome of the policy review. While North Korea stuck to its original claim that the only widening of talks should be to include compensation for lack of energy, the Bush administration attempted to widen the agenda for talks to include conventional forces, which given previous negative statements by the Bush administration regarding North Korea was interpreted as an attempt to disarm North Korea. Between the diplomatic isolation (“It is noteworthy that the new U.S. administration proposed to resume DPRK-U.S. dialogue which it unilaterally had put under suspension for four months, but we cannot but remain vigilant against its real intention.”) and the renewal of the “rogue state” rhetoric, the North Koreans perceived this as a break with the Clinton administration’s policy of gradual enlargement of the number of issues on which discussions could be made. Instead, they saw the Bush administration’s new policy as a major change, “an attempt of the U.S. to disarm the DPRK through negotiations.” The North Koreans also became more sensitive to other events; for example, the July 14 missile interceptor test by the United States

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185 Arms Control Today 2001
186 Korean Central News Agency 2001d
was roundly criticized\(^{187}\) as was the fourteenth sub-critical nuclear test carried out by the United States at the Nevada test site\(^{188}\) whereas previous tests had received little response.

Military deterrent threats began to appear, although indirect (a missile interceptor test) or vague (threats not to take advantage of the situation in Afghanistan post-9/11). Additional negative social actions by the IAEA to censure North Korea further increased acrimony. The June meeting of the IAEA board of governors opened with IAEA director Mohamed El Baradei calling on North Korea to comply with its request for safeguards inspections. The IAEA then issued a statement that North Korea was still in noncompliance. A repeat performance occurred in mid-September at the 45th IAEA General Conference. Each time, North Korea accused the United States and the IAEA of working together to shift the blame for a lack of progress.

During this period, evidence on the progress HEU program is very vague, and cannot be directly connected to individual actions by the United States. However, the result of the general US policy during this period was to deny the North Koreans the social benefits of high-level talks and to increase North Korean suspicions regarding US intentions significantly, leading to increasingly hostile relations. No overt nuclear moves occurred during this time, although evidence indicates that during the first year of the Bush administration, North Korea accelerated their uranium enrichment program. The CIA reported in its July-December 2001 report on the progress of various proliferators that “The North has been seeking centrifuge-related materials in large quantities to support a uranium enrichment program. It also obtained equipment suitable for use in uranium feed and withdrawal systems.”\(^{189}\) Previous to this report, the CIA had never mentioned any actions related to uranium enrichment technologies; later (November 19, 2002), the CIA reported that “North Korea embarked on the effort to develop a centrifuge-based uranium enrichment program about two years ago,”\(^{190}\) placing the start of the DPRK HEU effort at the end of the Clinton administration or possibly the beginning of the Bush administration.

\(^{187}\) Korean Central News Agency 2001g
\(^{188}\) Korean Central News Agency 2001a
\(^{189}\) Central Intelligence Agency Nonproliferation Center 2001
\(^{190}\) Central Intelligence Agency Nonproliferation Center 2002b
Although direct, overtly discernable nuclear actions were not taken, the general patterns of interaction during this period do demonstrate indirect evidence for and against some hypotheses. The tit-for-tat North Korea replies to negative comments are evidence against hypothesis H3b (Social Disincentives), while the back-and-forth nature of these interchanges supports hypothesis H5 (Positive Feedback). The effects of the vague military threats cannot be determined, however.


Relations continued to worsen through October 2002, as North Korea was identified as a potential target in the Nuclear Posture Review, part of an ‘axis of evil’ in Bush’s state of the union address, and as a ‘rogue state’ in the National Security Strategy. In June, the Bush administration finally attempted to schedule a high-level meeting with North Korea. However, a naval dispute in late June scuttled any chance of talks until October, which were preceded by administration officials briefing allies on evidence that North Korea had been pursuing an HEU program.

An implied nuclear threat was made in the Nuclear Posture Review, leaked on January 8, 2002 to the press; among other “immediate contingencies” it considered was a “North Korean attack on South Korea.” It also noted that “North Korea, Iraq, Iran, Syria, and Libya are among the countries that could be involved in immediate, potential, or unexpected contingencies. All have longstanding hostility toward the United States and its security partners; North Korea and Iraq in particular have been chronic military concerns. All sponsor or harbor terrorists, and all have active WMD and missile programs.” This was followed on January 29 by the State of the Union speech, in which President Bush grouped together Iran, Iraq, and North Korea: “North Korea is a regime arming with missiles and weapons of mass destruction, while starving its citizens.... States like these, and their terrorist allies, constitute an axis of evil, arming to threaten the peace of the world. By seeking weapons of mass destruction, these regimes pose a grave and growing danger.” Some administration officials attempted to temper this statement, saying that the United States was ready
to talk with North Korea. In an uncharacteristically quick response, North Korea issued a statement in response: “There has been no precedent in the modern history of DPRK-US relations that in his policy speech the US President made undisguised threatening remarks on aggression and threat against the DPRK, an independent and sovereign state. This is, in fact, little short of declaring war against the DPRK.”

Other members of the administration, including Rice and Undersecretary of State for Arms Control and International Security John Bolton also criticized North Korea around the same time for conducting covert programs for weapons of mass destruction and missile proliferation. Powell, when testifying before the Senate Foreign Relations Committee, said that Bush’s reference to Iran, Iraq and North Korea as an “axis of evil” was “not a rhetorical flourish—he meant it,” although Powell also stated that the US was not going to invade and was willing to engage in dialogue. Members of the House wrote to President Bush soon afterwards, calling upon him to reconsider implementing the Agreed Framework and later praising him for including North Korea as part of an “axis of evil.” They also introduced legislation to deny funding for KEDO.

North Korea responded through its UN ambassador, repeating the charge that this was equivalent to a declaration of war, but still added that North Korea would still respond in reciprocal ways to both positive and negative signs: “Nice words will be answered by nice words.” This policy of reciprocation was carried out the next day as North Korea accused the United States of being the “empire of devil.” This trading of verbal rebukes tapered off towards the end of February, and real attempts were still made on both sides to resume dialogue. The United States pursued negotiations through China and North Korean and US representatives met twice in March. In April, North Korea resumed negotiations with KEDO. In mid-June, special envoy Jack Pritchard met with North Korea’s UN ambassador.
to seek dates for a high-level US meeting.

On June 29, North and South Korean naval forces exchanged gunfire in disputed waters west of the Korean peninsula, resulting in four deaths and sunk ship on the South Korean side and about 30 deaths on the North Korean side. This brought to a halt diplomatic efforts to arrange a meeting between the United States and North Korea. Efforts to resume dialogue resumed at the end of the month; Colin Powell met unofficially for 15 minutes at the ASEAN Regional Forum with North Korea’s foreign minister. Several statements by North Korea and the United States in August mirrored each other, indicating a temporary thaw and a willingness to abide by the Agreed Framework. However, this was balanced out at the end of August by critiques of North Korea by Bolton during his visits to Tokyo and Seoul that reinvoked the “axis of evil” trope: “President Bush’s use of the term ‘Axis of evil’ to describe Iran, Iraq, and North Korea was more than a rhetorical flourish—it was factually correct.” These statements were duly rejected as “sheer lies” by North Korea soon afterwards. The National Security Strategy, released in September 2002, devoted an entire section to “rogue states,” mentioning explicitly Iraq and North Korea (but Iran only as a victim of aggression from Iraq), and enshrined the doctrine of preventive (called “preemptive”) action.

Mounting evidence of North Korean attempts to acquire capabilities for creating highly enriched uranium led members of the Bush Administration to brief Japan and South Korea on the program. Japanese Prime Minister Junichiro Koizumi subsequently paid a short visit on September 17 to North Korea, but only discussed abductions of Japanese citizens and missile testing; Kim Jong Il promised to maintain its moratorium on testing. At the end of the month, North Korea proposed a “technical consultation” with the IAEA to resolve suspicions.

The severe social sanction represented by the inclusion of North Korea into the “axis of evil” had multiple effects on North Korean behavior. This term became a persistent issue in a way that the older rhetoric of “rogue states” never did; the use of the term “rogue state”
was mentioned relatively infrequently in the KCNA in the past compared to “axis of evil.” Also notable is the reinvigoration of the term after the October 2002 meeting in which the North Koreans were accused of having a highly enriched uranium program. The phrase had several effects on the North Koreans: first, it linked them together with the Iraqis and the Iranians, thus making US policy towards these other countries even more salient than it would have been; second, the phrase itself suggests the necessity of regime change; while a “rogue” or an “outlaw” might be brought back into the international community, an “evil” regime requires removal; third, it could and probably was used by hard-line elements in North Korea as a reason to reject diplomatic solutions.\(^{206}\)

Again, evidence regarding the progress of the HEU program during this period cannot be connected directly to US actions. North Korea sought frequency converters, pure Cobalt, and approximately 2000 6000-grade aluminum tubes. CIA reports for January-July 2002 indicate that “[The United States] did not obtain clear evidence indicating that North Korea had begun constructing a centrifuge facility until recently.... North Korea’s goal appears to be a plant that could produce enough weapons-grade uranium for two or more nuclear weapons per year when fully operational.”\(^{207}\) In general, however, North Korea continued a policy of responding reciprocally to social sanctions, condemning both the “axis of evil” speech and other such comments made by administration officials, but also echoing periodic positive moves by the United States. The tit-for-tat North Korea replies to negative comments are evidence against hypothesis H3b (Social Disincentives), while the back-and-forth nature of these interchanges supports hypothesis H5 (Positive Feedback). However, this reciprocity was about to change.

**The Downward Spiral: October 2002–June 2003**

After the October 2002 meeting (in which the United States accused North Korea of having a highly enriched uranium program), dynamics between the United States and North Korea changed substantially. Instead of continuing to reciprocate both positive and negative social actions, North Korea continually rejected almost all diplomatic overtures and

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\(^{206}\) Off-the-record discussions have confirmed this.

\(^{207}\) Central Intelligence Agency Nonproliferation Center 2002a.
quickly reactivated its nuclear program. In a few short months, the DPRK kicked out inspectors, withdrew from the NPT, restarted its 5MWe reactor, and claimed to have started reprocessing the 8000 spent fuel rods that had previously been canned. During this period, the United States attempted several diplomatic overtures and various implicit and explicit threats of economic sanctions and potential military action, but no actions resulted in any change in DPRK policy; a single, three-way meeting occurred between China, the United States, and North Korea in April, which ended early and unsuccessfully. Finally, North Korea nullified the 1992 North-South nuclear pact in June 2003.

Having briefed key allies on the uranium program, the United States sent US Assistant Secretary of State for East Asia and Pacific Affairs James Kelly to Pyongyang in October 2002 to confront the North Koreans, stating that the United States had evidence that they were seeking equipment for a uranium enrichment facility. While Kelly maintains that the North Koreans admitted to the program one day after the accusations were made, the North Koreans insist that they only said that they had the right to pursue nuclear programs, without specifically referring to a uranium enrichment program, and accused Kelly of taking a “high-handed and arrogant attitude.” The North Koreans have released their transcript of the episode in question, which supports their argument.

After the announcement on October 16 by State Department spokesman Richard Boucher that the North Koreans had admitted to a program, North Korea was also criticized by the IAEA. This was the end of potential reciprocation between North Korea and United States. Although South Korea, Japan, and China urged the United States to continue negotiations and saw the admission as an offer to put up the program for negotiation (South Korea simultaneously criticized North Korea), such negotiations never began. The eighth set of inter-ministerial talks between South and North Korea continued as scheduled October 19-22, although separate talks between North Korea and Japan ended in dispute at the end of the month.

208 Pinkston 2002
209 Lewis 2004
210 Warrick 2002
211 Joongang Ilbo 2002
212 Goodman and Pomfret 2002
Encouraged by its generally improving relations with its neighbors, North Korea’s response to the October 16 announcement was to announce that it required three conditions to resolve the current impasse with the United States: recognition of sovereignty, not hindering economic development, and assurance of non-aggression, the latter of which became the primary demand of North Korea. Simultaneously, North Korea complained of US intransigence over the reactor, and revealed what was part of a confidential minute that only obligated North Korea to allow inspections after turbines and generators were installed: “Under article 4 of the framework and paragraph g of its confidential minute the DPRK is to allow nuclear inspections only after the ‘delivery of essential non-nuclear components for the first LWR unit, including turbines and generators’ is completed.” This was later verified by Wit, Poneman, and Gallucci.

North Korea’s new demands reflected three concerns: being named in the Nuclear Posture Review in January, being placed in the “axis of evil,” and fearing the then-newly released National Security Strategy of the United States, which enshrined the doctrine of preemptive action: “However, the Bush administration listed the DPRK as part of the ’axis of evil’ and a target of the U.S. preemptive nuclear strikes. This was a clear declaration of a war against the DPRK as it totally nullified the DPRK-U.S. joint statement and agreed framework. In the long run, the Bush administration has adopted it as its policy to make a preemptive nuclear strike at the DPRK.” With these new demands, North Korean reciprocation of any positive social approaches by the United States ended. Informal guarantees were no longer possible; a formal non-aggression pact was required. The phrase “non-aggression” appeared 283 times in the Korean Central News Agency between 1997 and 2003; 255 of these are after October 16th, 2002. The North Koreans had been convinced by US rhetoric (for there was little new material action up to this point against North Korea) that only binding guarantees were possible, and so spurned all positive social approaches after this point, reciprocating only material gestures (which were mainly negative in any case).

Korean Central News Agency 2002b
Wit et al. 2004
National Security Council 2002a
KCNA2002Treaty
On November 13, the US National Security Council decided to end heavy fuel oil shipments to North Korea. The next day the executive board of KEDO suspended shipments. This economic sanction led to further criticism from North Korea and additional declarations that the Agreed Framework was dead. At the end of November, the IAEA called on North Korea to cooperate with them to settle its safeguards commitments and clarify reports of the uranium enrichment program, to which the North Korean Foreign Minister replied that due to threats from the United States, it could not, and accused the IAEA of being a pawn of the United States.

On December 12, the Foreign Ministry announced that North Korea would “immediately resume the operation and construction of its nuclear facilities to generate electricity,” and the head of the Atomic Energy Department asked the IAEA to remove seals and monitoring cameras. On December 21, North Korea began removing seals and disabling cameras at the 5 MWe reactor site; followed by the storage facility for the 8000 spent fuel rods the next day, and the Radiochemical Laboratory the day after that. North Korea requested the removal of IAEA inspectors on December 27.

On New Year’s Eve, 2002, the North Korean Foreign Ministry accused the United States of “ditching” the 1994 agreed framework; North Korea’s ambassador to Russia claimed that “North Korea is not currently able to meet its commitments under the Treaty on the Nonproliferation of Nuclear Weapons,” implicitly threatening to leave the NPT. Simultaneously, the inspectors from the IAEA who were monitoring activity at the Yongbyon nuclear site were kicked out.

President Bush stated that he was certain that North Korea could be stopped “peacefully, through diplomacy.” Bush denied two days later that the United States had major differences with Asian nations over how to handle the dispute, although he also described Kim...
Jong Il as "somebody who starves his people." The next day, North Korea’s ambassador to China said that "The U.S. should respect the international community and respond to dialogue without any preconditions;" in response, the Bush administration reemphasized its precondition: that North Korea stop its programs to build nuclear bombs. On January 6, the IAEA passed a resolution unanimously deploring the expulsion of inspectors, dismantling of cameras, and removal of seals, and gave the North Korean government one more chance to be readmitted before referring the issue to the UN Security Council. That afternoon, Bush repeated three times that the United States has no intention of invading North Korea.

On January 9, North Korea agreed to hold cabinet-level talks with South Korea from January 21-24, while two North Korean diplomats met with the Governor of New Mexico, Bill Richardson, for informal talks regarding the nuclear crisis. The Bush administration, after two days of meetings with South Korea and Japan, expressed its willingness to informally talk to the North Korean government. The next day, North Korea announced its withdrawal from the Nuclear Nonproliferation Treaty. North Korea emphasized at the time that they had no intention of producing nuclear weapons. This statement is important with respect not to formal treaty obligations (although it allowed them to postpone the annulment of the North-South denuclearization treaty), but rather with respect to their informal international status. Just as India and Pakistan have been said to have made not one but two decisions when they tested their weapons—to test, and to declare themselves officially nuclear powers—North Korea consequently delayed this step until later. Still, North Korea’s withdrawal was condemned by many countries, including Japan, Russia, France, and South Korea. Republican Senators John McCain and Jon Kyl (R-AZ) said they would introduce legislation seeking penalties against North Korea. However, On the 11th, North Korea’s ambassador to China warned that it might resume long-range ballistic missile tests; a mass rally was held in North Korea that was unusual for being held outside
of traditional calendar events.\textsuperscript{232}

On January 13, James A. Kelly, the assistant secretary of state for East Asian and Pacific affairs, said during a visit to South Korea, that the United States was willing to talk, and mentioned potential economic assistance to North Korea after its nuclear program is dismantled.\textsuperscript{233} The next day, China offered to arrange a meeting between the United States and North Korea in Beijing, and President Bush said he would consider offering a “bold initiative,” and suggested that security guarantees and diplomatic recognition could also follow dismantlement of North Korea’s nuclear program.\textsuperscript{234} Satellite photos that day indicate that the power system at the “radiochemical laboratory” was being tested. The tests continued for two weeks. The “radiochemical laboratory” is better known as the North Korean reprocessing plant. Evidence for a test of the power system came when steam was seen billowing from the pipes connecting the power facility connected to the plant.\textsuperscript{235}

Meanwhile, relations between North and South Korea continued to be stable; on the 15th, they agreed to resume high-level talks; the next day, the President-elect of South Korea argued for a conciliatory approach and all but ruled out the use of force, stating that “North Korea wants to escape from its status as a rogue state.”\textsuperscript{236} During the high-level talks that began on the 21st, North Korea also reassured South Korea that it had no intention of producing nuclear weapons - at that stage.\textsuperscript{237} Outgoing South Korean President Kim Dae Jung encouraged the United States to have patience and respect when dealing with the North on the 24th.

On the 18th, Russian Deputy Foreign Minister Aleksandr Losyukov arrived in North Korea in an attempt to negotiate a solution. Upon his return, Russian Foreign Minister Igor Ivanov called for direct dialogue between the United States and the DPRK. However, North Korea criticized outside efforts to help resolve the impasse on the 25th.\textsuperscript{238}

More moderate parts of the Bush administration continued to express a desire to negotiate; Richard Armitage was quoted on the 19th as stating “We are not going to invade North
Korea. If we respect their sovereignty, and their economic activity, then there is a basis to move forward.” The aircraft carrier Kitty Hawk was reported to have left its home port for the Sea of Japan on the 24th to “monitor the Korean Peninsula,” which was met with condemnation by North Korea (it was later revealed that the Kitty Hawk was being redeployed to Iraq; instead, the carrier Carl Vinson replaced Kitty Hawk) On January 30, photos showed the fuel rods at the Yongbyon plant being loaded into trucks. The destination of the trucks was and still is unknown; however, they are generally assumed to have been reprocessed.

The next day, the Pentagon announced that the commander of American forces in the Pacific, Adm. Thomas B. Fargo, had requested additional air and naval forces the previous week. Secretary of Defense Donald Rumsfeld placed 24 long-range bombers on alert for possible employment on February 3, and labeled North Korea a “terrorist regime,” both of which North Korea dutifully condemned. On February 5, North Korea announced that it had resumed normal operations at the Yongbyon reactor. The Bush administration then warned North Korea against trying to take advantage of the situation in Iraq.

On the 7th, President Bush sought China’s support for resolving the crisis with North Korea; However, Chinese officials replied on the 11th that they had been working hard to help mediate, but that the two sides would need to find a solution themselves. South Korean President-elect Roh Moo Hyun dispatched a team to Washington to discuss foreign policy, but it was clear that the new South Korean administration would not fall in line easily; a senior South Korean said that the new government “would prefer that North Korea had nuclear weapons to seeing it collapse.” The Bush administration then asked the IAEA on the 12th to find North Korea in violation of its NPT responsibilities, and announced that it was developing plans for sanctions against North Korea on the 17th. North Korea responded the next day by threatening to abandon its commitment to the 1953
Korean War armistice.

Colin Powell visited South Korea, Japan, and China from the 21st through the 25th in an attempt to gain their support for additional measures against North Korea. However, officials in China, Australia, and South Korea instead urged the United States to talk directly to the North Koreans. At the end of the trip, the State Department announced that it was cutting food donations to North Korea for this year; the same day, North Korea tested a ballistic missile, its first test in three years. The next day, North Korea reactivated the Yongbyon reactor. The 5 MWe reactor at Yongbyon was reactivated at the end of February; photos indicate a plume of steam coming from the reactor (in a separate part of the Yongbyon complex from the reprocessing plant). There are reports that this reactor was shut down on September 11, but was then reactivated on October 2. Some photos seem to indicate another shutdown in early June, but there are no other reports discussing a shutdown at this point. Whether shutdowns after February were policy moves on North Korea’s part or are simply due to technical difficulties is debated. Two days later, the reprocessing plant was also restarted, a month after the original tests of its power system.

On March 3rd, North Korean fighter jets attempted to intercept a reconnaissance plane on a surveillance mission over the Sea of Japan. The next day, senior Pentagon officials announced that two dozen long-range bombers would be deployed to Guam (although the order had been signed before the previous incident). White House officials described it as “insurance against North Korean ‘opportunism’ if military action begins in Iraq,” while Bush remarked that if administration efforts “don’t work diplomatically, they’ll have to work militarily.” It was followed by remarks two days later by Secretary of Defense Donald Rumsfeld, who mentioned that the Defense Department was looking at ways of reducing the vulnerability of the 37,000 troops in South Korea. On March 9, North Korea test-fired a surface-to-ship missile.

This exchange was interrupted by the US invasion of Iraq, during which Kim Jong
Il disappeared completely (in fact, his last noted public appearance had been in mid-February), and North Korea postponed talks with South Korea on March 22. The reason for Kim Jong Il’s disappearance was elaborated by the KCNA’s reaction to the decapitation strikes on Saddam Hussein: “The arrogant and outrageous behavior of the U.S. that adopted it as its national policy to kill the state leader of another country is typical state terrorism that can never be tolerated.”

Japan launched two spy satellites at the end of the month in response to North Korea’s missile launches. In early April, North Korea moved even closer to nuclear acquisition by arguing that only a “tremendous military deterrent” would be needed.

“Even the signing of a non-aggression treaty with the U.S. would not help avert a war. Only the physical deterrent force, tremendous military deterrent force powerful enough to decisively beat back an attack supported by any ultra-modern weapons, can avert a war and protect the security of the country and the nation. This is a lesson drawn from the Iraqi war. The U.S is seriously mistaken if it thinks that the DPRK will accept the demand for disarming while watching one of the three countries the U.S. listed as part of an “axis of evil” already subject to the barbarous military attack.”

After this rejection of disarmament, the United States moved back from its position on passing a UNSC resolution condemning North Korea, while China indicated that it would be willing to assist with dialogue between the United States and the DPRK, and Russia warned that it would not welcome North Korean nuclear weapons. In response to Chinese pressure, North Korea agreed not to insist upon solely bilateral talks with the United States, and the United States agreed to talks without prior conditions with North Korea (with China moderating) a few days later. Just previous to the talks, North Korea announced that they were ready to reprocess the fuel rods, but then also proposed high-level
Talks with the United States began on April 23rd. North Korean officials claimed that they already possessed nuclear weapons, and were reprocessing the plutonium in the 8000 fuel rods. Some debate remains over when the rods were reprocessed; see Chapter 6. Talks ended abruptly afterwards, leading to a temporary lull in the crisis, until a statement on May 12 “nullifying” the North-South Denuclearization Agreement, which went into affect in early 1992. The DPRK’s withdrawal statement from the North-South agreement was scheduled the same day that the new South Korean president, Roh Moo Hyun, made his first official visit to the United States, and so is likely to have been an attempt to overshadow that visit.

A final nuclear status provocation came late in August under similar circumstances as the previous ones; during the first round of six-party talks, North Korea asserted that it would soon break two nuclear status thresholds: testing a weapon and declaring itself a nuclear state. However, the former has not happened, and without proof of a nuclear test, North Korea’s nuclear weapons program remains in an ambiguous state.

Summary

Unlike the first crisis, few actions by North Korea during the second crisis seemed to be directly related to US actions. The tit-for-tat North Korea replies to negative comments preceding the crisis itself are evidence against hypothesis H3b (Social Disincentives). The suspension of heavy fuel oil deliveries preceded the first announcement of resumption of nuclear activities by a month, evidence against hypothesis H2a (Economic Disincentives). This period provided substantial evidence against hypothesis H3a (Social Incentives); overtures in early January by the Bush administration were followed by the North Korean withdrawal from the NPT and testing of the power system at the reprocessing plant, while the April talks ended when North Korea announced that they possessed nuclear weapons. Similarly, there is evidence against Military Disincentives (H1b): North Korea condemned aircraft carrier movements in late January (and moved fuel rods soon afterwards); Rumsfeld’s

261 Sanger 2003e
262 Sanger 2003a
263 Sanger and Kahn 2003
alerting of long-range bombers on February 3 was followed by resumption of operations at
the 5 MWe reactor. The invasion of Iraq (an indirect threat, but made salient by the link-
ing of Iraq and North Korea in many public speeches) was followed by a declaration that
North Korea would seek a “tremendous military deterrent.” Threatened economic sanc-
tions also seemed to lead to additional negative actions, evidence against H2b (Economic
Disincentives).

Domestically, both the executive and legislative branches were aligned against a deal
with North Korea during the crisis. It is unclear whether individual statements regarding
North Korea would have undercut US policy or not, since efforts at reconciliation were half-
hearted at best; consequently, hypothesis H4a is neither supported nor refuted. By contrast,
positive feedback (H5) is well supported both before and during the crisis. Military moves
were made by both sides in response to each other (North Korea’s ballistic missile test;
US movement of long-range bombers to Guam; North Korea’s attempted interception of
a reconnaissance plane; US public consideration of repositioning troops; another missile
test, etc.) Social moves also mirrored each other, but in reverse; diplomatic overtures were
rejected, only to be renewed again.

Were the root causes of North Korea’s nuclear actions structural or did they spawn
from interaction? Although some interaction hypotheses seem to be supported, the lack of
direct connections made by North Korea in statements between actions by the United States
and North Korea’s nuclear actions makes it likely that an underlying structural shift—in
this case a social structural shift—contributed to North Korea’s decision to abandon the
Agreed Framework, supporting hypothesis H6b (Structural Motivation). When the Bush
administration broke off high-level talks for over two years, they deprived North Korea
of the recognition and equal treatment they clearly valued, then continued to take actions
that heightened North Korean suspicions, leading to a fundamental, structural shift in how
North Korea viewed its social relationship with the United States (as was evidenced by
North Korean reactions to US actions), such that the short-term social benefits offered
through interaction no longer led to reciprocation. This lends support to hypothesis H6b
(Structural Motivations). Finally, Chinese, South Korean, and Japanese efforts to close the
gaps between the United States and North Korea failed, evidence against hypothesis H7
(Multi-party Interactions).

### 4.4 Conclusions

While realist, liberal, and constructivist hypotheses are all supported (in that military, economic, and social incentives or disincentives played a significant role), evidence for each hypothesis is very mixed; the results are summarized in Table 4.3. One of the most striking results of both the quantitative testing and the qualitative analysis was how much North Korean responses to US actions varied not only between but within the two administrations. For example, while economic disincentives were useful in the first few and last few months of the first crisis, they were counterproductive during the intervening months. Similarly, they were ineffective during the second crisis. This is largely due to a lack of credibility; without alignment of the other parties to the crisis, the threat of sanctions was empty.

Another striking, and initially puzzling, result is how strategies that were consistently effective during the first crisis became ineffective during the second one. Social incentives

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Dates</th>
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<tbody>
<tr>
<td>H1a (Military Incentives)</td>
<td>++</td>
</tr>
<tr>
<td>H1b (Military Disincentives)</td>
<td>——</td>
</tr>
<tr>
<td>H2a (Economic Incentives)</td>
<td>++</td>
</tr>
<tr>
<td>H2b (Economic Disincentives)</td>
<td>+</td>
</tr>
<tr>
<td>H3a (Social Incentives)</td>
<td>++</td>
</tr>
<tr>
<td>H3b (Social Disincentives)</td>
<td>——</td>
</tr>
<tr>
<td>H4a (Veto Players)</td>
<td>——</td>
</tr>
<tr>
<td>H4b (Coalition Politics)</td>
<td>——</td>
</tr>
<tr>
<td>H5 (Positive Feedback)</td>
<td>Yes*</td>
</tr>
<tr>
<td>H6a (Interaction Motivation)</td>
<td>Yes</td>
</tr>
<tr>
<td>H6b (Structural Motivation)</td>
<td>Yes</td>
</tr>
<tr>
<td>H7 (Multiparty Interaction)</td>
<td>Yes</td>
</tr>
</tbody>
</table>
were consistently beneficial during 1993-1994, but were completely useless during 2002-
2003; similarly, when military disincentives were briefly credible, they contributed towards
North Korea’s backdown, but otherwise only exacerbated the crises. These differences were
not due to a fundamental difference in general approaches; both administrations attempted
to use military and economic sanctions to prevent North Korea from taking nuclear steps
and attempted to use social benefits to entice North Korea to freeze its program.

The reason for these differences can be traced to key events in the Clinton and Bush
administrations. In the first half of the first crisis, the Clinton administration was unable
to align the interests of important international actors in order to make deterrent threats
credible; consequently, North Korea reacted negatively to material threats. But once North
Korea came close to violating the “red lines” the Clinton administration had set up, the ad-
ministration reacted strongly and the deterrent threat of economic sanctions worked—but
only once the administration convinced other actors to support the sanctions, making the
threat credible, as well as clear and consequential, and combined the threat with counter-
balancing incentives. By contrast, not only were the attempted deterrent moves of the Bush
administration verbally unconnected to North Korean actions, but other members of the
international community were unconvinced; consequently, such threats (primarily military
instead of economic) contributed to a negative reaction on the part of the North Koreans
rather than a backdown.

Deterrence was also more successful during the Clinton administration because of the
social benefits offered in tandem. While both administrations used high-level talks as a
bargaining chip rather than simply as a process or a method of negotiation, the Bush ad-
ministration used this strategy for much longer period of time, thus depriving the North
Koreans of the social benefits of being treated as an equal, raising North Korean suspicions
of whether the Bush administration would make a good faith effort to solve the impasse.
The consistent (yet vague) targeting of North Korea in 2002 and negative rhetoric (which
continued to a limited extent through the crisis) turned this suspicion into reality, as could
be seen in the trajectory of North Korean rhetoric; by the time the second crisis began, the
North Koreans had abandoned their strategy of social reciprocation, and instead rejected
social overtures. By contrast, the Clinton administration followed a consistent policy of
social engagement with the North Koreans. This fundamental shift from social engagement to estrangement undercut the social overtures during the second crisis, depriving the Bush administration of the key bargaining tool needed to balance material disincentives and bring North Korea seriously to the bargaining table.

While occasionally the legislative branch of the US government attempted to play a role in both crises, there was no significant evidence supporting domestic politics hypotheses. There was some variation in individual players’ strategies with respect to North Korea; these differences of opinion might have had an effect upon interactions with North Korea, if North Korea seemed to suspect only certain members of the Bush administration. However, it seems that North Korea mistrusted the entire administration, so these differences of opinion had less of an effect than they would have otherwise. The lack of evidence for or against coalition politics in North Korea is probably in part due to the opacity of the North Korean regime; although it is possible to speculate as to whether divisions within North Korea caused certain actions, lack of internal evidence prevents verification of this speculation.

Feedback loops played an important role at the height of both crises, amplifying US strategies; in the case of the first crisis, it helped to bring about the Agreed Framework, while in the second, it assisted in its dissolution. Finally, while multiparty interactions were very important in the Clinton adminstration’s success, they did not play a significant role in the failure of the Bush administration in 2003 to freeze North Korea’s nuclear program; rather, the most relevant parties (China, South Korea, and Japan) already favored US negotiations with North Korea.

These results have important implications for both policy towards North Korea and towards other countries. With respect to North Korea, it is clear that social inducements (e.g. high-level talks) are a significant enticement—but in the current situation, will not be sufficient unless North Korea can be convinced that its relationship with the United States has fundamentally changed. The importance of Chinese participation is underscored by the outcome of the first crisis; without Chinese acquiescence, the threat of (additional) economic sanctions is not only ineffective, but counterproductive. While other actors (especially Japan and South Korea) can offer economic benefits, the United States still has the
ability to offer the most enticing social benefit—full diplomatic recognition.

US policies towards North Korea have been focused primarily on the North Korean demand for nuclear weapons. However, this is not the only counterproliferation strategy that the US has followed in the post-Cold War era. Supply-side strategies have also been an intrinsic part of US strategy, and have played a larger role in counterproliferation policy with respect to other states. The role of supply-side strategies is the subject of the next two chapters; Chapter 5 examines US policy towards Iran, while Chapter 6 looks at proliferation networks.
Chapter 5

Iran

“While there is currently consensus across the political spectrum with respect to the necessity of sustaining a nuclear research program, no such agreement is evident on the issue of actually crossing the nuclear weapons threshold.”– Ray Takeyh[1]

5.1 Introduction

In the previous chapter, I discussed US counterproliferation policy toward the DPRK. I found that economic and military threats were only useful in a limited set of circumstances (only in the short term, and if credible), while social benefits were productive in a wider set (both in the short and long term). However, the conditions under which social strategies worked were also circumscribed. Due to repeated social snubs, the North Koreans had inverted their patterns of response to US strategies by the end of 2002, and subsequently took significant strides towards a nuclear capability.

In this chapter, I test a similar set of hypotheses with respect to the Islamic Republic of Iran (hereafter Iran). Relative to the US strategy toward the DPRK, the US strategy toward Iran over three administrations has been relatively constant. Moreover, much of the US strategy has been indirect, attempting to convince other countries not to cooperate with Iran rather than negotiating directly with the Iranians. These attempts can be evaluated and

compared with what is known about Iran’s clandestine programs to determine the overall effects of US strategy on Iran’s nuclear program. Next to North Korea, during the post-Cold War period, Iran has probably come the closest to developing nuclear weapons, although (as I argue in this chapter) they are still some distance away from achieving success.

It is more difficult to determine proper cutoff points for analysis in the Iranian case than it is in the North Korean case due to less clear variation in Iran’s nuclear program. I therefore examine two periods: the Iranian nuclear program from the Revolution until the revelations of Iran’s uranium enrichment facilities in August 2002, then until the end of the first round of the current crisis in November 2003. I argue that while the US was fairly successful in preventing imports from first-tier nuclear suppliers, the effort to oppose Iran’s nuclear power program (in particular, the Bushehr reactor) was counterproductive, in that it gave Iran a justification for developing a complete fuel cycle; additionally, bilateral efforts to negotiate with Iran were too meager to make a difference, as can be seen in the contrast between US actions and EU actions regarding Iran’s clandestine program.

Since US strategies mainly focused on supply, multiple-party interactions (H7) were key to restricting Iranian progress. Most of the evidence in the Iranian case relates to hypotheses 8-10, which specify the importance of incentives and disincentives of a military, economic, or social nature respectively. The US never used military leverage towards suppliers, so most of the evidence has to do with using economic or social leverage in order to cut off Iran’s access to nuclear technology. The majority of the incidents involved used economic benefits to convince suppliers, while in a few cases the implicit threat of sanctions or social incentives were used to convince states to cut off support. The US made a limited number of attempts to deal directly with Iran, which were complicated by both Iranian and US domestic politics (H4). Due to a general lack of direct interaction, feedback (H5) did not play an important role, and the causal roles of interaction and structure (H6) could not be evaluated.

In this chapter, I first discuss possible Iranian nuclear motivations during the mullahs’ rule while describing the positions of important players within its domestic political structures. I then give a brief background for Iran’s nuclear program during the time of the shah, followed by a technical overview of Iran’s nuclear progress since 1979. The next
section deals with US policy broken up by country, detailing how the United States attempted to influence Russia, China, and other states to stop them from assisting Iran. I also examine bilateral relations with Iran, focusing on the multiple layers of US sanctions placed on Iran over the past two and a half decades. I then look at the clandestine elements of Iran’s program during these years, tracing the intelligence community’s (usually pessimistic) warnings about Iran, describing Iran’s attempts to acquire uranium and uranium enrichment technologies, and giving a brief overview of the IAEA’s failures to detect the clandestine elements of Iran’s program. In the final section, I chronicle the first year of the current crisis, from discovery of Iran’s enrichment facilities in August 2002 until its first agreement with the EU3 in November 2003.

5.2 The Roots of the Iranian Nuclear Program, 1957–2003

5.2.1 Iranian Motivations

Since the Iranian Revolution, ultimate responsibility and underlying motivations for the Islamic Republic’s nuclear program have been quite murky. Nonetheless, some powerful individuals have made statements or have been named as particular backers of either the nuclear project in general or nuclear weapons in particular. The AEOI has had only two directors since the 1979 revolution—first Reza Amrollahi, then Reza Aghazadeh. Other key players include Hashemi Rafsanjani and Hassan Rowhani. In this section, I look into some of Iran’s motivations for developing nuclear weapons, chronicle key individuals and their apparent roles, and list the various statements that have been interpreted as being in favor of nuclear weapons development by Iran (denials of intent or ability to acquire nuclear weapons are so prevalent as to not be worth mentioning).

Iran’s desire for a nuclear weapons capability seems to be related to several factors. The most overt statements supporting a weapons program cite Iraq, Israel, and the United States as potential threats. Regional powers Russia and Pakistan also possess nuclear weapons, although relations with Russia have generally been much better than with Pakistan. While the 2003 Iraq War removed Iraq itself as Iran’s most immediate threat, Iran now has the
United States military as a direct neighbor on both sides. Kenneth Pollack argues that while Iran has many incentives for a nuclear program, deterring a US attack is the most important. Pollack recommends a ‘triple track’ approach to Iran’s nuclear program, including a ‘Grand Bargain,’ a ‘True Carrot-and-Stick’ approach, and ‘Preparing for a New Containment Regime.’ Economics seems to at least not stand in the way of Iran’s nuclear program; although the Shah cut back significantly on the scale of his program in the late 1970s in part due to a lack of funds, Iran’s program appears to have been well funded, at least after the end of the Iran-Iraq War.

Prestige seems to be a major motivator for nuclear facilities, if not necessarily weapons. Sharam Chubin has argued that Iran’s motivations are linked to Iran’s desire for status and its view of itself as a major Islamic power, and not to military needs. While Iran may seek a nuclear weapons capability, it does not necessarily seek weapons; Iran’s desire to create an indigenous capability indicates prestige motives as much as anything else. Chubin argues that with prestige as a motive, it may be more difficult to get Iran to give up a nuclear program than if it is motivated by security needs, since outside interference is likely to backfire. George Perkovich argues similarly that a clear military need for nuclear weapons is ephemeral, and that international prestige and status help drive Iran’s program. Perkovich recommends offering technological and economic benefits, and argues that economic and social sanctions have proven to be ineffective.

This contrasts with neoconservative perspectives, which argue that Iran is ‘dead set’ on proliferating. From this perspective, Iran’s pursuit of nuclear weapons is intrinsic to its regime, requiring regime change to cut short its program. A committee of prominent neoconservatives has called for governmental change in Iran. This perspective presumes that support for a nuclear program is limited to a few powerful figures in the current Iranian

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2 Pollack 2004, 259.
3 Pollack 2004, 400-416.
4 Chubin 1994, 53-5.
6 Chubin 2002, 111.
7 Perkovich 2003.
8 Perkovich 2005.
9 Bolton 2004d.
10 Committee on the Present Danger 2004.
However, domestic support for an Iranian nuclear program is uniformly high\textsuperscript{[11]} although some are suspicious of Iran’s nuclear power program due to the high cost in general of nuclear power around the world, Iran has managed to get Russia to complete the Bushehr for a fraction of its actual cost; consequently, power over the long run will be competitive with other sources, even for an oil- and gas-rich country. The low marginal price for Bushehr also undercuts domestic opposition, who might object to wasting money on a nuclear power plant otherwise. Others argue that Iran has no reason to obtain a uranium enrichment plant for fuel reasons, due to a glut of global fuel; however, Iran’s ambassador to the UN contends that the fuel facilities are needed because US pressure could potentially undermine foreign fuel sources\textsuperscript{[12]} Given the past record of the United States with respect to any and every aspect of Iran’s program, these contentions are difficult to reject out of hand.

Responsibility for the nuclear program is difficult to trace, due to the complex power relationships within the Iranian government and the small number of people who run the nuclear program\textsuperscript{[13]} The structure of the Iranian government is split in two (see the top of Figure 5.1 for the overlapping membership of various bodies and the relationships between these bodies\textsuperscript{[14]} on one side are the elected officials, which include the President, the Parliament, and the Council of Experts, while on the other side lies the Guardian Council (half appointed by the Supreme Leader directly, half by the chief of the judiciary, who is appointed by the Supreme Leader) and most of the Expediency Council. The Supreme National Security Council (SNSC) lies somewhere between, with a mix of appointed and non-appointed members. At first glance, the system has many checks and balances (see the bottom of Figure 5.1), since the President, Parliament, and the Council of Experts (who elects the Supreme Leader) are all popularly elected; in practice, since the Supreme Leader appoints the Guardian Council, which vets all candidates for election, the Supreme Leader, advised by the Expediency Council and the SNSC (not in Figure 5.1), wields most of the

\textsuperscript{[11]} Takeyh 2003, Perkovich 2005
\textsuperscript{[12]} Lynch 2003
\textsuperscript{[13]} Perkovich 2003, 4.
\textsuperscript{[14]} Figures based on Pike 2003 and Public Broadcasting System 2004
Figure 5.1: Iranian government structure and relations

Appointed by President  Elected after vetting by Guardian Council  Appointed by Supreme Leader

Expediency Council (36)  Chairman  26 add'l Members

8 Vice Presidents

President  Parliament Speaker  Judiciary Chief  6 jurists

Interior Minister  Supreme National Security Council (9)  Mgmt & Planning  Rep of Leader

Intel Minister  Armed Forces Chief  

Foreign Minister

Council of Ministers (31)

19 add'l Ministers

Majlis Parliament (290)

Council of Experts (86)

Vets Candidates  Elects  Supreme Leader  Appoints

Expediency Council (36)  Advises  Guardian Council (12)

Mediates  Bills
power. Support for the nuclear program in general is uniform; support for nuclear weapons in particular has shifted frequently since the Iranian Revolution.

In May 1979, during the Iranian Revolution, Khomeini adviser Ayatollah Muhammad Beheshti reportedly told energy specialist Dr. Fereydun Fesharaki, “It is your duty to build the atomic bomb for the Islamic Republican Party.”\(^{15}\) Fesharaki, claimed to be the head of the secret Iranian program under the Shah, left the country only to return in 1987.\(^{16}\) Yet Khomeini had also called the Shah’s nuclear program “the work of the devil.”\(^{17}\)

In 1982, Reza Amrollahi took over the directorship of AEOI\(^{18}\) and was later appointed to one of Iran’s vice president positions in the Council of Ministers (see Figure 5.1) in 1989.\(^{19}\) Some sources claim that Amrollahi was a major backer of a nuclear weapons option in the mid-1980s.\(^{20}\) However, others argue that he did not have complete control over AEOI.\(^{21}\)

A concerted effort instigated by Hashemi Rafsanjani (speaker of the parliament from 1980-1989, president of Iran between 1989-1997, and head of the Expediency Council thereafter) was made to send students abroad for nuclear training as well as bring back nuclear scientists living abroad starting in the late 1980s.\(^{22}\) Rafsanjani also reportedly commissioned preliminary studies in 1987 on a nuclear option for Iran,\(^{23}\) and is claimed by some to be the chief director of Iran’s nuclear effort.\(^{24}\) However, the effort by Iran to pursue nuclear technology in the 1980s was much less than that taken by Iraq; one source notes that estimates of the total number of people working on Iran’s nuclear program in the late 1980s was around 500, versus 7500 for Iraq’s program, a more typical number for a nuclear weapons program.\(^{25}\)

Like the bombing of the Osiraq reactor, the bombing of the Bushehr power plant by
Iraq during the later years of the Iran-Iraq war may have led the target—in this case Iran—to seek out other, more clandestine methods of acquiring nuclear knowledge. In any case, Iran’s reinvigoration of its nuclear program was directly connected by Iranian leaders first to the Iran-Iraq war and to the Israeli nuclear threat; in October 1988 while acting commander-in-chief of the armed forces, Rafsanjani argued that “we should fully equip ourselves both in the offensive and defensive use of chemical, bacteriological, and radiological weapons.” In a similar vein, Vice President Atalollah Mohajerani called in October 1991 for Muslim states to acquire an “atomic capacity” equivalent to Israel’s.

Iranian statements regarding nuclear weapons aspirations became increasingly scarce after 1991. Amidst a great deal of denial, former Iranian Defence Minister Akbar Torkan implied an Iranian desire for nuclear weapons in 1993; when asked what Iran would do against a threat from the United States, he responded, “The way to go about dealing with such a threat requires a different solution entirely.” In September 1994, Iran threatened to withdraw from the NPT since it was not being given access to Western technology, but said that a decision would be postponed until after the final Preparatory Committee meeting for the 1995 NPT Review and Extension conference. Iran’s delegate to the Chemical Weapons Convention in the Hague on September 30, 1995, declared that Iran was “keeping its nuclear options open.” Like the NPT review, Iran threatened to block the CTBT in 1996 due to its lack of a commitment to begin wider disarmament talks but later agreed to sign it.

With the surprise election of reformer Mohamad Khatami as president of Iran in May 1997 (supported by AEOI head Amrollahi), one report argued that “hard-core Islamicists in the middle ranks of the AEOI and nuclear hawks in the Organization of Revolutionary Guards will be on the defensive.” However, Amrollahi was replaced as the head of

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26 Krosney 1993: 188.
27 Krosney 1993: 192. Note that a distinction can be made between radiological and nuclear weapons, so this quote may not constitute a direct call for nuclear weapons.
30 Hibbs 1994c.
31 Iran Brief 1995.
32 Financial Times (London) 1996.
33 Hibbs 1997.

AEOI in September 1997 with former oil minister Gholam Reza Aghazadeh, a move seen variously as replacing an incompetent manager, de-emphasizing Iran’s nuclear weapons program, or simply increasing the efficiency of spending. In reaction to the election of Khatami, Supreme Leader Khameini appointed Former President Rafsanjani as the head of the Expediency Council in 1998; formerly this council had been headed by the President. Additionally, the council was given the new power to pass legislation.

After the May 1998 nuclear tests by India and Pakistan, Judiciary Chief Ayatollah Mohammad Yazdi declared in a June 1998 speech that “we are living at [a] time when the United States supports Israel, which has the biggest arsenals of the mass destruction and nuclear weapons [and] an atomic power is needed in the world of Islam to create a balance in the region.” On June 14, 1998, Mostafa Zarei, a Majlis deputy from Sarvestan, called for the Islamic Republic of Iran to acquire nuclear weapons to counter the Israeli nuclear threats.

Iranian elections to the Majlis (Parliament) on February 18, 2000 left reformists in power of this branch of government as well as the presidency. However, reforms were slow in coming and were generally blocked by the Guardian Council; it is thought that the reformers in general quietly opposed a nuclear weapons program, although probably not a nuclear power program. In public, reformers tended to support both. The Expediency Council generally sided with the Guardian Council on these matters in any case. Expediency Council head Rafsanjani warned in a speech on December 17, 2001 that “The use of even one nuclear bomb inside Israel will destroy everything.” Through 2003, both reform and conservative politicians continued to express support for a nuclear weapons option for Iran.

Although in early years Iranian rhetoric in favor of a nuclear option was outspoken, nuclear threats became less strident and more indirect after about 1991. Broad support for...
nuclear technology in general and often for nuclear weapons (or a nuclear weapons option) in particular has spread across the conservative-reformer divide, although conservatives have seemed to be more strident in general. Recently, the Iranian nuclear program has become motivated by pride as much as anything else—the program is extremely popular, not just with the government, but with the population.\(^{42}\)

### 5.2.2 The Origins of the Program

During the rule of the Shah, Iran received assistance from many Western countries, including the United States, Germany, and France. The Shah had an ambitious nuclear program, much of which never got past the initial drawing board. However, the Shah’s programs laid the groundwork for later expansion by the Islamic Republic of Iran, including hot cells, a partially constructed nuclear power facility at Bushehr, and the beginnings of a laser enrichment program that was to continue through 2003. US policy during this period shifted from favoring reprocessing to opposing reprocessing under the Carter administration; however, Iran still received the “Most Favored Nation” status in reprocessing—meaning mostly that if the United States permitted other states to reprocess, Iran would also be permitted\(^{43}\) and, ironically, was encouraged to develop complete fuel cycle facilities within the Middle East, presumably with Pakistan.\(^{44}\)

Under Atoms for Peace, the United States supported Iran’s nuclear program, signing a cooperation agreement in 1957, followed by the purchase in 1959 of a 5 MWt research reactor for Tehran University that ran on 93% HEU, which was installed in 1967.\(^{45}\) at the same time, the United States supplied its first load of fuel as well as 112 g of plutonium for start-up sources.\(^{46}\) A few hot cells suitable for radioisotope production (but not plutonium separation from spent fuel) were also installed.\(^{47}\)

Iran signed the NPT on July 1, 1968, and ratified it on February 2, 1970, signing a safeguards agreement in 1973 that entered into force the next year. In 1974, the Shah

\(^{42}\) Perkovich 2005; MacFarquhar 2005.  
\(^{43}\) Poneman 1982, 88.  
\(^{44}\) Cahn 1975, 190-1.  
\(^{45}\) Poneman 1982, 84-5.  
\(^{46}\) Department of State 1980.  
\(^{47}\) Albright 1995, 25.
announced a plan to build nuclear power stations totaling 23,000 MWe, then established the Atomic Energy Organization of Iran (AEOI) in March 1974. Iran initially sought to master all parts of the nuclear fuel cycle, investing in a uranium enrichment plant in France being constructed by the Eurodif consortium, seeking uranium supplies from Australia and South Africa, and purchasing a 15% stake in the Rossig uranium mine in Namibia in 1975. Iran also ordered two nuclear plants to be built by a French company (Framatome) at Darkhovin near Ahwaz and two plants from a German company (A subsidiary of Siemens, Kraftwerke Union, a.k.a. KWU) to be built at Bushehr. Iran also discussed purchasing six additional reactors from France and four from Germany. Iran also held talks with the United States regarding providing up to eight nuclear power plants as well as reprocessing facilities. All except the Bushehr reactors were canceled before or during the 1979 revolution due to funding difficulties.

In June 1974, when a French interviewer asked whether Iran would have its own nuclear arms, the Shah responded, “Without a doubt and sooner than one would think.” He soon backed away from the statement. However, studies of the Iranian nuclear program generally date Iran’s initial attempt at acquiring weapons from about this date. A secret nuclear weapon design group may have been set up by the Shah in the 1970s. Suspicion also surrounds the beginnings of a laser enrichment program: a laboratory was established in 1975 to investigate laser enrichment. In 1976, scientist Jeff Eerkens traveled to Iran; in 1978, he exported four lasers from the United States to Iran. The lasers operated at a different wavelength than that required for enrichment, but could be easily adapted to the purpose of enrichment. The US government at the time didn’t oppose the export since it was thought that laser enrichment was a technological dead-end.

One unfortunate side effect of early Western support for the Shah’s nuclear program is that the Islamic Republic has been able to object to subsequent Western export controls on the grounds that they are discriminatory. While this argument gets little traction in

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50 Cahn 1975, 199.
51 Spector 1987, 50.
52 IAEA Board of Governors 2003a, 10.
the West, it has gained Iran significant support with the Non-Aligned Movement within
the IAEA,\footnote{See, for example, the NAM statement of support for Iran in September 2003. Non-Aligned Movement 2003} giving Iran the ability to decrease the threat of being reported to the Security Council and making Iran’s accession to the Additional Protocol a bargaining chip rather than an expected concession.

5.2.3 The Post-Revolution Program

Iran’s program can be split into three areas: general activities that could apply to either a highly enriched uranium or a plutonium program, such as training, uranium acquisition, and uranium processing, listed in Table 5.1; activities that involve enrichment of uranium through laser or centrifuge technologies, listed in Table 5.3; and activities that pertain to fabrication of fuel rods, building of reactors, or isotope separation. Unlike North Korea, for most of its history Iran has been in good standing with the IAEA. Its actions with respect to the treaty during the latest crisis are detailed later. Most of these activities have parallel justifications in a civilian program. The current status of Iran’s nuclear facilities as of the end of 2004 is listed in Table 5.4. A flowchart that outlines Iran’s current claimed flow of nuclear materials that is associated with these facilities is pictured in Figure 5.2.

Iran has made steady, albeit slow, progress toward a nuclear capability. Some preliminary activities were taken between 1979 and 1984, including initial construction at the Isfahan nuclear complex; however, the bulk of Iran’s program has been built much more recently. Iranian nuclear scientists have been sent abroad since the mid-1980s to China, Pakistan, and Russia for training.\footnote{Boureston and Ferguson 2004} After the discovery of uranium at Saghand in 1985, Iran’s uranium mining and milling facilities have been slowly improved. It performed bench-scale experiments on all of the different parts of the uranium conversion cycle and fuel fabrication in the 1980s and early 1990s. Iran attempted to acquire pilot-scale or full-scale facilities for uranium conversion and fuel fabrication starting in the early 1990s. Using Chinese blueprints acquired in 1997, Iran began construction of a full-scale facility to convert uranium and fabricate fuel at Isfahan in 1999, and has conducted small-scale hot tests of parts of the facility.
Table 5.1: Iran Nuclear program timeline
* = unknown prior to 2003 IAEA visits

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>Pakistan (AEOI/Munir Khan) agrees to train Iranians</td>
</tr>
<tr>
<td>1989-1991</td>
<td>China agrees to train Iranians</td>
</tr>
<tr>
<td>1995</td>
<td>Russia agrees to train Iranians</td>
</tr>
<tr>
<td></td>
<td>Training</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>Yazd (Saghand) deposits discovered</td>
</tr>
<tr>
<td>1989</td>
<td>Yazd mine construction started</td>
</tr>
<tr>
<td>1991</td>
<td>Iran receives 1.8 tons of NU from China*</td>
</tr>
<tr>
<td>1992-1993</td>
<td>Iran seeks LEU from Kahazkstan</td>
</tr>
<tr>
<td>2004</td>
<td>Bandar Abbas (Gehine) ore production started</td>
</tr>
<tr>
<td>2006</td>
<td>Yazd ore production to start</td>
</tr>
<tr>
<td></td>
<td>Uranium acquisition</td>
</tr>
<tr>
<td>1981-1984</td>
<td>Iran seeks FFL/UCL at Isfahan from foreign supplier</td>
</tr>
<tr>
<td>1987-1993</td>
<td>Tehran bench-scale AUC/UO$_2$/UF$_6$/UF$_4$ experiments*</td>
</tr>
<tr>
<td>1984</td>
<td>Isfahan opens</td>
</tr>
<tr>
<td>1981-1993</td>
<td>Isfahan bench-scale UO$_2$ experiments*</td>
</tr>
<tr>
<td>1988</td>
<td>Iran seeks pilot UO$_2$ from Argentina; US pressure blocks</td>
</tr>
<tr>
<td>1991</td>
<td>Iran seeks full-scale UCF from China</td>
</tr>
<tr>
<td>1994</td>
<td>Iran receives TBP from China</td>
</tr>
<tr>
<td>1995-2000</td>
<td>Tehran JHL UF$_4$ to U conversion experiments*</td>
</tr>
<tr>
<td>1997</td>
<td>Isfahan UCF canceled due to US pressure</td>
</tr>
<tr>
<td>1998</td>
<td>Iran seeks AHF from China; US pressure blocks</td>
</tr>
<tr>
<td>1999</td>
<td>Isfahan full-scale UCF construction started</td>
</tr>
<tr>
<td>2000</td>
<td>Iran informs IAEA of Isfahan UCF</td>
</tr>
<tr>
<td></td>
<td>Uranium processing</td>
</tr>
</tbody>
</table>

Less progress has been made towards a plutonium capacity. Iran conducted bench-scale isotope separation experiments starting in the late 1980s from irradiated uranium targets, but currently has only small-scale isotope separation capabilities, which requires significantly less shielding than plutonium reprocessing from fuel rods. Iran received several small reactor facilities from China in the early 1990s. Iran also sought a medium-sized research reactor (ideal for plutonium production) starting in the late 1980s, then decided in the mid-1990s to construct a heavy-water reactor after these attempts were blocked by the United States. Construction on a heavy-water plant at Arak was mostly completed by the end of 2004, and construction of a 40MWt research reactor there was started in 2003. Hot cells are planned for Arak, but little design information has been provided; Iran has been rumored to be seeking hot cells capable of plutonium reprocessing, not just isotope...
Table 5.2: Iran Pu program timeline

* = unknown prior to 2003 IAEA visits

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Fabrication</td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>Iran seeks pilot facility from Argentina</td>
</tr>
<tr>
<td>1985-1993</td>
<td>Isfahan bench-scale fuel fabrication*</td>
</tr>
<tr>
<td>1997</td>
<td>Iran seeks Zr tube facility from China</td>
</tr>
<tr>
<td>1988</td>
<td>Iran seeks Pilot HW production facility from Argentina; US pressure blocks</td>
</tr>
<tr>
<td>2007</td>
<td>Isfahan FMP to be commissioned</td>
</tr>
<tr>
<td>Reactors</td>
<td></td>
</tr>
<tr>
<td>mid-1980s</td>
<td>Iran begins HWR research*</td>
</tr>
<tr>
<td>1985</td>
<td>Iran seeks conversion of Tehran reactor by Argentina</td>
</tr>
<tr>
<td>late 1980s</td>
<td>Iran seeks research reactor from India; US pressure blocks 1991</td>
</tr>
<tr>
<td>1992</td>
<td>Iran received two sub-critical facilities from China</td>
</tr>
<tr>
<td>1994</td>
<td>Isfahan MNSR critical</td>
</tr>
<tr>
<td>1995</td>
<td>Isfahan HWZPR critical</td>
</tr>
<tr>
<td>1984-1988</td>
<td>Bushehr attacked by Iraq</td>
</tr>
<tr>
<td>1990</td>
<td>China agrees to supply 27 MWt reactor</td>
</tr>
<tr>
<td>1990</td>
<td>USSR signs cooperation protocol</td>
</tr>
<tr>
<td>1991</td>
<td>China agrees to supply 27 kWt reactor</td>
</tr>
<tr>
<td>1991</td>
<td>Germany refuses to finish Bushehr</td>
</tr>
<tr>
<td>1992</td>
<td>China agrees to supply 300 MWe reactors</td>
</tr>
<tr>
<td>1993</td>
<td>Russia cancels research reactor due to US pressure</td>
</tr>
<tr>
<td>mid-1990s</td>
<td>Iran decides to build HWR*</td>
</tr>
<tr>
<td>1995</td>
<td>China cancels 300 MWe reactors under US pressure</td>
</tr>
<tr>
<td>1995</td>
<td>Russia agrees to finish Bushehr</td>
</tr>
<tr>
<td>1996</td>
<td>Ukraine considers cooperation on Bushehr; US pressure blocks</td>
</tr>
<tr>
<td>2000</td>
<td>Czech Rep. considers cooperation; US pressure blocks</td>
</tr>
<tr>
<td>2002</td>
<td>Russia agrees to take back spent fuel from Bushehr</td>
</tr>
<tr>
<td>2002</td>
<td>Arak HW facility construction started*</td>
</tr>
<tr>
<td>Isotope separation</td>
<td></td>
</tr>
<tr>
<td>1988-1999</td>
<td>Tehran irradiation, processing of UO$_2$ targets*</td>
</tr>
<tr>
<td>1988-1993</td>
<td>Tehran separates Pu*</td>
</tr>
<tr>
<td>1989-1993</td>
<td>Tehran irradiation of Bi for Po separation (unsuccessful)*</td>
</tr>
<tr>
<td>1995</td>
<td>MIX facility construction begins*</td>
</tr>
</tbody>
</table>
separation, which would require much less shielding.

Table 5.3: Iran HEU Program Timeline
* = unknown prior to 2003 IAEA visits

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>Beginning of Literature search</td>
</tr>
<tr>
<td>1987</td>
<td>Iran meets with, receives P1 plans from A.Q. Khan*</td>
</tr>
<tr>
<td>1988-1995</td>
<td>Tehran conducts R&amp;D*</td>
</tr>
<tr>
<td>1990</td>
<td>Iran seeks technology from China</td>
</tr>
<tr>
<td>1994-1996</td>
<td>Iran receives centrifuge parts, P2 plans from A.Q. Khan*</td>
</tr>
<tr>
<td>1995</td>
<td>Iran seeks technology from USSR; US pressure blocks</td>
</tr>
<tr>
<td>1995-2002</td>
<td>Kalaye centrifuges assembled, tested from 1997*</td>
</tr>
<tr>
<td>2001</td>
<td>Iran seeks Al tubes from Russia; US alerts Russia</td>
</tr>
<tr>
<td>2001</td>
<td>Natanz construction started*</td>
</tr>
<tr>
<td>2002-2003</td>
<td>Tehran P2 research conducted*</td>
</tr>
<tr>
<td>2003</td>
<td>Natanz research starts; UF₆ introduced</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975-1998</td>
<td>Iran receives laser equipment from four states</td>
</tr>
<tr>
<td>1987</td>
<td>Iran holds laser enrichment conference</td>
</tr>
<tr>
<td>1993-2000</td>
<td>Tehran laser program</td>
</tr>
<tr>
<td>1994</td>
<td>Iran receives copper-vapor laser from China</td>
</tr>
<tr>
<td>2002-2003</td>
<td>Lashkar Ab’ad laser program (dismantled 2003)*</td>
</tr>
</tbody>
</table>

Iran’s laser and centrifuge enrichment programs date back to the mid-1970s and mid-1980s respectively. After receiving plans for the P1 centrifuge from A.Q. Khan in the late 1980s, Iran conducted basic research and development at the Tehran Nuclear Research Center. However, once centrifuge parts were received in the mid-1990s from the A.Q. Khan network, development shifted to the Kalaye Electric Company until 2002, when work moved to the Natanz uranium enrichment facility. In parallel, Iran’s laser enrichment program continued slowly, acquiring laser enrichment equipment from four states, although it had little success; it was moved from Tehran to Lashkar Ab’ad in 2002, then dismantled in 2003.

Currently, Iran is building facilities that will complete the nuclear fuel cycle (See Table 5.4). Uranium mining and milling will take place at Yazd and Bandar Abbas; conversion to UF₆ will occur at Isfahan; enrichment will take place at Natanz; fuel fabrication from the enriched uranium will be done back at Isfahan; finally, irradiation of fuel will be done

55The United States, China, Russia, and a fourth unnamed state
CHAPTER 5. IRAN

Figure 5.2: Iran materials production flowchart

Key:
\[ \text{U}_3\text{O}_8 = \text{Uranium concentrate (yellowcake)} \]
\[ \text{UO}_2 = \text{Uranium dioxide} \]
\[ \text{U} = \text{Uranium metal} \]
\[ \text{UF}_4 = \text{Uranium tetrafluoride} \]
\[ \text{UF}_6 = \text{Uranium hexafluoride} \]
\[ \text{HWR} = \text{Heavy-water reactor} \]
\[ \text{LWR} = \text{Light-water reactor} \]
\[ \text{SWU} = \text{Separative Work Unit} \]
at Bushehr and Arak. Of course, these facilities could just as easily be used for fissile materials production; uranium could be enriched to weapons-grade levels at Natanz, then cast into pits at an unknown location, or plutonium could be separated from the rods removed from Arak and cast into pits elsewhere. However, many of these facilities are not operating now, and will not be for a number of years. For example, the heavy water reactor will not be operating until 2010; Natanz has less than one percent of the total number of centrifuges it needs; and Isfahan is far from completion. Iran would be at least five years away from a nuclear weapon if it decided to seek one, and then only if no additional difficulties were encountered with its facilities.

Although the IAEA revealed a great deal of information in 2003 and 2004 about Iran’s nuclear program, many of Iran’s nuclear activities—in particular, those that involved outside suppliers other than the A.Q. Khan network—were already known to the United States; many of these activities were stopped by US pressure on these suppliers. Three areas of Iran’s nuclear program that were previously unknown were revealed by the IAEA: a limited number of clandestine experiments involving uranium conversion and plutonium separation; the extent and progress of Iran’s centrifuge program, including the Natanz facilities; and the Arak heavy-water production facility (the Arak reactor was only recently started). However, most of the other major facilities were already known to the IAEA and the United States. In the first section below, I chronicle Iranian attempts to acquire nuclear technology and US attempts to block them; in the next major section, I give an overview of clandestine activities, intelligence attempts to discover them, and the IAEA’s failure to detect them.

5.3 Iranian Actions, US Reactions, 1979–2002

Between 1979 and 2002, US (and European) policy towards Iran’s nuclear program consisted primarily of attempts to avoid assisting any aspect of Iran’s nuclear capabilities, civilian or otherwise. While in Europe this was primarily restricted to export controls, the United States placed layer after layer of sanctions and restrictions, both on Iran and on foreign entities cooperating with Iran, whether on nuclear-related issues or not.\(^\text{56}\) In

\(^{56}\) Perkovich and Manzanero 2004
<table>
<thead>
<tr>
<th>Site Type</th>
<th>Abb. Name</th>
<th>Status (Nov 2004)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tehran Uranium Enrichment (Laser)</td>
<td>LSL</td>
<td>Laser Separation Laboratory, Dismantled</td>
</tr>
<tr>
<td></td>
<td>CSL</td>
<td>Comprehensive Separation Laboratory, Dismantled</td>
</tr>
<tr>
<td></td>
<td>TRR</td>
<td>Tehran Research Reactor, Operating</td>
</tr>
<tr>
<td></td>
<td>MIX</td>
<td>Radioisotope Production Facility, Constructed, but not operating</td>
</tr>
<tr>
<td></td>
<td>JHL</td>
<td>Jabr Ibn Hayan Multipurpose Laboratories, Operating</td>
</tr>
<tr>
<td></td>
<td>WHF</td>
<td>Waste Handling Facility, Operating</td>
</tr>
<tr>
<td></td>
<td>UCL</td>
<td>Uranium Chemistry Laboratory, Closed down</td>
</tr>
<tr>
<td></td>
<td>UCF</td>
<td>Uranium Conversion Facility, Hot testing/commissioning stage</td>
</tr>
<tr>
<td></td>
<td>GSCR</td>
<td>Graphite Sub-critical Reactor, Decommissioned</td>
</tr>
<tr>
<td></td>
<td>FFL</td>
<td>Fuel Fabrication Laboratory, Operating</td>
</tr>
<tr>
<td></td>
<td>FMP</td>
<td>Fuel Manufacturing Plant, Construction to begin in 2004, operation 2007</td>
</tr>
<tr>
<td></td>
<td>ZPP</td>
<td>Zirconium Production Plant, Under construction</td>
</tr>
<tr>
<td></td>
<td>FEP</td>
<td>Fuel Enrichment Plant, Under construction (suspended)</td>
</tr>
<tr>
<td>2. Kalaye (Tehran) Uranium Enrichment (Centrifuge)</td>
<td>KEC</td>
<td>Electric Company, Dismantled pilot enrichment site</td>
</tr>
<tr>
<td>3. Bushehr Reactor (power)</td>
<td>BNPP</td>
<td>Bushehr Nuclear Power Plant, Under construction</td>
</tr>
<tr>
<td>4. Esfahan Reactor (research)</td>
<td>MNSR</td>
<td>Miniaturized Neutron Source Reactor, Operating</td>
</tr>
<tr>
<td>5. Natanz Uranium Enrichment (Centrifuge)</td>
<td>PFEP</td>
<td>Pilot Fuel Enrichment Plant, Operational (suspended)</td>
</tr>
<tr>
<td></td>
<td>FEP</td>
<td>Fuel Enrichment Plant, Under construction (suspended)</td>
</tr>
<tr>
<td>6. Lashkar Ab’ad Uranium Enrichment (Laser)</td>
<td>PULEP</td>
<td>Pilot Uranium Laser Enrichment Plant, Dismantled</td>
</tr>
<tr>
<td>7. Arak Reactor (research)</td>
<td>IR-40</td>
<td>Research Reactor, Operating</td>
</tr>
<tr>
<td>8. Yazd Uranium Mining</td>
<td>HWPP</td>
<td>Heavy Water Production Plant, Under construction</td>
</tr>
<tr>
<td>9. Yazd Uranium Enrichment Plant</td>
<td>PFEP</td>
<td>Fuel Enrichment Plant, Under construction</td>
</tr>
<tr>
<td></td>
<td>ZPP</td>
<td>Zirconium Production Plant, Under construction</td>
</tr>
<tr>
<td></td>
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<td>Fuel Enrichment Plant, Under construction</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>MNSR</td>
<td>Miniaturized Neutron Source Reactor, Under construction</td>
</tr>
</tbody>
</table>

*Table 5.4: Iranian nuclear facilities*
doing so, the United States successfully managed to block Iran’s attempted acquisition of a proliferation-prone heavy-water reactor and other nuclear technologies from multiple sources, yet at the same time spent a large amount of diplomatic capital attempting to block various countries from assisting Iran with projects unlikely to significantly increase Iran’s potential to develop nuclear weapons.

In particular, the United States spent a great deal of time attempting to keep multiple countries from assisting Iran with Bushehr. While this may have delayed significantly construction of the plant, failure to cut off all potential sources of technology (in particular, the A.Q. Khan network) meant that Iran was able to undermine export controls in its uranium enrichment program. However, ultimately a lack of effort on Iran’s part, coupled with the many difficulties they had in operating imported technology, has kept Iran from gaining the ability to develop nuclear weapons.

5.3.1 Russia and Bushehr

Bushehr and the Initial Russian Deal, 1979–1994

Due to the Iranian revolution, KWU stopped construction on the Bushehr power plants in 1979. Litigation ensued and continued throughout the 1980s between KWU, the renamed Islamic Republic of Iran, and the German government; Iran attempted to hold KWU to its contract, KWU tried to find a suitable compromise, and the German government refused to allow for export licenses due to the ongoing war between Iran and Iraq (the Bushehr power plant site was attacked several times by Iraq between 1984 and 1988). After the war ended and under diplomatic pressure from the United States, Germany decided in early 1991 to definitively tell Iran that the reactors would not be finished; even the parts that were already manufactured and paid for were not delivered. Similar litigation occurred between Iran and the Eurodif consortium.

Iran also (unsuccessfully) sought assistance in finishing the Bushehr power plants starting in 1982 from China, India, Sweden, South Korea, Czechoslovakia, Argentina, Spain, and Brazil (the latter three in connection with, or subcontracted from, KWU). Finally, in

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5 Cordesman 2000, 7.
56 Hibbs 1991b.
1990, Prime Minister Rafsanjani signed first a cooperation protocol with the Soviet Union then later an agreement to construct two 440MW plants and two larger plants in October 1990. Once the German government refused to allow the necessary export licenses, this agreement evolved into an agreement to finish one of the Bushehr reactors instead.

Russian cooperation with Iran continued to grow throughout the 1990s. However, negotiations with Iran over a natural-uranium proliferation-prone research reactor were canceled in 1993 under US pressure. Additionally, President Boris Yeltsin agreed in October 1994 to halt $1 billion of arms exports to Iran. Plans to have Russia finish the Bushehr reactor moved forward haltingly, although the holdups were often due to disagreements about funding rather than US pressure; for example, Iran wanted to maximize the amount of “in kind” barter, while Russia wanted to maximize the cash part. Initial predictions made in 1994 and 1995 that the plant would be completed in 1999 proved to be excessively optimistic; as of July 2005, the plant is still not complete.

US Pressure Mounts, 1995

In 1995 rumors of an extra protocol that included gas centrifuge technology and training of Iranian scientists caused a crisis between the United States and Russia. This was initially sparked by the signing of an $800 million contract on January 8, which included provisions for a uranium enrichment centrifuge plant; it appears that the inclusion of the latter was due to Minister of Atomic Energy Viktor Mikhailov’s independent initiative, rather than the Kremlin. In a meeting with his counterpart the next week in Geneva, Secretary of State Christopher pressed Foreign Minister Andrei V. Kozyrev of Russia on the sale; this plea to terminate it was rejected.

In mid-March, the US Senate voted 97–3 in favor of cancelling funding on nuclear safety projects to Russia in the event that it supplied a nuclear power plant to Iran, and Republican members of Congress urged Clinton to cancel the US-Russian summit scheduled...
for May 9. Russia rejected these moves and said that it would go ahead with the construction of Bushehr on March 18. A meeting between the Russian Foreign Minister and the US Secretary of State the next week failed to reach a compromise. On March 28, the United States postponed signing a nuclear agreement with Russia in response. A compromise that included “very stringent constraints on the fuel that is generated” was mooted as a secondary, albeit much less preferred, option by US Secretary of Defense William Perry on April 3; subsequently, termination of the contract was again rejected despite US efforts to mollify Russia with additional sweeteners such as participation in KEDO.

Perhaps fearing a US agreement with Russia that canceled the plant, Iran announced its intention to return spent fuel to Russia just days before the Clinton-Yeltsin summit. During the summit, Yeltsin agreed that all aspects of the deal which would leave Iran in a position to create nuclear weapons from the reactor project would be eliminated (uranium enrichment, leaving the spent fuel rods in Iran), which was formalized by the Gore-Chernomyrdin Commission in June 1995. An agreement between Iran and Russia was officially signed in late August regarding the return of fuel to Russia; work on Bushehr was scheduled to start in October, with a timeframe of 55 months to completion. Senate Republicans threatened to prevent $250 million in economic aid shortly after the agreement was signed. However, the Russian Deputy Atomic Energy Minister in charge of nuclear fuel cycle activities (Yevgeniy Mikerin) claimed in an interview in December that Russia might not repatriate the fuel.

The US’s attempt to coerce Russia into stopping the Bushehr reactor deal in 1995 was in part hamstrung by three linked policy issues; first, a desire to continue aid to Russia, since the Nunn-Lugar nuclear safety and security programs that were in danger of being...
canceled directly contributed to US security; second, the simultaneous discussion of expansion of NATO, which left the Russians in an uncooperative mood; third (ironically), the US promise to build light-water reactors for North Korea. While the United States attempted to draw a distinction between swapping North Korea’s plutonium production reactors for light water reactors and Iran’s attempts to gain a reactor in the first place, these claims fell on deaf Russian ears. Moreover, both the United States and Russia were highly constrained by hard-line domestic opposition to cooperation.

More Obstacles, 1996–2000

The Ukraine temporarily flirted with cooperating with Iran in 1996 and 1997, when the Turboatom plant offered to supply turbines for Bushehr for $45 million. However, later in 1997 Ukrainian President Leonid Kuchma announced that his country would not supply equipment for Iran’s Bushehr nuclear plant project. Through 1998, the United States continued to put substantial pressure on Ukraine to not assist in the Bushehr project, including holding up a $1.2 billion sale of a reactor to Ukraine. In March 1998, Secretary Albright signed an agreement with Ukrainian Foreign Minister Hennadiy Udovenko to block the Ukraine from participating in the Bushehr reactor deal, although turmoil continued in the Ukraine for months after. Later, officials complained that they had suffered “significant economic losses,” one putting the tally at $1.5 billion; an unlikely figure given that Russia was only charging $800 million for the entire plant at the time.

Progress on Bushehr was slow due to technical problems with fitting the horizontal VVER steam generators in place of the vertical Siemens generators. Other major issues included financing difficulties stemming from barter versus cash agreements, objections to having Jewish Russians financing parts of the project, earthquake mitigation, friction between Iranians and Russians at the work site, and problems with Iranian subcontractors.

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75 Hiatt 1995
76 Katz 1995
77 Kohler 1996; Cordesman 2000: 12.
78 Brall 1997
79 Agence France Presse 1998
80 Gordon 1998b
81 Deutsche Presse-Agentur 2002b
82 Hibbs 1996d
who performed so poorly that in a 25 month period, they set back the project by 20 months. Iran converted the project to a “turnkey” in February 1998 due to past problems with the Iranian portion of the Bushehr plant; this may in part have been due to bad management by the AEOI head Amrollahi, who was replaced in late 1997.\footnote{Cordesman 2000, 12-13:4.} In early March 1998, the Russian Atomic Energy Minister, Viktor Mikhailov, was replaced by Yevgeniy Adamov\footnote{Gordon 1998a.} however, no change in Russia’s policy towards Iran occurred. Russia promised to make the turbines in St. Petersburg instead of the Ukraine shortly after the Albright-Udovenko agreement. Adamov announced in April that Russia was also planning on building a research reactor in Iran\footnote{Washington Post 1998.} However, this reactor was never built. Madeleine Albright issued an ultimatum to Russian Foreign Minister Igor Ivanov to pull out of nuclear projects with Iran or risk a reduction in funding for nuclear disarmament and nonproliferation issues (it appeared that this was directed at new projects, as opposed to Bushehr); in response to the threats, Russian officials spoke in favor of tougher control over the export of technology and equipment by Russian enterprises to Iran\footnote{Antonov 1998.}

After vetoing legislation that would have required the administration to implement sanctions against Russian entities unless the president determined that a waiver of sanctions was “essential” to U.S. national security, in 1998 the Clinton administration modified an existing executive order to be able to implement such sanctions—but at its instigation—to prevent an override of the veto.\footnote{Rice 2000.} The administration then targeted seven Russian entities for sanctions instead of warning the Russian government directly.\footnote{Interfax (Moscow) 1998.} Apparently these targeted sanctions were successful in convincing some of these entities to cease cooperation; however, others took over instead.\footnote{Eisenstadt 2001.} The House also cut IAEA funding by the amount that the IAEA spent assisting Iran with Bushehr\footnote{Abrams 1998.} Pressure on other governments regarding Bushehr continued; the Czech company ZVVZ Milevsko was to provide air-conditioning equipment for Bushehr, but the threat of sanctions from the United States and Great Britain...
caused the Czech government to pass a bill in April 2000 to ban Czech companies from participating in the project; ZVVZ Milevsko was compensated for the loss of business. In April 2000, Russian Security Council Secretary Sergei Ivanov modified a 1995 Russian-American protocol to halt arms exports to Tehran to include previously agreed-upon contracts, and Russian President Vladimir Putin altered the 1992 presidential decree “On Controlling the Export of Nuclear Materials, Equipment and Technologies From the Russian Federation” to allow Russia to export nuclear technology to countries whose programs are not completely monitored by the IAEA (with Iran, Cuba, and India as the likely recipients). In late November 2000, Russia abrogated the 1995 Gore-Chernomyrdin agreement on sales of conventional arms to Iran.

The Clinton Administration was initially successful in its strategy to attempt to confound foreign involvement in the Bushehr project, cancelling sales from the Ukraine and the Czech Republic. However, these moves simply redistributed the sources of those components to Russia, while spending diplomatic capital and potentially harming relations with both countries, as the companies had to be compensated for their losses by their governments. Sanctions targeted at individual companies rather than governments had some limited success (although these were also preferable to the previous situation, in which Russia occasionally reacted to leaks passed on from the United States regarding potential violations of export controls simply by silencing leaks rather than solving the problem). However, these were (and continued to be) more symbolic than effective, since some targeted companies did not do any business with the United States, and others that gave up their activities were simply replaced by new companies who did not have ties with the United States.

Bush and Russia, 2001–2002

At the end of March 2001, Russian President Vladimir Putin replaced Minatom head Yevgeny Adamov with Aleksandr Rumyantsev, director of the Kurchatov Institute. No changes in Iran policy were expected; Putin reaffirmed around the same time that nuclear
cooperation would continue with Iran, blaming delays on “sluggishness on both the Iranian and Russian side.” A shipment of aluminum in June 2001 suspected to be intended for use as centrifuge rotors from Russia was boarded; the Russian inspectors claimed that the aluminum was to be used for aircraft. In December, Russia signed a new partnership agreement with Iran including the "peaceful use of the nuclear atom." Concerns about Russian export control policy continued; a few “bottom-feeder” companies were blamed for unauthorized transfers. Reports surfaced in February 2002 claiming that Iranian scientists being trained at Nikiet ostensibly for reactor technology were actually part of an Iranian nuclear weapons program. However, in June 2002, Deputy Atomic Energy Minister Valery Lebedev affirmed that Russia would take back spent fuel—after three years had passed to allow the fuel to cool off. Russian Atomic Energy Minister Alexander Rumyantsev confirmed this in July, saying that a protocol with Iran for taking back the fuel would be signed that fall. The protocol had been written in November 1998 but had not yet been signed, since the Duma did not pass a law until 2001 to allow reimporting the spent fuel. However, a full agreement wasn’t completed until 2005.

Following the Clinton administration’s shift to placing sanctions directly on foreign companies and entities that are suspected of contributing to Iran’s weapons programs, the Bush administration placed penalties on Chinese, Armenian, and Moldovan companies (the latter two as Russian companies operating in the former Soviet states) in January and May 2002 under the Iran Nonproliferation Act.

A much-mooted proposal for Russia to build additional reactors in Iran was released in late July 2002, but formal contracting was postponed until the completion of the Bushehr plant. The United States raised objections to this move; President Bush had thought that he had been assured by Russian President Putin that cooperation would be limited to the
CHAPTER 5. IRAN

Bushehr reactor\textsuperscript{103} Some members of the Bush administration supported a pre-emption option on the reactors; Israel publicly warned Iran that it considered Bushehr to be a threat to its national security.\textsuperscript{104} In October 2002, John Bolton implicitly threatened Russia with further delays of nonproliferation funds: “Concerns about Russia’s performance on its arms control and nonproliferation commitments have already adversely affected important bilateral efforts, and unless resolved could pose a threat to new initiatives.”\textsuperscript{105} However, US officials reportedly offered assistance in lowering barriers to Russia’s importation of spent fuel from the rest of the world (a potentially lucrative market) in exchange for a cessation of nuclear activities with Iran, which was rejected by Russia.\textsuperscript{106}

Iran claimed that fuel for Bushehr would be supplied by May 2003, and that construction on the Isfahan uranium conversion facility would be inaugurated around the same time.\textsuperscript{107} However, this optimistic deadline hasn’t been met either.

5.3.2 China

After Russia, China has made the largest contribution towards Iran’s nuclear power program (Pakistan notwithstanding). In 1984, Iran opened up a new nuclear research center at Isfahan with assistance from China.\textsuperscript{108} China also provided training for nuclear engineers through agreements signed in 1989 and 1991.\textsuperscript{109} Iran received a calutron from China in 1989, which IAEA inspectors viewed at Karaj in 1992.\textsuperscript{110} Iran’s calutron was only one milliamp, versus the 600 milliamp machines used by Iraq, making it unsuitable for uranium enrichment on a scale of interest to proliferators.\textsuperscript{111} In 1990, an agreement was reached for additional calutrons, uranium enrichment technology, and a 27 MWt reactor to be added to Isfahan.\textsuperscript{112} An initial contract was also signed for the delivery of two 300 MWe reactors in 1992. China signed another contract with Iran for a 27 kWt research reactor in
1991 and delivered 1.8 tons of uranium to Iran, which went undeclared until 2003. Two sub-critical facilities were delivered in 1992. However, US pressure on China over most-favored-nation (MFN) trading status stopped the sale of the 27 MWt heavy-water reactor in 1993.

Chinese cooperation with Iran continued through the mid-nineties. Around 1994, a copper-vapor laser and a supply of tri-butyl phosphate (TBP), a chemical used to separate uranium and plutonium from other elements, were also supplied by China. In particular, extensive negotiations regarding the two 300MWe reactors agreed to in 1992. The United States objected strongly to the sale; in talks with Chinese foreign minister Qian Qichen in April 1995, US Secretary of State Warren Christopher warned that nuclear cooperation with Iran was “too dangerous to justify.” However, for multiple reasons, including US pressure and extensive use of components manufactured in other countries that could be embargoed (i.e. Germany and Japan), the Chinese promised to cancel the deal for the two reactors in a meeting with US Secretary of State Warren Christopher in September 1995. The only reactor projects completed in this period by China were a small 27 kWt miniature neutron source reactor at Isfahan, which went critical in mid-1994, and a zero-power heavy water reactor that went critical in 1995. US pressure also kept Pakistan from allowing Iranian access to a Chinese-supplied reactor in Pakistan. Iran also appears to have been seeking a uranium hexafluoride conversion plant from China around the same time, which was only started before being blocked by the United States; however, China left extensive blueprints, which Iran used to build the facility. At the time, Iran claimed that it was going to use the facility to create uranium hexafluoride from natural uranium, then export the hexafluoride to be enriched for use as nuclear fuel in the Bushehr reactor; its clandestine domestic enrichment program was only discovered later.

The Chinese contribution to Iran’s nuclear program continued to waver; after having

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11 Skootsky 1995
12 Hibbs 1992d
14 Hibbs 1994a
15 Walker 1995
16 Sciolino 1995
18 Hibbs 1994d
promised that the two 300 MWe power plants would be canceled, Iranian and Chinese officials claimed in late 1995 that there were simply disagreements over the site. On January 9, 1996, China announced that the reactors were canceled again. However, in mid-April, Chinese technicians arrived to begin construction of a facility to create uranium hexafluoride. US pressure in November 1996 by US Undersecretary of State for Arms Control and International Affairs Lynn Davis led to a Chinese pledge to withdraw from the project; however, the IAEA continued to report that China was still preparing to complete it. In response, the United States postponed certification under a 1984 nuclear cooperation agreement that would allow export of certain nuclear components to China from the United States.

In October 1997, Chinese Foreign Minister Quian Qichen made a pledge in a meeting with US Secretary of State Madeleine Albright to discontinue nuclear assistance to Iran, with the exception of two small projects (a zero-power research reactor that used natural uranium and heavy water, and a zirconium tube factory); the UF₆ facility was to be scrapped. Formal certification of China’s nonproliferation credentials were transmitted to Congress in December.

Interactions between China and the United States continued in 1998; in January, President Clinton certified China as meeting its non-proliferation commitments, although suspicions lingered. In March, the Chinese agreed to suspend the sale of hundreds of tons of anhydrous hydrogen fluoride (AHF), enough for “a lifelong supply” of the chemical, needed to convert uranium dioxide to uranium tetrafluoride for enrichment. However, the contract was with a private supplier and was only in the very early stages. After 1998, however, Chinese cooperation with Iran seems to have ended.

US efforts with China were more successful than its efforts with Russia. In the case of China, the United States had greater leverage, including a threat to revoke MFN status,
which seemed to work to get China to cancel the research reactor deal. Additionally, since unlike Russia, China could not manufacture all of the components of the proffered 300MWe reactors, there were more susceptible to outside pressure. The United States also had an excellent carrot: the supply of nuclear technology that have already been agreed to back in 1984, but which was based on Chinese compliance with nonproliferation. Unlike the Nunn-Lugar funding, the United States only had a financial, not a security stake in this program, and so could more credibly threaten to withhold funds.

### 5.3.3 Other States

The United States did manage to successfully exert pressure on nations apart from Russia and China to cut back on or eliminate the flow of nuclear technology to Iran. Three cases not connected to the Bushehr reactor stand out: cooperation with Argentina, India, and Kazakhstan. The United States successfully convinced Argentina not to cooperate with Iran apart from replacing the HEU fuel in Iran’s US-made research reactor with LEU. When the United States cut off Iran’s supply of uranium for its research reactor, the availability of another potential supplier may have undercut the US ability to monitor the Teheran research center without limiting proliferation, since the amount of HEU in the reactor was much smaller than the amount required to construct a weapon.

In 1985, Argentina signed a general nuclear cooperation agreement with Iran to (among other things) reconfigure the US-built research reactor to run on 20% enriched uranium rather than HEU and to sell Iran the required fuel; a specific agreement was signed in 1987; the IAEA approved the transfer of enriched uranium in September 1988. Argentina is also suspected of having transferred a few tons of uranium dioxide to Iran via Algeria, although evidence of this has yet to appear in any of the extensive IAEA reports on Iran’s undeclared uranium imports. However, the United States shared information with Argentina that kept the deal from progressing past this point, preventing the sale of a pilot fuel fabrication facility and a uranium dioxide conversion plant, essential equipment that

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131 Hibbs 1992c.  
had been ready for shipping; the collapse of this deal also pre-empted negotiations between

Iran also sought a small research reactor from India\footnote{Middle East Defense News 1992c} which was suppressed due to US pressure.\footnote{Krosney 1993, Coll 1992} In these cases, the pressure exerted was primarily through information-sharing and economic incentives rather than through economic or diplomatic sanctions; it appears that India’s decision was due to a diplomatic visit by Assistant Secretary of State Bartholomew in 1991 that convinced the Indians that Iran’s aims were suspicious.\footnote{Krosney 1993, Wallfish 1993} the Argentine firm that stood to lose business was compensated through promises of better ties with US firms.\footnote{Coll 1992}

Concern was also raised in the early 1990s over Iranian visits to a beryllium plant in
Kazakhstan in 1992-3, and whether the Iranians had sought beryllium, LEU, or HEU. The
discovery that 600 kg of HEU was inadequately safeguarded at or near the plant which the
Iranians had visited led the United States and Britain to conduct Operation Sapphire, in
which the HEU was purchased and removed in November 1994. However, US and Kazakh
sources later said that the Iranians were seeking LEU and did not try to purchase or steal
the fuel.\footnote{Coll 1992} It was subsequently discovered that the material in question was only enriched
to between 30 and 60 percent $^{235} \text{U}$, some of it had been already used as naval reactor fuel,
and that much of it was contaminated with other isotopes.\footnote{Dizard III 1994}

\section*{5.3.4 Bilateral Actions}

The United States cut off supplies of HEU for the Tehran University reactor in 1979 and
began an embargo on the import of Iranian oil as well as the export of weapons and spare
parts for weapons. Another layer of sanctions was placed on Iran in 1984 when they were
added to the State Department’s State Sponsors of Terrorism list. Most US imports from
Iran were banned in late 1987\footnote{Schott 1997} A third layer was added when Congress passed the 1992
Iran-Iraq Arms Non-Proliferation Act, which prohibited the export of dual-use technology and required sanctions against foreign entities that export items that “materially contribute to either country’s acquiring chemical, biological, nuclear, or destabilizing numbers and types of advanced conventional weapons.”

The United States also attempted to exert direct pressure on Iran; Secretary of State Warren Christopher warned Iran in June 1993 that it could not have “normal commercial relations” while attempting to develop nuclear weapons. Clinton announced that he would ban all US trade with Iran on April 30, 1995, including $326 million in US exports to Iran and approximately $800 million in imports of Iranian oil; this was imposed by executive order on May 8. However, a US call for a multilateral embargo failed. A bill was passed and signed in December 1995 (the Iran and Libya Sanctions Act) to place sanctions on foreign firms that contribute to the development of oil in Iran.

The replacement of Warren Christopher as Secretary of State with Madeleine Albright in January 1997 also opened up the possibility that US policy would also soften. However, the softening of the administration was undercut by a Congress determined to keep the pressure on Iran. After a fight with President Clinton in 1998 which led to a veto of the Iran Nonproliferation Act of 2000) in March 2000; although its main effect was to increase reporting requirements, it didn’t help relations with either Russia or Iran, since it called for cutting back cooperation with Russia (at least this time with respect to the international space station, not nonproliferation objectives) if the president did not certify that Russia was not “demonstrating a

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142 House of Representatives 1992
143 Kempster 1993
144 Devroy 1995
145 Barbash 1995
146 Lippman 1995
147 Hibbs 1997
148 Associated Press 2000
149 Rice 2000
sustained commitment to seek out and prevent” aid to Iranian weapons programs. Secretary of State Albright made a concessionary speech on March 17, 2000 that admitted US support for the Shah in 1953 and for Iraq between 1980-1988. She also promised an easing of sanctions; in the context of the recently passed Iran Nonproliferation Act, however, it engendered a hostile official response from Iran. Similarly, the 2000 Iran Nonproliferation Act mainly increased tensions with Russia.

A temporary thaw in US-Iranian relations after September 11, which culminated in a handshake between Secretary of State Colin Powell and Iranian Foreign Minister Kamal Kharazi after a UN meeting on the future of Afghanistan, quickly disappeared once President Bush named Iran as part of an “Axis of evil” in his 2002 State of the Union speech, and Iran was one of seven countries mentioned in the leaked Nuclear Posture Review; Iran protested to the UN. In May, Iran was found to have placed air defense batteries around the Bushehr plant.

The cumulative effect of US sanctions (both economic and social) on Iran has been largely nonexistent or negative. Since the United States effectively ran out of bilateral sanctions in the 1980s, it turned to sanctioning third parties in the 1990s. The 1992 Iran-Iraq Arms Non-Proliferation Act was directed specifically at biological, chemical, and nuclear weapons (as well as advanced conventional weapons); however, the 1996 Iran and Libya Sanctions Act broadened this to other commercial dealings, which primarily had the effect of increasing tensions with Europe, but little effect on Iran. The Clinton administration attempted to open up a 'dialogue of civilizations,’ between 1998 and 2000. Unfortunately, the peak of this policy—Madeleine Albright’s apology to Iran for previous US actions—occurred long after conservatives had re-established control of Iranian institutions, and therefore fell on deaf ears.
5.4 Iranian Clandestine Action, 1979-2002

US policy was consistent, and in general successful, against Iranian nuclear moves that involved outside suppliers. Unfortunately, US intelligence failed to discover or stop transfers from the A.Q. Khan network to Iran. Oddly enough given this lapse, US intelligence (and other services) consistently overestimated Iran’s progress in its nuclear program. While these estimates proved to be useful in the short term in convincing certain suppliers (notably India and Argentina), in the long term it has undermined US intelligence credibility. The IAEA fared little better; for years, it visited Iranian nuclear facilities and failed to detect any clandestine experiments. Still, this is in part due to a lack of power on the IAEA’s part; most inspections were only visits without monitoring equipment. In the next three subsections, I give an overview of intelligence about Iran’s clandestine program, a description of the actual covert experiments that Iran carried out, and IAEA attempts to uncover these experiments through inspections.

5.4.1 Intelligence Estimates

Estimates of Iran’s nuclear capabilities have varied greatly over the years; here I list a small sampling of the most widely cited estimates (almost all proven to be wrong so far). The most reasonable (and nuanced) estimate was made by Bill Perry in the mid-1990s, who separated the estimate into two parts: less than five years if they already had fissile material, and more than five years if they didn’t. Most estimates are usually based on (implicitly) assuming one of these two conditions.

In 1984 came the first report of an impending Iranian nuclear weapon from West German intelligence, supposedly within two years. US intelligence officials in 1987 reportedly said that Iran was close to producing a suitcase bomb. Another scare came in 1991, when numerous reports claimed that Iran purchased three nuclear warheads from Kazakhstan; the stories turned out to be false, and the supposedly missing warheads were apparently at the bottom of three test shafts at the Semipalatinsk test site.

\[156\] Timmerman 1992, 43.
\[158\] Middle East Defense News 1992b.
During the 1990s, concerns about Iran seeking centrifuge technology abroad continued to grow. Around the time of the 1995 crisis with Russia, many predictions surfaced. One senior official noted that “Iran is concentrating on centrifuge designs and looking toward a pilot plant,” and likely had plans for “G1 and G2” centrifuges (which turned out to be quite close to the truth, unlike most estimates). Predictions of when Iran would produce a nuclear weapon range varied greatly, with the low end two to five years. Secretary of Defense William Perry offered two ranges, one with fissile material (maximum five years), the other without (minimum five years). Secretary of State Warren Christopher in 1995 described Iran’s program as a “crash effort to develop nuclear weapons.”

Dire warnings of Iranian nuclear capacity slowed somewhat after 1995. Israeli Prime Minister Shimon Peres claimed in April 1996 that Iran could have nuclear weapons within four years. However, John Holum, director of the US Arms Control and Disarmament Agency, predicted in 1997 that Iran would not be able to produce enough fissile material until 2005-2007, versus 2003 two years previously. In 1998, an Israeli paper cited “experts” as claiming that Iran could have a weapon within three years, Iran and Pakistan were cooperating, and that Iran was working to acquire uranium enrichment technology.

The CIA changed its assessment of Iran in 2000, arguing that it could not rule out Iran’s development of a bomb simply because it could not reliably track Iran’s acquisition. Israeli intelligence, which had formerly predicted an Iran nuclear weapon by 2000, came up with a new prediction (2005) when that date passed; however, this new estimate was disputed by the defence minister, who argues that Iran was further behind.

CIA director George Tenet gave an unusually long timeframe for Iranian acquisition of nuclear weapons in February 2002, predicting proliferation by the end of the decade if Iran received no fissile materials from outside the country. By contrast, Amin Tarzi, an
analyst at Monterey, argued that “Iran’s [nuclear] program is in shambles, and the people who read all the intelligence know that.”  

The difficulty with these estimates is threefold: first, they all tend to be worst-case scenarios in which no errors or problems are assumed to crop up; second, they tend to assume that Iran will acquire fissile materials; third, they often come up in a context for the United States is attempting to convince other states to curtail cooperation with Iran, producing short-term gains while sacrificing long-term credibility. However, sharing estimates of intentions with friendly suppliers seems to be a highly effective tool; in India and Argentina, diplomatic visits that stressed Iran’s intentions seemed to work. Such tactics were less effective in Russia and China.

5.4.2 Domestic and Clandestine Uranium Experiments

Iran has developed its domestic capabilities significantly, in part due to consistent US attempts to block supplies of foreign technology. While it imported small amounts of uranium from other countries (in particular, China), it has worked steadily on mining and milling uranium domestically. Its uranium and laser enrichment programs, initially reliant on foreign suppliers, have become increasingly self-reliant. However, Iran has encountered substantial difficulties with both programs as a result.

Iran discovered uranium deposits at the Saghand mine in Yazd in 1985. Plans were drawn up in the late 1980s to exploit these deposits; a uranium processing center was reportedly finished in 1989 and possibly opened in 1990. Note that center itself is to process the ore; the mine itself is not expected to be fully operational until the end of 2006. A supply of uranium from Namibia via South Africa was rumored to have continued through 1989; when “large amounts” of uranium were transferred according to one report. However, after extensive surveys, the IAEA only found two instances of unreported imports: 1.8 tons of natural uranium from China in 1991 and 50 kg of natural

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168 Peterson 2002a
169 Timmerman 1992, 47.
171 IAEA Board of Governors 2004a, 3.
172 Krosney 1993, 250.
uranium metal in 1993 from an unidentified source as part of a laser enrichment project. The natural uranium consisted of UF\(_6\) (1000 kg), UF\(_4\) (400 kg) and UO\(_2\) (400 kg).\(^{174}\) Iran also sought LEU from Kazakhstan in 1992-1993.\(^{175}\)

Iran has had an extensive clandestine uranium enrichment program that has primarily relied on cooperation with Pakistan. In 1985, Iran began a concerted effort to develop uranium enrichment facilities using open-source data and brought a small-scale fuel fabrication laboratory into operation.\(^{176}\) The beginning date of cooperation between Pakistan and Iran is somewhat fuzzy. Some sources claimed that A.Q. Khan visited Bushehr in 1986 and 1987 and that Iran and Pakistan signed a nuclear cooperation agreement.\(^{177}\) Another more recent source claims that a meeting occurred in 1987 in Dubai.\(^{178}\) A third identifies a meeting in 1988.\(^{179}\) In any case, cooperation began in the mid-to-late 1980s, although it is unclear to what extent this cooperation was sanctioned by Pakistan’s government. Centrifuge research was carried out from 1988 until 1995 at the Teheran Nuclear Research Center, using the plans provided by A.Q. Khan as a starting point.\(^{180}\)

A separate agreement was signed in 1987 or 1988 between Munir A. Khan, Chairman of the Pakistan Atomic Energy Commission and Reza Amrollahi, head of the AEOI, that permitted Iranian scientists to travel to Pakistan for general nuclear training.\(^{181}\) Low-level cooperation may also have existed between North Korea and Iran on nuclear technology, although this cooperation is a speculative outgrowth of the ballistic missile ties between the two.\(^{182}\)

There are also claims that AEOI head Amrollahi visited South Africa in early 1996 with a “comprehensive list of requested items,” but the parties involved denied the meeting had taken place.\(^{183}\) In July 1996, British customs seized 50 kg of maraging steel on its way to Iran, which can be used as rotors for G2-type centrifuges (although very few could be

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\(^{174}\) IAEA Board of Governors 2004a 4,13.
\(^{175}\) Hibbs 1995c.
\(^{176}\) IAEA Board of Governors 2004a 6,8,14.
\(^{178}\) Linzer 2005.
\(^{179}\) Hibbs 1991a.
\(^{180}\) IAEA Board of Governors 2004a 8.
\(^{181}\) Dean 1988; Krosney 1993 249.
\(^{182}\) Krosney 1993 249.
\(^{183}\) Venter 1997; Gilmore 1997.
made out of only 50 kg. Iran did receive plans for the P2 (a.k.a. G-2) centrifuge in the mid-1990s, but claimed to have put aside the plans until 2002 due to a lack of resources and an inability to manufacture the maraging steel rotors needed for the G-2.

Iran received parts for 500 (used) P1 centrifuges from the network in two shipments, one in March 1994 and the other in July 1996. Work on the P1 centrifuge was conducted at the Kalaye Electric Company from 1995 to 2003. The most extensive experiment conducted there occurred in 2002, when UF$_6$ was fed into a small test cascade of 19 machines. Work moved to the Natanz facility in 2003. Many of the centrifuges Iran put together were found to be defective.

Laser enrichment, first explored in the days of the Shah, was restarted in 1987, when a laser isotope separation conference was held. Iran developed a small domestic industry during the 1990s, but still remained dependent on clandestine foreign imports. Iran carried out testing at TNRC between 1993 and 2000. Iran contracted with a foreign supplier (possibly China) to deliver laser enrichment equipment in the early 1990s. Experiments were reportedly successful; an analysis carried out by the foreign supplier involved in the project claimed that the highest average enrichment achieved was 8%, and the peak enrichment was 13%; however, after 1994, Iran was unable to perform useful enrichment.

In the late 1990s, the United States pressured Russia not to sell technology that could be used for laser enrichment to Iran, despite the fact that the United States Enrichment Corporation (USEC) abandoned the technology in 1999 as too expensive after investing $2 billion. Russia temporarily halted the sales, despite the wattage of the lasers falling well below the Nuclear Suppliers Group threshold of 40W. Iran moved its research from TNRC to Lashkar Ab’ad in 2002 and attempted to set up a pilot plant, but dismantled the equipment there by 2003.
Many US attempts to block clandestine activities were thus directed at the wrong targets; laser enrichment, as the USEC determined, is a technological dead end that the Iranians have had little success with. Iran’s uranium enrichment program, on the other hand, has achieved much more success. Fortunately, due to the difficulty of passing on tacit knowledge (discussed in-depth in Chapter 6), such lapses have not hurt as much as they might have.

### 5.4.3 IAEA inspections

If the intelligence agencies have not done well, neither have the inspectors on the ground. The IAEA made several visits to Iran between 1992 and 2000, most based on information from third parties. However, these were not official inspections with full equipment, and uncovered nothing due to a lack of equipment; some of the sites were conducting nuclear activities that should have been reported. The IAEA made an initial visit in 1992 to six nuclear sites (Bushehr, the Isfahan Nuclear Technology Center, the Amirabad Nuclear Research Center in Tehran, the Karaj Agricultural and Medical Research Center, Saghand, and Moallem Kalayeh) without measuring equipment. The IAEA gave Iran a clean bill of health, but suspicions remained regarding additional sites, and whether the inspectors had been taken to the real suspected nuclear sites. A second visit in 1993 included Isfahan, Karaj, and Tehran.

The IAEA was sent a team to investigate charges that Iran had a clandestine uranium enrichment program in March 1996, but the inspectors’ visits uncovered nothing. Iran objected in October 1996 to environmental monitoring of its nuclear facilities, supposedly to prevent the United States from obtaining samples. The IAEA also demanded that Pakistan curb its nuclear pursuits, including exports to Iran, Iraq, and North Korea; however, they appeared to be objecting to re-exports of West German technology rather than the exports of indigenous Pakistani technology that were taking place at that time.

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196 Hibbs 1996b.
197 Hibbs 1996c.
198 Alam 1996.
Hans Blix, the then-Director General of the IAEA, made a visit in July 1997 that included three smaller research centers (Karaj, Bonab, and Ramsar), and found nothing out of place. Karaj later turned out to be a radioactive waste storage facility. A final visit in May 2000 by the new Director General, Mohammed El Baradei, included the Bushehr nuclear power plant and found nothing out of place. However, Iran refused in May 2000 to sign INFCIRC-540, known as the Additional Protocol, without assurances that the United States would reciprocate by halting obstructions to Iran’s nuclear program.

Although the IAEA didn’t manage to uncover any activities until 2002 due to a general lack of a mandate or intelligence to search Iran for suspect activities, solid support from member states and good intelligence have enabled the IAEA to uncover significant portions of Iran’s program since then.

5.5 The Iranian Nuclear Crisis, 2002–2003

In mid-August 2002, the National Council of Resistance of Iran, formerly known as the Mujahedin-e Khalq, announced that Iran had two clandestine nuclear facilities: a “nuclear fuel production plant and research lab at Natanz and a heavy water production plant at Arak.” Both were reported to be near completion. These reports were confirmed by CNN in December. However, IAEA head El Baradei said that he had known for six months about the facilities; Iran officially informed the IAEA of the facilities in September 2002. A visit by El Baradei originally planned for October was rescheduled by the Iranians for February 2003; during the meeting, Iran agreed to provide design information on future new facilities in advance, a standard provision that most other states in the IAEA had already agreed to. Accordingly, in May, Iran informed the Agency that it would construct a 40 MWt heavy water research reactor at Arak (the IR-40) and build a fuel manufacturing plant at Isfahan planned to go into operation in 2007. Iran also admitted the receipt in

199 Hibbs 2000a.
200 Lumpkin 2002.
201 Albright and Hinderstein 2002.
202 Dareini 2002.
1991 of previously unreported natural uranium imported from China. The total effective amount of uranium (i.e. $^{235}\text{U}$) was insufficient for a nuclear weapon, and when measured in the IAEA’s slightly odd unit of “effective kilograms,” was only 0.13, which (as Iran pointed out in its reply) was under the inspection (but not reporting) threshold. Iran claimed that it had informed the IAEA of the facilities in June 2002, while State Department spokesman Richard Boucher argued that they admitted the existence of the facilities only after they had been made public.

In May, the United States lobbied to have Iran found in violation of the NPT by the IAEA; Secretary of State Colin Powell expressed concern, but said that it was not a matter for military action “at the moment.” However, the Pentagon urged a harder line; Senator Sam Brownback proposed the Iran Democracy Act to fund Iranian opposition groups which passed, albeit without funding. Members of the House also pushed the administration to use the 1996 Iran and Libya Sanctions Act to put sanctions on companies dealing with Iran; through June 2003, it had never been used. The US government shortly after imposed sanctions on Chinese and North Korean companies under the 2000 Iran Nonproliferation Act, however.

In general, the US response was hampered by internal divisions within the administration; as George Perkovich observed, “The administration does not have a strategy because there is a fight in the administration over whether you should even deal with this government in Iran.”

At the end of May, the EU also decided to step up diplomatic pressure regarding its weapons program. Russia also threatened to not supply fuel for the Bushehr reactor.
5.5. THE IRANIAN NUCLEAR CRISIS, 2002–2003

unless Iran signed the Additional Protocol\textsuperscript{216} but in early June declined to make this a requirement, instead insisting on the return of the fuel\textsuperscript{217}

In its June 2003 meeting, the IAEA Board fell short of reporting Iran in violation of the NPT; however, the detection on June 11 of HEU particles at the Natanz facility raised suspicions, and Iran went ahead with introducing \( \text{UF}_6 \) into centrifuges at the PFEP (Pilot Fuel Enrichment Plant), first into single machines on June 25, then into a small ten-machine cascade on August 19\textsuperscript{218} After the negative report\textsuperscript{219} which the secretary of the Supreme National Security Council, Hassan Rohani, termed “technical problems,” El Baradei visited Iran again on July 9\textsuperscript{220} Just before his July trip, El Baradei encouraged the Iranians to sign the Additional Protocol\textsuperscript{221} Iranian President Khatami promised ElBaradei during his trip that advance notice would be given on further construction, but stopped short of promising to sign the Protocol\textsuperscript{222} The inspection was cut short due to the post-war search for nuclear facilities in Iraq; El Baradei only visited Natanz, and not Arak or Bushehr. A small cascade of centrifuges was discovered already in place there, which El Baradei deemed “sophisticated.”\textsuperscript{223} A subsequent report revealed for the first time that Iran admitted it had received drawings of the centrifuges in 1987 and components, but no assistance with assembly or training.\textsuperscript{224} Soon after, in an interview AEOI head Aghazadeh offered to sign the Additional Protocol if nuclear-related sanctions were lifted by Western countries\textsuperscript{225}

A technical demonstration was made to the IAEA on July 13 of the planned Iranian indigenously-designed heavy-water reactor which was claimed to be for the production of isotopes\textsuperscript{226} Some suspicions were raised over the purpose of this reactor, as no plans were included for hot cells to separate out the isotopes, and the heavy manipulators and leaded windows Iran sought had specifications that were excessive for isotope separation,\textsuperscript{216} Dinmore 2003b, 217\textsuperscript{Sands 2003}, 218\textsuperscript{IAEA Board of Governors 2003c, 2,7}, 219\textsuperscript{IAEA Board of Governors 2003b}, 220\textsuperscript{Fathi 2003}, 221\textsuperscript{Charbonneau 2003a}, 222\textsuperscript{Gordon 2003}, 223\textsuperscript{IAEA Board of Governors 2003c, 6-7}, 224\textsuperscript{Associated Press 2003}, 225\textsuperscript{IAEA Board of Governors 2003c, 8}
but appropriate for fuel reprocessing (i.e. plutonium separation).\footnote{IAEA Board of Governors\textit{2004b}}

During a trip to Iran in late June, British Foreign Minister Jack Straw called on the government to ratify the Additional Protocol; Iranian Foreign Minister Kamal Kharazi responded that such a move would require positive steps on the part of the international community.\footnote{Smith\textit{2003}} In early August, the EU3 (Britain, France, and Germany) sent a letter to Iran promising access to advanced nuclear technology in exchange for cessation of its uranium enrichment program despite lobbying by the United States; President Khatami responded with a letter promising to enter negotiations to sign the Additional Protocol, but not to abandon enrichment.\footnote{Taylor and Charbonneau\textit{2003}}

On August 24, the Iranian representative to the IAEA declared that they were prepared to begin negotiation on the Additional Protocol.\footnote{IAEA Board of Governors\textit{2003c}} Russia offered to have the United States participate in the building of additional reactors in an attempt to mollify US concerns about Russian cooperation.\footnote{Dareini\textit{2003c}} IAEA Director ElBaradei remarked at the IAEA board meeting in September that “testing with nuclear material must have taken place for Iran to reach the stage that it has.”\footnote{ElBaradei\textit{2003}} The United States circulated a draft resolution declaring Iran in non-compliance, but quickly dropped it due to a lack of support.\footnote{Charbonneau\textit{2003b}} The board passed a resolution on September 12 that decided that Iran must provide a full declaration and grant unrestricted access by the end of October.\footnote{IAEA Board of Governors\textit{2003d}} A spokesman for the State Department warned that failure to comply would result in referral to the Security Council.\footnote{BBC News\textit{2003c}} while Assistant Secretary of State Bolton remarked that all states should be required to sign the Additional Protocol; on the Iranian side, conservative papers called for withdrawal from the NPT, as the Iranian delegation to the IAEA threatened before “storming” out of the IAEA meeting.\footnote{Peterson\textit{2003}} Other influential politicians also proposed leaving; Ayatollah Ahmad Janati, the
head of the Guardian Council, argued that Iran should reconsider its membership. Others argued for signing the Additional Protocol; Deputy Foreign Minister Mohsen Aminzadeh even claimed that it should have been signed years before.

Over American objections, the EU3 (Germany, France, and the United Kingdom) offered incentives to Iran, which were initially rejected. Although Iranian opinion was unanimous on seeing the October deadline as “an affront to Iran’s national dignity,” reformist elements supported signing an Additional Protocol, while more conservative ones supported leaving the NPT. AEOI head Aghazadeh assured the IAEA that Iran was not about to leave the treaty, while Akbar Salehi, Iran’s representative to the IAEA, claimed that they would scale back cooperation. Foreign Minister Kamal Kharrazi said that Iran was willing to negotiate with the IAEA, but was concerned that would be insufficient for the United States. He characterized Iran’s nuclear program as “a matter of national pride to have this capability.” A split between hard-liners and reformers was visible, with Expediency Council head Rafsanjani in the middle.

An IAEA delegation visited Iran, and found additional traces of HEU at the Kalaye Electric Company where initial testing of centrifuges had taken place (the earlier samples had been at Natanz). At the end of September, ElBaradei said that the October 31 deadline was “decisive” and “non-negotiable” but that the deadline provided “ample time.”

Iran assembled a five-member panel to decide the country’s policy towards the deadline. The panel consisted of Foreign Minister Kamal Kharrazi, Minister of Information Ali Yunessi, Defense Minister Ali Shamkhani, Secretary of the High National Security Council Hassan Rowhani, and the supreme religious leader’s Adviser for International Affairs...
CHAPTER 5. IRAN

Ali Velayati. This panel thus balanced three members of the relatively reformist Cabinet (Kharrazi, Yunessi, and Shamkhani) with appointees to the Executive Council (Velayati and Rowhani), although Yunessi was also a cleric. Former President Rafsanjani condemned the IAEA resolution, but indicated that Iran would be willing to meet some international demands for inspection as long as certain sites such as places of worship and military sites were excluded: “...that our national security not be endangered, that our (Islamic) values and our sacred sites not be affected, that (military) secrets unconnected with the nuclear program not be revealed and that others fulfill their duty” to assist Iran with its civilian nuclear program. Salehi, Iran’s IAEA representative, also claimed that Iran was not bound by the IAEA resolution, but would continue to cooperate. Yunessi said Iran would sign the protocol under certain conditions if Iran received more technological assistance with its nuclear program.

External pressure for a military strike increased during this period. British Foreign Minister Jack Straw answered a question about military sanctions by responding that the government wished to see it resolved peacefully, which some took to imply a refusal to take military action off the table. Mossad was reported in this period to have drawn up “achievable” attack plans against six targets in Iran.

On October 16, representatives of the EU3 and ElBaradei flew separately to Iran to attempt to resolve the outstanding issues. The head of the parliament’s National Security and Foreign Policy committee, Mohsen Mirdamadi, advocated a compromise on military sites, expressing a strong desire to avoid being referred to the Security Council. In a meeting on October 16 with the IAEA, Dr. Rohani, Secretary of the Supreme National Security Council of Iran, stated that a decision had been taken to provide a full disclosure of Iran’s nuclear activities, its readiness to conclude an additional protocol, and act in accordance with the protocol pending its entry into force. On October 18, Iran began

\footnotesize{\textsuperscript{247} New York Times 2003a \textsuperscript{248} Ghazi 2003a \textsuperscript{249} Ghazi 2003b \textsuperscript{250} Crerar 2003 \textsuperscript{251} Agence France Presse 2003a \textsuperscript{252} Murphy 2003 \textsuperscript{253} IAEA Board of Governors 2003a 3-4.}
negotiations with the IAEA over the Additional Protocol. This willingness to cooperate was reinforced by a letter from Vice President Aghazadeh the next week. In this letter, Iran admitted that the 1.9 kg of UF₆ that had been formally reported as leaked had been used to test centrifuges at the Kalaye Electric Company between 1999 and 2002, it had had a laser enrichment program between 1992 and 2000 that had used 30 kg of uranium metal, and had irradiated 7 kg of UO₂ targets and extracted small amounts of plutonium between 1988 and 1992. On October 21, the Iranian Government and the Foreign Ministers of France, Germany and the United Kingdom issued in Tehran an agreed statement in which Iran agreed to suspend all uranium enrichment and reprocessing activities, and the EU3 agreed that Iran could get easier access to foreign technology and supplies. Iran also provided a letter to the IAEA that provided a “full picture” of Iran’s nuclear activities. In an additional letter on November 10, Iran accepted the draft text of the additional protocol and officially informed the IAEA of its suspension of uranium-related activities.

Iran made two important decisions during this period. The first, to make a full disclosure to the IAEA, was made probably before October 16; the second was to halt enrichment activities (Iran hadn’t reprocessed in years), which was probably made between the 16th and the 21st. The decision to cooperate with the IAEA was thus decided upon prior to halting enrichment; the offer of the EU3 to assist Iran with its nuclear program (as well as other potentially important incentives not mentioned in the statement on the 21st) probably tipped the balance between simply cooperating and actually halting its program. This freeze probably has set back Iran’s nuclear ambitions between Nov 2003 and May 2005 by at least a year (a rollback of the freeze between June 2004 and Nov 2004 somewhat undercut this benefit).

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254 Dareini 2003a
255 IAEA Board of Governors 2003a 3-4.
256 Iran Ministry of Foreign Affairs 2003.
257 IAEA Board of Governors 2004a 7.
258 IAEA Board of Governors 2003a 3-4.
5.6 Conclusions

US policy towards Iran’s nuclear program has been primarily focused on cutting off the supply of nuclear technology from foreign suppliers. Multiple-party interactions (H7) were therefore key to restricting Iranian progress, since US strategies were supply-side rather than demand-side; the United States had to convince many countries not to supply nuclear technology to Iran. The United States has been fairly successful in preventing known transactions from occurring; except for the Russian construction of Bushehr, no other major nuclear facilities have been provided by foreign entities. For the most part, the United States was able to do this through economic and diplomatic pressure using positive incentives rather than by threatening sanctions, supporting hypotheses H9a (Economic Incentives) and H10a (Social Incentives), while in a few cases the implicit threat of sanctions was used to convince states to cut off support. Over time such barriers are permeable, however. The A.Q. Khan network provided plans and parts for 500 P1 centrifuges as well as plans for P2 centrifuges; however, even without the parts, Iran has been able to construct its own centrifuge program. Similarly, the Chinese plans for a full-scale uranium conversion facility apparently were sufficient to enable Iran to construct the facility using domestic technology in about six years. Although this facility has not been fully tested and has problems (see Chapter 6), this is still a significant achievement.

The diplomatic capital spent on trying to convince various countries not to aid Iran with the Bushehr plant was ineffective in the end; however, sharing of intelligence and gentle diplomatic pressure was effective in preventing Iran from acquiring a medium-sized research reactor, which would be a much more significant threat than Bushehr. As a result of the US campaign to stop Bushehr, Iran has gained support from the non-aligned movement; it has been able to partially justify its uranium enrichment program by pointing out that constant US threats have made future fuel supplies uncertain.

Very little effort has been put into attempting to convince Iran to give up its nuclear program directly; layers of sanctions without any clear path of relief have proven entirely ineffective in convincing Iran. The US made a limited number of attempts to deal directly with Iran, which were complicated by both Iranian and US domestic politics (H4). The
efforts by the Clinton administration to reach out to Iran were rebuffed, in part due to the near-simultaneous sanctions that were placed on Iran or other states if they cooperated with Iran. Ultimately, however, such efforts may have been futile, since reformists lost control of power in Iran, an event that would most likely not have been significantly affected by warming relations with the United States.

Significant opportunities for better relations with the United States have been lost. Offers from Iran to negotiate after the invasion of Afghanistan in 2001 and during the Iraqi War in 2003 were turned down or lost through harsh rhetoric such as calling Iran part of an “axis of evil.” The relative success of the EU3 in halting Iran’s uranium enrichment program through the potential of improved diplomatic and economic ties indicates that negotiation and the offer of improved relations can be significant bargaining chips. Now that Iran’s primary security concern has been ameliorated by the US invasion of Iraq (although it may have simply promoted the United States to the top spot), social benefits such as recognition and integration into the world system may prove to be a useful substitute for nuclear weapons, since Iran would be motivated primarily by inertia and pride rather than military concerns if its concerns about US intentions were assuaged.
Chapter 6

Ringing in Proliferation: How to Dismantle an Atomic Bomb Network

6.1 Introduction

In the previous two chapters, I examined US policies towards North Korea and Iran. While US policies on North Korea focused on decreasing the demand for nuclear weapons, strategies toward Iran have primarily been to block its supply of nuclear technology. In this chapter, I combine these two sides of US policy in order to look at the general problem of second-tier proliferation networks. Demand for proliferation is a measure of how determined states are; supply is a measure of how easy it is for states to acquire technology. In this chapter, I present two perspectives on these two variables: proliferation determinism and proliferation pragmatism. Determinism holds that states are dead set on proliferating and have easy access to technology; consequently, a policy of regime change is necessary. By contrast, pragmatism argues that most states are not so determined to acquire a nuclear weapons capability; nor are proliferation networks structured such that it is easy for new proliferants to acquire nuclear technology.
6.2 Proliferation Determinism

The nonproliferation regime has come under attack from a group of academics and policymakers who argue that traditional tools such as export controls, diplomatic pressure, arms-control agreements, and threats of economic sanctions are no longer sufficient to battle proliferation. They point to North Korea’s reinvigoration of its plutonium program, Iran’s apparent progress in developing a nuclear capability, and the extent of the Abdul Qadeer (A.Q.) Khan network as evidence that the regime is failing. This group claims that proliferation is driven by the inevitable spread of technology from a dense network of suppliers and that certain “rogue” states possess an unflagging determination to acquire nuclear weapons. Consequently, they argue that only extreme measures such as aggressively enforced containment or regime change can slow the addition of several more countries to the nuclear club. This proliferation determinism, at least in rhetoric, is shared by many prominent members of President George W. Bush’s administration and has become the main thrust of U.S. counterproliferation policy. Yet current proliferators are neither as “dead set” on proliferating nor as advanced in their nuclear capabilities as determinists claim. To dismantle the network of existing proliferation programs, the administration should instead move toward a policy of proliferation pragmatism. This would entail abandoning extreme rhetoric, using a full range of incentives and disincentives aimed at states seeking to acquire a nuclear capability, targeting the hubs of proliferation networks, and engaging in direct talks with the Islamic Republic of Iran and the Democratic Peoples’ Republic of Korea (DPRK).

In practice the Bush administration’s nonproliferation policies have been more varied and less aggressive than its rhetoric would suggest. Strong words can be used strategically to convince proliferators that accepting a settlement offer would be better than continuing to hold out. Yet unyielding rhetoric has placed the United States into a position that is difficult to back down from, combined with a lack of positive incentives, this stance has

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2 See, for example, Wolfowitz 2003; Bush 2004; Rice 2004; Bolton 2004b; Cheney 2004.
3 Bolton 2004d.
4 As Vice President Dick Cheney has argued, “I have been charged by the president with making sure that none of the tyrannies in the world are negotiated with. We don’t negotiate with evil; we defeat it.” Quoted in
convincing proliferators that the United States will not agree to or uphold any settlement short of regime change. Moreover, the administration has not formulated any coherent counterproliferation policies other than regime change and an aggressive form of export controls—the Proliferation Security Initiative. With respect to two of the key proliferators today—Iran and North Korea—the United States has shown little interest in offering either any significant incentives or defining any clear red lines. Instead, the United States has been relying almost exclusively on China to convince the DPRK to give up its nuclear program and has declined to join the United Kingdom, France, and Germany in talks with Iran.

Proliferation determinists present two arguments. First, dense networks among second-tier proliferators such as Iran, North Korea, and Libya and private agents—including A.Q. Khan, Buhary Seyed Abu (B.S.A.) Tahir, and Urs Tinner—have rapidly accelerated proliferation and lowered technological barriers. Since these networks are widespread and decentralized, global measures rather than strategies that target individual states become necessary. Second, certain rogue states are dead set on proliferation. These two arguments define two variables—network structure and state intentions—that encompass four potential states of the world. In Figure 1, these four states of the world are mapped to

\[\text{Network Structure}\]

\[\begin{align*}
\text{Centralized–Decentralized} & \\
& {\text{Persuadable–Determined}}
\end{align*}\]

\[\begin{align*}
\text{Incentives} & \\
\text{Isolation} & {\text{Global Controls}}
\end{align*}\]

\[\begin{align*}
\text{Regime Change}
\end{align*}\]

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\[\text{Figure 6.1: Network structure and state intentions (mapped to nonproliferation strategies)}\]

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\[\text{On the roles of Tahir and Tinner, see Polis Diraja Malaysia 2004}\]
four different nonproliferation strategies. Proliferation determinists argue that a number of states (e.g., North Korea, Iran, formerly Libya) are in the upper-right quadrant of Figure 6.1 (regime change); since these regimes are determined to seek nuclear weapons and are connected by effective, decentralized networks, they must be changed. Both parts of the determinist argument are based on an interpretation of the progress of new proliferators that is at odds with publicly available documents. The evidence that new proliferants are well advanced in their nuclear capabilities due to decentralized proliferation networks is contestable; the evidence that certain types of regimes are dead set on nuclear proliferation and cannot be persuaded is even less compelling. Although the source of nuclear knowledge may have shifted from first-tier (advanced industrialized) to second-tier (developing industrial) states, there is no cause for a proliferation panic.

Based on these two critiques, I propose an alternate position—proliferation pragmatism. Pragmatists argue that nuclear proliferation networks are highly centralized and are much less effective than is claimed by determinists, and that proliferators can be persuaded, given sufficient incentives, to halt or roll back their programs. Consequently, most if not necessarily all states are in the lower-left quadrant of Figure 1; proliferation can be slowed or halted by proper application of country-specific incentives selected from a broad palette. The presence of second-tier networks is indeed a new problem, but measures to deal with it should be based on an analysis of the structure of the network and the speed of technological development. The hub-and-spoke structure of nuclear weapons and ballistic missile networks—which, I argue, is due in part to the difficulty of passing on the tacit knowledge required to successfully build and operate these weapons—requires a policy that targets the hubs rather than a policy of system-wide coerced change. Past successes in slowing the spread of nuclear weapons through the use of targeted incentives—rather than demanding regime change—indicate that even the most seemingly determined proliferants can be slowed without resorting to extreme measures.

The two remaining quadrants (global controls and isolation in Figure 1) differ in their policy prescriptions from pragmatism or determinism. If a proliferation network is decentralized but states that are part of it can be persuaded to halt their programs, global methods
6.3 NEW PROLIFERATORS

(such as those discussed by Chaim Braun and Christopher Chyba\textsuperscript{6} that improve the bargain of the nonproliferation treaty by adding additional incentives and make transfers of nuclear technology more difficult are most appropriate. If the network is centralized but states are determined, then proliferation can be stopped by threatening to isolate a few key states, similar to the policy of dual containment of Iran and Iraq pursued by the United States under the administration of President Bill Clinton.\textsuperscript{7} Unlike regime change, these prescriptions (especially global controls) are potentially compatible with incentives targeted at specific states, although they will most likely fail if used without incentives.

In the next section, I argue that nuclear proliferation networks have not significantly altered the length of the development cycle of nuclear weapons programs and that regime type has little influence on states’ desires to seek such weapons, contrary to the claims of determinism; In the following section, I examine the structure of the proliferation networks and discuss the role of tacit knowledge in shaping those structures and hindering new proliferants. In the third section, I review and critique steps taken to dismantle these networks.

6.3 New Proliferators: Neither Advanced Nor Determined

Proliferation determinists contend that the inevitable spread of technology, combined with regimes that are dead set on proliferating, requires regime change. Although countries’ capabilities and intentions are difficult to ascertain, it is possible to compare particular claims made by determinists with publicly available data and reasonable calculations to demonstrate that the determinist case is far from certain; a policy of regime change requires much better evidence than has been presented by advocates of determinism. In this section, I focus primarily on the cases of North Korea, Iran, and Libya. Since these countries were the primary recipients of nuclear technology from the A.Q. Khan network and have been singled out as by the United States as “rogue states,” these should be easy cases

\textsuperscript{6} Global methods advocated by Braun and Chyba include universalization of export controls, extension of the Proliferation Security Initiative (PSI), an Energy Security Initiative (ESI) to complement the PSI, a Fissile Material Cutoff Treaty (FMCT), and a policy of nuclear de-emphasis by the U.S.\textsuperscript{Braun and Chyba 2004}

\textsuperscript{7} Lake 1994
for determinism. In the first subsection below, I examine the technological progress of these states; in the second subsection, I evaluate the claims that particular regimes are predisposed to proliferation. I find that the available evidence fails to support the claims of determinists.

6.3.1 Nuclear Networks: Leapfrogging or Falling Down?

Determinists argue that proliferation networks are ubiquitous, interlinked, and must be attacked everywhere. Some even group together proliferation networks and terrorist networks; for example, President George W. Bush argued in February 2004 that “with deadly technology and expertise going on the market, there’s the terrible possibility that terrorists groups (sic) could obtain the ultimate weapons they desire most.” The same month, National Security Advisor Condoleezza Rice noted, “we now know, however, that there are actually two paths to weapons of mass destruction—secretive and dangerous states that pursue them and shadowy, private networks and individuals who also traffic in these materials, motivated by greed or fanaticism or, perhaps, both.” Similarly, Vice President Dick Cheney contended in April 2004 that “our enemy no longer takes the form of a vast empire, but rather a shadowy network of killers, which, joined by outlaw regimes, would seek to impose its will on free nations by terror and intimidation.” But how effective are these proliferation networks? Undersecretary of State John Bolton warned in May 2004, “it is clear that the recently revealed proliferation network of A.Q. Khan has done great damage to the global nonproliferation regime and poses a threat to the security of all states gathered here today.” Yet the difficulties that North Korea, Iran, and Libya have encountered indicate that there are still significant barriers to the development and transfer of technological knowledge.

Although North Korea has received relatively little outside help with its plutonium program, proliferation determinists cite its possession of “up to eight bombs” as a rationale for action, arguing that North Korea may seek to sell plutonium to third parties. Evidence suggests, however, that North Korea may have much less plutonium than is commonly
claimed. Under the 1994 Agreed Framework, almost 8,000 fuel rods were placed in sealed cannisters under IAEA supervision; standard calculations estimate that these rods (plus the rods that North Korea irradiated before 1989 and may have removed and reprocessed) could contain as much as 41.5 kg of plutonium.\footnote{According to David Albright, Hans Berkhout, and William Walker, if between 1989 and 1994 the plant was operated 80 percent of the time a high estimate could have produced an 33 kg of Pu in addition to the 9.5 kg still in the rods if only a few rods were extracted in 1989. Albright \textit{et al.} 1997, 298-299} This calculation, however, assumes a high capacity factor\footnote{Capacity factor is equal to the actual energy produced divided by the energy that could have been produced if the reactor was run constantly for the entire time period at 100 percent power.} of 80 percent for the reactor between 1989 and 1994. But the North Koreans also placed about 700 broken fuel rods into dry storage, making such a robust reliability unlikely.\footnote{Robert Alvarez, interview with author, Washington, D.C., November 8, 2004; and Alvarez 2003 Alvarez was a senior policy adviser in the U.S. Energy Department who oversaw the canning of the spent fuel rods. Albright, Berkhout, and Walker note the presence of 650 rods in dry storage in addition to the rods extracted from the reactor. See Albright \textit{et al.} 1997, 294} Multiple shutdowns between 1989 and 1994 have been reported, possibly caused by mechanical problems rather than regular maintenance.\footnote{See, for example, the images at the Institute for Science and International Security (ISIS) of the DPRK nuclear power plant. Hinderstein 2003 These photos indicate a shutdown sometime between March and June; a second shutdown occurred later that fall. Jehl 2003} Since the reactor was restarted in early 2003, it has been shut on and off multiple times, indicating that the North Koreans are still facing difficulties operating the reactor.\footnote{Hecker 2004b} Many accounts assume that the North Koreans are understating the amount of plutonium that they have produced; this ignores the fact that the North Koreans have significant incentives to overstate the amount they may possess as a deterrent and for greater leverage.

Since former Los Alamos National Laboratory Director Sigfried Hecker verified that the 8,000 fuel rods were no longer in their cannisters at the Yongbyon facility in January 2004, most analysts have assumed that the rods were reprocessed, increasing the potential nuclear material separated by the North Koreans significantly. Yet whether the rods have been reprocessed is unclear; Hecker avoided arguing that all of the rods had been reprocessed, simply noting that they were no longer in the cooling pond.\footnote{Paternoster 1992, 8.} Any of three remote sensing technologies could have detected reprocessing. First, satellite photos could have picked up visible emissions from the reprocessing plant.\footnote{Paternoster 1992, 8.} Second, steam from the
power plant connected to the reprocessing plant could be observed; this was seen briefly in January 2003 but has not been observed since. Third, detectors on the border could find Krypton-85 gas emissions; such emissions were reported only once in July 2003. While the CIA and DIA had concluded that North Korea had reprocessed the rods, State Department intelligence was unconvinced as of mid-2004. The reprocessing might have been done instead in an unknown underground facility, which could potentially circumvent these detection methods. Even if the rods have been reprocesed, the amount of plutonium might still be insufficient for six to eight weapons due to reprocessing inefficiencies. For example, if the reactor ran at a 40 percent capacity factor from 1989 to 1994 and reprocessing losses were 25 percent, North Korea would have a total of about 20 kg of plutonium. With the large number of broken rods, the capacity factor of the reactor could around this figure, which is also more consistent with the operating record of the reactor before the 1989 shutdown. With 9.5 kg already in the rods, the additional amount of plutonium in the rods would then be about 16.5 kg for a total of about 26 kg. Without skilled knowledge of the PUREX process, the amount of plutonium extracted could be significantly less than assumed. The fraction by which this would decrease the amount of plutonium extracted is highly uncertain. One possible indication, however, is the amount of material North Korea itself claimed to have lost in its reprocessing—about 30 percent. The amount of plutonium that North Korea could potentially extract from these rods is therefore probably closer to 20 kg than 42 kg. Although the standard figure for calculating the amount of plutonium used per weapon is around 5 kg, 6 kg is often used as a more conservative estimate and the first weapon built by a new proliferator can require up to 8 kg. Using the more conservative figure, North Korea would have enough plutonium for only three weapons, not enough to sell or use in a test and still maintain a sufficient deterrent. There is also some question as to whether North Korea has produced nuclear weapons with this

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17 Sanger 2003i.
18 Shanker and Sanger 2003a.
19 Sanger and Broad 2004b.
22 The Trinity atomic test on July 16, 1945 and the bomb dropped on Nagasaki on August 9, 1945 both used 6 or more kg of plutonium. Garwin 1997.
material. Although the CIA’s assessment in 2003 that “North Korea has produced one or two simple fission-type nuclear weapons” is widely cited, the next sentence of the assessment indicates that this conclusion may have been reached using only the vaguest of evidence: “Press reports indicate North Korea has been conducting nuclear weapon-related high explosive tests since the 1980s in order to validate its weapon design(s).”\(^\text{24}\)

Many officials also raise concerns over North Korea’s HEU (highly enriched uranium) program. In particular, much has been made of the North Korean attempts to acquire parts for its centrifuges in Europe. The CIA reported in November 2003 that “A shipment of aluminum tubing—enough for 4,000 centrifuge tubes—was halted by German authorities.”\(^\text{25}\) The shipment in question, however, contained only 214 tubes. If North Korea had received this shipment, these tubes could have been turned into the vacuum housings for 428 centrifuges—only enough for a pilot-sized facility.\(^\text{26}\)

The North Koreans seem to be seeking parts for the more advanced P2 (aka G-2) centrifuge,\(^\text{27}\) which operates at higher speeds and requires more sophisticated materials than the simpler P-1. Consequently, this increases the amount of time required to construct a uranium-enrichment facility capable of producing sufficient quantities of nuclear-weapons grade HEU for a nuclear weapon. As one expert has noted, “The North Koreans assumed that their path to HEU would be shortened if they procured the most advanced materials available. Iraq also ‘made that mistake.’”\(^\text{28}\) Germany’s capture of the aluminum tubing in April 2003 reveals that the DPRK did not even have enough vacuum housings at that time for a small pilot plant. It seems unlikely that North Korea would have already acquired difficult-to-manufacture maraging steel rotors or other sensitive parts if they could not manufacture the much simpler vacuum housings. Even with a simpler design, North Korea would probably not have progressed to the point of being able to make HEU by now.\(^\text{29}\)

\(^\text{24}\) Central Intelligence Agency 2003.
\(^\text{25}\) Central Intelligence Agency Nonproliferation Center 2003, 11.
\(^\text{26}\) Warrick 2003
\(^\text{27}\) Assuming 5 SWU/yr P2 centrifuges, 428 centrifuges would take nearly two years to produce 20 kg of 93 percent enriched uranium (a standard assumption for a small implosion nuclear weapon using HEU). But this assumes that no centrifuges break down, which is highly unlikely given the record of North Korea’s plutonium program and the difficulties faced by states unfamiliar with centrifuge technology.
\(^\text{28}\) Quoted in Hibbs 2002a
\(^\text{29}\) One “Western centrifuge expert” doubted North Korean progress, arguing “That the North Koreans
Libyan and Iranian programs have been active much longer than the North Korean program, suggesting that even with extensive help, HEU programs are difficult. Libyan authorities “made a strategic decision to reinvigorate its nuclear activities” in July 1995. Despite massive assistance from the A.Q. Khan network, including receiving twenty pre-assembled P-1 centrifuges, Libya had installed only one 9-machine cascade by April 2002—and never fed any nuclear materials into it. Libya also could not develop the uranium hexafluoride production facilities required to feed the centrifuges. Since it requires about 1,600 P-1 centrifuges and around 4,500 kg of natural uranium to produce 20 kg of weapons-grade HEU in a year, Libya’s program was far from completion. The centrifuges that Libya sent the United States after it gave up its nuclear program did not even have rotors installed.

The Iranian centrifuge enrichment program has existed since the mid-1980s, while the laser enrichment program was started in 1975. After transient and somewhat dubious successes, Iran has been unable to separate isotopes using lasers since 1994 due to “continuous technical problems.” The equipment Iran received from its foreign suppliers between 1975 and 1998 for laser enrichment was for the most part incomplete or never properly functioned; the success of the pre-1994 experiments was measured by the same foreign suppliers who carried out the experiments, lending some doubt as to the veracity of the results. Similarly, despite having had about ten years between receiving parts for 500 centrifuges (split between two shipments in 1994 and 1996) from the A.Q. Khan network and the present to work on its centrifuge technology, Iran has achieved relatively little. Problems with the bellows required additional shipments in 1997. More than half of the rotors that Iran had assembled as of spring 2004 were unusable. Iran received P2 designs in 1995, could make HEU on a consistent basis with (the CNOR/SNOR design) after, say, five years time, is pretty unlikely, given all the challenges,” quoted in The CNOR/SNOR is a simpler aluminum-rotor design similar to the P-1 centrifuge used by Pakistan and distributed by the A.Q. Khan network.

Assuming a natural uranium feed and a 0.3% tails assay, 4,000 SWU are required to produce 20 kg of 93% enriched HEU from 4,500 kg of natural uranium, enough for a first-generation implosion device. A P-1 centrifuge produces about 2.5 SWU/yr, so 1,600 centrifuges would be required. See Albright et al. 1997, 469.

Uranium centrifuges typically have one or more bellows (connectors) between individual stacked segments to prevent the centrifuges from self-destruction when passing through resonance velocities. Albright and Hinderstein 2004a.
but reportedly did little work on the P2 centrifuges due to the extensive problems they were already having with the simpler P-1 centrifuge, delaying work on the more advanced design until 2002. The owner of the private company in charge of the P2 work stated that Iran was not capable of manufacturing the maraging steel cylinders required by it, and began work on adapting the design to use a shorter (probably single-rotor) composite carbon tube instead.\footnote{IAEA Board of Governors 2004a, 11}

These timeframes are quite close to—or even exceed significantly—the ten to fifteen years that other countries have required to develop centrifuge programs.\footnote{Hibbs 2002b}

### 6.3.2 The Irrelevance of Regime Type

Along with arguing that proliferation networks have significantly decreased development times, proliferation determinists contend that particular regimes—referred to variously as “rogue states,” “outlaw regimes,” or an “axis of evil”—are inherently prone to proliferation and cannot be deterred or contained and so must be replaced. In his January 29, 2002 State of the Union Address, Bush singled out Iran, Iraq, and North Korea as an “axis of evil.” Two days later, Rice identified the same three states.\footnote{Bush 2002; Rice 2002.} Secretary of State Colin Powell announced the Bush administration’s policy of regime change in Iraq in testimony before Congress on February 6, 2002.\footnote{Purdum 2002.} Discussing Iraq just days before the U.S. invasion, Bush stated “Should we have to go in, our mission is very clear: disarmament. And in order to disarm, it would mean regime change.”\footnote{Bush 2003.} Although the administration has sought to limit explicit calls for regime change for countries other than Iraq since Powell’s testimony, a secret memo by Secretary of Defense Donald Rumsfeld leaked in April 2003 called explicitly for regime change in North Korea\footnote{Rennie 2003} and Deputy Secretary of Defense Paul Wolfowitz demanded “fundamental change” in the DPRK’s regime.\footnote{Wolfowitz 2003.} The investigative journalist Seymour Hersh has reported that the Department of Defense is already conducting covert
operations in Iran.\footnote{Hersh 2005} Even without an explicit call for regime change, the logic of proliferation determinism—that new proliferants cannot be contained, deterred, or bribed out of their weapons—leads to the inevitable conclusion that regime change must occur.

This position is untenable for three reasons. First, there is little or no systematic evidence that regime type is linked to proliferation propensity. Second, in Iraq, Libya, and North Korea, proliferation desires have historically varied without regime change, while in Iran, the 1979 revolution actually held up its nuclear program. Third, the direct evidence that contemporary proliferators are dead set on acquiring nuclear weapons doesn’t hold up to scrutiny.

While it is possible that authoritarian regimes might be more prone to obtaining nuclear weapons and ballistic missiles, this is only one factor among many. Surveys of the proliferation literature emphasize security and prestige benefits or organizational pathologies as drivers of nuclear proliferation rather than domestic political structures or particular leaders.\footnote{See Sagan 1996/97; Ogilvie-White 1996} A few studies argue that it is economic liberalization, not particular leaders, that may restrain regimes from developing nuclear weapons.\footnote{Solingen 1994b, a} Ironically, since economic growth is also linked to proliferation, the net effect of economic liberalization may be to increase the probability of proliferation. Statistical studies of proliferation between 1945 and 2000 have found either a positive correlation between democracy and proliferation or no relationship. Factors such as diplomatic isolation, economic growth, interstate rivalries, and security threats were much more influential than how democratic or autocratic a regime is.\footnote{See Singh and Way 2004; Jo and Gartzke 2003; Sasikumar and Way 2004} Five of the nine established or suspected nuclear weapons states (the United States, the United Kingdom, France, Israel, and India) are well-established democracies.

Although it is still possible that a particular leader might make a difference at the margin, none of the cases of contemporary “rogue state” proliferators support the thesis strongly. Bolton argued that “historically, countries have given up their nuclear weapons programs only at a time of regime change.”\footnote{Bolton 2004a} Yet this argument doesn’t seem to be true with respect to the states singled out as rogue regimes. The Iraq Survey Group, constituted
by Australia, Britain, and the United States to search for evidence of non-conventional weapons programs after the 2003 Iraq war, found “no evidence to suggest concerted efforts to restart the [nuclear] program” after the 1991 Persian Gulf war. Libya gave up its nuclear, chemical, biological, and long-range missile programs while maintaining the same leader. North Korea’s nuclear ambitions have varied while its leaders have been relatively constant; factors other than regime type such as rapprochement with South Korea and U.S. promises to open up diplomatic and economic ties in exchange for a freeze on its program influenced its decisionmaking. Iran sought nuclear weapons even as a U.S. ally under the shah; the revolution actually led to a cessation of Iran’s nuclear ambitions until at least 1985.

Much of the argument for regime change comes from a reading of these countries’ intentions based on their progress. This is especially true of Iran. Like the North Korean case, arguments regarding the rate of Iranian acquisition are based on worst-case estimates and incomplete information. This is not to suggest that Iran’s pursuit of a nuclear capability is solely for civilian purposes, as the Iranian government asserts; rather, advocates of regime change have exaggerated the military capabilities of Iran’s nuclear facilities. Moreover, the long gestation period and rate of growth of Iran’s nuclear program is incompatible with a notion of a regime determined to acquire weapons at any cost.

Bolton made remarks in an address to the Hudson Institute on August 17, 2004 that are typical of determinist claims regarding Iranian intentions. He emphasizes the potential size of the Iranian pilot facility (1,000 centrifuges) and the planned production facility (50,000 centrifuges). Yet according to the IAEA, only a 164-machine centrifuge cascade was actually installed at the pilot plant by the Iranians; as of August 2005, this pilot cascade has not been operated. Uranium was fed into a small test cascade of 19 machines at the Kalaye Electric Company only in 2002. This is a substantial lack of progress given the receipt of parts for 500 centrifuges more than ten years earlier. A regime determined to
acquire nuclear weapons presumably would have attempted to have moved more quickly despite any significant technical difficulties. Iran has been working on laser enrichment technology even longer—since 1975. Bolton claims that Iran is developing enrichment facilities to produce weapons-grade uranium (containing 90+ percent uranium-235). But the samples acquired by the IAEA from the laser enrichment facility were enriched to one percent; only gram quantities were produced at this level. Moreover, Iran shut their laser enrichment program down due to lack of progress and interest by May 2003.\footnote{IAEA Board of Governors 2004a, 12-14}

Bolton also claims that Iran has a vibrant plutonium production program, highlighting the capabilities of Iran’s planned 40 MW nuclear reactor: “The technical characteristics of this heavy water moderated research reactor are optimal for the production of weapons-grade plutonium.” Initial estimates projected that this reactor would not be online until 2014—hardly a crash nuclear weapons program\footnote{IAEA Board of Governors 2004a, 12-15} especially given that Iran has been planning this reactor since the mid-1990s.\footnote{IAEA Board of Governors 2003c, 9} More recent reports claim that it could be finished more quickly, perhaps by 2009, based on construction times of similar reactors in other countries.\footnote{Boureston and Mahaffey 2003} An early completion date seems unlikely, given the difficulties that Iran has had in the past with attempting to finish Bushehr, a light-water nuclear power plant originally ordered in 1975 from Germany. Even working with the Russians, Bushehr has seen significant delays due to Iran’s inexperience with nuclear technologies; at one point, Iranian contractors had completed only five months of work in twenty-five months.\footnote{Cordesman 2000, 13} Moreover, the reactor initially will need 80-90 tons of heavy water to be started; as of November 2003, only one of the two heavy water production lines was completed. Production of 8 tons per year was supposed to have started in 2004,\footnote{IAEA Board of Governors 2003a, 14} but as of February 2005 even the first production line had not yet started.\footnote{Institute for Science and International Security 2005} Consequently, the reactor will not have a sufficient amount of heavy water until at least 2010.

Bolton also laments that Iran could use the Bushehr reactor to generate plutonium if it pulled out of the NPT—a claim true for any of the seventy countries currently or previously
in possession of research or power reactors, and consequently not a useful measure of a particular regime’s desire to proliferate. Moreover, Iran would have to master reprocessing technology; so far, the Iranians have succeeded so far in reprocessing only milligram quantities of plutonium from irradiated targets—a very different technical challenge than reprocessing reactor fuel rods. They would also have to construct a large-scale facility that would be relatively easily detectable. It is also unclear how much knowledge Iran could gain from the Bushehr reactor; Russian Minister of Atomic Energy Aleksandr Rumiantsev has claimed that Russian training of Iranian technicians is limited to operation only, without the transfer of knowledge of “actual nuclear technology.” Finally, the highly publicized revelation in early 2005 of Iran’s small stake in a uranium mine in Namibia was, in the end, old news: Iran had acquired the stake in 1975 under the shah; this stake does not give Iran rights to the uranium.

It will take Iran years to develop a nuclear weapons capability. If the resuspension of centrifuge manufacturing that began in late November 2004 holds, the acquisition date will continue to be pushed back. Bolton’s claims regarding the timetable of Iran’s nuclear ambitions—that they are “dead set on building nuclear weapons,” and are proceeding with an urgency “quite consistent with a desire to produce a nuclear weapon as soon as possible”—seem implausible in this light, especially since U.S. intelligence on Iran has been called into doubt. Even some in the Bush administration estimate that Iran will not have a nuclear capability until next decade. Bolton has argued that the introduction of uranium hexafluoride gas in June 2003 into centrifuges at Iran’s pilot plant and the temporary resumption of centrifuge manufacture in July 2004 are inexplicable other than by desire for rapid proliferation. Yet the Iranian leadership has admitted taking these actions primarily to gain a better bargaining position—which seems more plausible, given the difficulties

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59 Bolton’s presentation also includes technical inaccuracies, such as confusing deuterium (D) with heavy water (D2O).
60 IAEA Board of Governors 2004a, 17
61 I thank Sonja Schmid for bringing this to my attention and providing a translation.
62 Charbonneau 2005a
63 Bolton 2004d
64 Reuters News 2005b
65 Kralev 2005
66 Bolton 2004d
67 Fathi 2004
they have had with centrifuges and the considerable length of time before their program would be complete.

Similar arguments hold for Libya and North Korea. Libya had only about thirty people working on its program, far less than the thousands usually required for nuclear weapons development. Libya’s program may have been intended only as a bargaining chip rather than as a serious nuclear program; pieces were collected haphazardly, and development proceeded slowly.\textsuperscript{68} North Korea, after signing the Agreed Framework in 1994, made a deal with Pakistan on materials and plans for centrifuges in 1997 at the earliest,\textsuperscript{69} embarked on an effort to develop a program only by late 2000,\textsuperscript{70} and started seeking the necessary materials in large quantities in late 2001.\textsuperscript{71} Although these dates are ultimately uncertain, the bulk of public evidence does support them: multiple efforts to seek parts have been reported after 2000, with only a single effort to procure frequency converters in 1999 before then.\textsuperscript{72} As with Libya and Iran, the program may have been intended as a bargaining chip; some argue that North Korea’s admission of its uranium program to U.S. diplomats in October 2002 may have been intended as an offer to put it on the table in exchange for a grand bargain with the United States.\textsuperscript{73}

6.4 Proliferation Networks: Star Structures Constrained by Tacit Knowledge

Proliferation determinism depends on the assumption that technology will rapidly spread through decentralized networks to justify a policy of regime change. Yet proliferation networks in general and nuclear proliferation networks in particular resemble a star-shaped (a.k.a. hub-and-spoke) structure. This structure is a function of the difficulty of transferring tacit knowledge through these networks, restricting their growth. This constraint makes

\textsuperscript{68} Crawford 2004
\textsuperscript{69} Bermudez Jr. 2002; Hersh 2003
\textsuperscript{70} Central Intelligence Agency Nonproliferation Center 2002b
\textsuperscript{71} Central Intelligence Agency Nonproliferation Center 2001
\textsuperscript{72} North Korea unsuccessfully sought two frequency converters, used for timing centrifuges, in 1999, then tried again in 2002 and 2003. Part of the 2003 shipment was delivered, while the others were stopped. Hibbs 2002b
\textsuperscript{73} Hibbs 2003b
these networks vulnerable to a range of counterproliferation measures that target the hub states directly.

6.4.1 The Structure of Proliferation Networks

In their study of “proliferation rings,” Braun and Chyba examine second-tier proliferation, in which developing states aid each other in their ballistic missile and nuclear programs. These proliferation networks have undercut existing export control measures, but have been less successful than proliferation determinists contend. The best strategy to halt the growth of these networks depends on their structure. These networks could be structured as rings or circles (where the connections between nodes—in this case, states—form a circle), stars (where every node is connected through a central hub), or cliques (where all of the nodes are all directly connected). Simple examples of these three structures are diagrammed in Figure 6.2. If the structure is a ring or a clique, then shutdown of any single node would not unravel the entire network; consequently, global strategies that seek to stop all nodes or all connections between nodes might be better to dissolve the network rather than strategies that aim at key connections or nodes. Densely connected, decentralized networks where no single node holds a crucial position in the network are easier in one sense to shut down: connections to additional nodes in the network are easier to discover, although this is balanced by the number of nodes and connections that need to be dealt with to eliminate the network. But if the structure is a star then the network is highly centralized; efforts are best concentrated on eliminating the central node and preventing other nodes from becoming hubs.

Existing ballistic missile and nuclear proliferation networks appear to closely resemble stars, in which North Korea and Pakistan are the “hubs” or central nodes for each network (see Figures 6.3 and 6.4 respectively). No nuclear transactions between the “spokes”

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74 Braun and Chyba 2004
75 Network drawings in this article done with OmniGraffle Pro. Omni Group 2005
76 These are ideal types and do not by any means exhaust potential network structures; centralization and density are only two possible network measures. See Wasserman and Faust 1994
77 Missile proliferation data extend through 2002, and are from Nuclear Threat Initiative 2005. Individual and minor incidents were discarded. Only the core second-tier proliferators are in this diagram; other countries that only received limited assistance (e.g., Yemen, Sudan) are excluded.
78 Nuclear proliferation data are from Kampani 2004. Suspected contacts with Saudi Arabia and the UAE
in the nuclear network have been confirmed as of June 2005. Interestingly, the missile network seems to be closer to a clique than the nuclear network; however, only Iran and North Korea form hubs. A.Q. Khan delivered plans or parts to Iran, Libya, and North Korea, and offered assistance to other countries such as Iraq and possibly Syria. Although it is not certain how much the Pakistani government knew about the nuclear network, it gave A.Q. Khan unprecedented operational autonomy; shutting down the network requires convincing Pakistan to re-establish bureaucratic control over Pakistan’s program, obtain information from Khan, and stop leaks of technology. Consequently, Pakistan is pictured as the central hub rather than A.Q. Khan himself. Similarly, North Korea formed the center of a missile proliferation network, delivering missile technology to Libya, Egypt, Pakistan, Iraq, Syria, and Iran, among others. Iran formed a smaller hub for missile sales, linking Libya, North Korea, and Syria.

Braun and Chyba also cite other sources of missile technology (e.g., China and Russia), but these nodes are currently less central and in any case less likely to take on a central role if the existing hubs are shut down. Since joining the Missile Technology Control Regime (MTCR) in 1995, Russia has decreased its proliferation of missile technology, although it

\[79\] An uncorroborated report alleges that North Korea and Iran have assisted each other since the late 1990s. Charbonneau 2005

\[80\] Braun and Chyba also argue that China, Russia, Taiwan, Macedonia, and Belarus also assisted Iran. Braun and Chyba 2004

\[81\] According to the Nuclear Threat Initiative (NTI), China has also given assistance to Iraq, Pakistan, Saudi Arabia, North Korea, and Syria; Russia (or the Soviet Union previously) has also helped Iraq, Egypt, Libya, Syria, and North Korea. See Nuclear Threat Initiative 2005
is still suspected of assisting North Korea and Iran at a lower level than previously. China agreed to abide by the MTCR and pledged not to assist in the development of nuclear-capable missiles in 2000, then passed related domestic regulations in 2002. It was still assisting Pakistan and Iran as of 2002, but it has made progress since then, although China had still not become a full member of the MTCR as of the end of 2004.\footnote{On China’s missile exports and dates, see \textit{Nuclear Threat Initiative} 2005. On its bid to join the MTCR, see \textit{Boese} 2004.}

The missile proliferation network shown in Figure 6.3 exhibits a more dynamic structure than the nuclear proliferation network. North Korea received assistance from Egypt from 1974 to 1981, importing Scud missiles that were reverse-engineered by North Korean scientists. Iran gave the North Koreans in 1988 the wreckage of Al-Hussein missiles used by Iraq against Iran. North Korea reciprocated by assisting both Egypt and Iran with their development of ballistic missiles, then later Libya. Syria gave North Korea information on SS-21 Scarab missiles from 1994 to 1996, while North Korea exported variants of the Scud and Nodong between 1991 and 2000 back to Syria. North Korea also exported Nodong technology to Pakistan, possibly in exchange for nuclear technology, while unconfirmed reports identify exports to Iraq, possibly as recently as 2001. Libya and Syria assisted Iran...
early in its program by supplying Scud-B missiles; Iran later reciprocated with assistance with Scud-C technology (Syria) and development assistance (Libya). Missile technology thus appears to be more transferable than nuclear technology; many of the relationships in Figure 6.3 involve these reciprocal exchanges. This may in part be a result of the many small technical challenges posed by ballistic missiles, which allows for more decentralization and specialization than nuclear weapons technology. The density of ties among the participating nodes makes the total shutdown of such networks much more difficult, but also makes it easier to trace relationships and discover additional nodes in the network.

Evidence that the nuclear proliferation network continues to be centralized was provided in early 2005. In February, the U.S. government contended that North Korea had sold uranium hexafluoride to Libya. The “alarming intelligence” that North Korea was “actively exporting nuclear material” was deduced “not on a murky intelligence assessment but on hard data.” The data that led U.S. “government scientists to conclude with near certainty” that the uranium was from North Korea was either from uranium isotopic

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82 For details on these trades, see Nuclear Threat Initiative 2005
83 I thank Dean Wilkening for pointing this out.
84 Kessler 2005
85 Sanger and Broad 2005a
ratios or from plutonium contaminating the three cylinders of uranium hexafluoride that Libya had received in 2000 and 2001. This would indicate that the network was becoming more decentralized, as nuclear trading was taking place between the separate nodes rather than through the hub. One recently retired Pentagon official described the trades as “huge, because it changes the whole equation with the North. It suggests we don’t have time to sit around and wait for the outcome of negotiations.” Additional evidence was distributed by the U.S. government in March regarding large financial transfers from Libya, which the United States claimed implicated North Korea.

Contrary to U.S. claims, the plutonium, uranium, and financial evidence are far from conclusive. The IAEA performed similar analyses and found no plutonium traces on the cylinders. The precision of the method used to determine the potential source of uranium has also been called into question, since the isotopic ratio measured (U234 to U238) can vary up to 10 percent. Yet the United States contention that the uranium must be from North Korea “with a certainty of 90 percent or better,” is belied by the admission that the U.S. team had no sample of North Korean uranium. Additionally, these concentrations can vary greatly even within a single mine, making it difficult to identify a distinctive fingerprint. The uranium in two of the three cylinders was natural uranium, while the other held depleted uranium; the latter is generally useless for creating either nuclear weapons or fuel, while the total extractable uranium content of the former was about 7 kg, far too little.

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86 Sanger and Broad reported isotopic ratios; Kessler reported plutonium. Sanger and Broad 2005a
87 Sanger and Broad 2005a
88 Sanger and Broad 2005b
89 Kessler and Linzer 2005
90 Fetter 1993
91 See Sanger and Broad 2005a
92 Wolfsthal 2005
for a nuclear weapon. Since the DPRK had not even started attempting to acquire enrichment capabilities in 2000, the depleted uranium is most likely the by-product of Pakistani enrichment. This is additional evidence that the uranium must have at least passed through Pakistan on its way to Libya, consistent with the existing structure of the nuclear network.

One of A.Q. Khan’s middlemen, B.S.A. Tahir, reported that the cylinders had been flown to Libya aboard a Pakistani airplane in 2001. With respect to the financial evidence, American and foreign officials who had seen the documents in question said that they did not demonstrate that payments went directly to North Korea. Neither were the payments necessarily for nuclear materials; they could equally have been for missile transfers. The suppression of information by the United States that Pakistan was the likely intermediary in the deal and the high probability that the container originated in Pakistan upset U.S. allies since it appeared that the U.S. government was manipulating intelligence information to put pressure on North Korea.

### 6.4.2 Tacit Knowledge and the Spread of Nuclear Weapons

Nuclear proliferation networks are more likely to adopt star structures rather than ring or clique structures in part because nuclear proliferation has greater tacit knowledge requirements. Tacit knowledge is knowledge that cannot be formulated in words or symbols, but must be learned through trial and error, potentially under the direct tutelage of someone who has already learned it; nuclear weapons design and production in particular is heavily

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93 Two of the three cylinders delivered to Libya (one small and one large) contained natural uranium hexafluoride (UF6); the other small cylinder contained depleted UF6 at 0.3 percent enrichment. The large one had 1,600 kg of UF6; the small ones had 25 kg each. Libya received the large cylinder in February 2001, and the small ones in September 2000. See [IAEA Board of Governors 2004e](#IAEABoardofGovernors2004e); and [IAEA Board of Governors 2004c](#IAEABoardofGovernors2004c). Based on a natural uranium percentage of 0.71 percent, this would give a total of 11.6 kg U235; assuming a standard tails assay of 0.3 percent and an HEU enrichment of 93 percent, 7.2 kg of HEU could be extracted, about a third of the amount necessary for a small first-generation implosion weapon. Depleted uranium can be put in a blanket around a reactor core to produce plutonium or as a tamper in a nuclear weapon, but cannot be usefully enriched.


95 Sanger and Broad 2005b

96 I thank Paul Kerr for pointing this out. See Lewis and Kerr 2005

97 Kessler and Linzer 2005

98 Linzer 2005
dependent on such knowledge. Both Britain and the Soviet Union attempted to replicate the U.S. design from documents that they possessed, yet they had to devote major resources to make it work. Every nuclear program has taken longer than the three and a half years the Manhattan project took to build an initial nuclear weapon despite transfer of information and even scientists from one program to another.\textsuperscript{99} One of the major preoccupations of the U.S. nuclear weapons complex is to retain tacit knowledge in the absence of testing.\textsuperscript{100} Ballistic missile development, while also requiring tacit knowledge,\textsuperscript{101} would seem to be somewhat less restricted. Indeed, one reason for believing that tacit knowledge is behind the structure of the nuclear networks is that direct ties would be likely to follow the missile networks, yet this has only happened in a single case between Pakistan and North Korea. Even between these two, nuclear transfers were unidirectional: from Pakistan to North Korea.

This constraint structures the proliferation networks. Only the central “hub” can dispatch experts to train new proliferants in constructing and operating equipment, whereas satellite states might be able to help each other with acquiring equipment but not with tacit knowledge. The hub might also have incentives to restrict information transfer, selling (for example) parts for centrifuges but not instructions on how to create them in order to maintain profits. Individual satellite nodes are usually likely to form ties (nuclear or not) with each other through their common connections with the hub, thus decreasing chances of a potential dismantlement of the network by eliminating the hub. Such actors—called “structurally equivalent” in network terms—have a propensity to act in similar ways, often forming ties or networks between or among themselves when direct competitive pressures are weak.\textsuperscript{102} Tacit knowledge requirements, however, help suppress these ties.

While some nonstate actors (such as B.S.A. Tahir and Urs Tinner) involved in nuclear proliferation networks have been able to individually supply a few parts for centrifuges, they cannot supply the crucial tacit knowledge required to operate them. The much-discussed Malaysian company SCOPE whose parts were intercepted on the BBC China,\textsuperscript{99} MacKenzie and Spinardi [1995] MacKenzie [1993] Montgomery [1999] Montgomery [1999] Montgomery [1999] Competitive pressures or direct negative ties can overcome the tendency of structurally equivalent actors to cooperate unless faced with a greater threat for example, animosity between Iran and Iraq.
a Libya-bound ship from the A.Q. Khan network, was only producing about 15 percent of the total number of parts for Libya’s centrifuges, including none of the most sensitive parts. While decentralized manufacturing may be efficient in some ways, the lack of both a direct connection and the ability to rapidly supply parts and feedback on their performance further hinders nonstate actors from properly supplying parts, let alone providing a complete proliferation solution. Iran reported that “many difficulties had been encountered as a result of machine crashes attributed to poor quality [imported] components.”

Although A.Q. Khan supplied both plans and parts, it appears that without the tacit knowledge required to develop nuclear weapons, successfully developing a capability requires much trial and error. Indeed, this seems to have been North Korea’s problem: Mark Hibbs noted, “One official said that some information suggests the DPRK may have slavishly followed a recipe calling for some more advanced components or materials, as called for in the design package provided by its helpers.” Although Iran did not fall into this trap, the numerous problems it encountered in its program indicate that A.Q. Khan was unable to transfer tacit knowledge easily. The parts Iran bought on the black market for its centrifuges were of highly variable quality; neither the sellers nor the Iranians knew how to judge the quality of the parts purchased. Iran is building a yellowcake-to-UF₆ (uranium hexafluoride) conversion plant at Isfahan based on Chinese blueprints. Yet Iran has had difficulties producing high quality UF₄ (uranium tetrafluoride) and turning it into UF₆.

Although less evidence is available from Libya’s program, the lags in time and difficulties seem to indicate that similar problems were encountered there. According to one observer, these problems suggest that Libya bought “nuclear technology without actually knowing how it worked.”

Yet materials acquisition is only one step in the nuclear weapons acquisition process. Even with a bomb design, many intermediate steps are required to develop a nuclear

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103 Albright and Hinderstein 2004b
104 IAEA Board of Governors 2003c, 7
105 Hibbs 2002a
106 Mohammadi 2005
107 Joseph Cirincione, personal communication, June 3, 2005, from conversations with western officials and IAEA experts.
108 Crawford 2004
6.4. PROLIFERATION NETWORKS

weapons arsenal. Being able to cast fissile materials and high explosives into the necessary shapes requires extensive experience. Siegfried Hecker has noted, “The real secrets are in the details of the metallurgy, the manufacturing and the engineering.” A.Q. Khan apparently attempted to pass on these secrets, offering uranium re-conversion and casting capabilities. His success in describing the necessary processes in enough detail, however, appears to have been limited. A delivery system must also be created for these weapons; although some of these countries have advanced ballistic missile programs, miniaturizing, toughening, and fitting a nuclear device so it can be used as a nuclear warhead on a missile is not a straightforward task.

The bomb design that Libya acquired from the A.Q. Khan network was too large to fit on any of its ballistic missiles—or, indeed, possibly on any missile in development by North Korea or Iran, both of which may have also received copies of the design. Accounts describe the design as “crude” and incomplete. Some sources note that the warhead has a mass of about 500 kg; most attribute the warhead in question to the fourth Chinese nuclear test in 1966. Yet China did not have a 500-kg warhead in the 1960s; the warhead that most closely fits this description is the one on the Chinese DF-2A, a 32-ton, 21-m long, 1.65-m wide missile deployed from 1966 to 1979. This warhead, a 12 kiloton device, weighs 1,290 kg; with a 200 kg re-entry vehicle, the total payload would be almost 1,500 kg. By contrast, all of the missiles currently owned or in development by Libya, Iran, and North Korea are designed with a maximum intended payload of at most 1,000 kg. Although range can be traded off with payload, whether the warhead is small enough to fit on the missiles is unclear; Scud-based missiles have a diameter of 0.88 m, and the missile with the largest diameter available to these new proliferants, North Korea’s No-dong 1, is a 1.32-m wide, 16-m long, 16.25-ton missile, a third of a meter narrower and half the mass

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109 MacKenzie and Spinardi 1995
110 Quoted in Broad and Sanger 2005
111 Goldschmidt 2005
112 Crawford 2004
113 Sanger 2004
114 Albright and Hinderstein 2004a, 70
115 Sanger and Broad 2004a
116 Lewis and Di 1992
117 Kimball 2002
118 MacKenzie and Spinardi 1995
119 Quoted in Broad and Sanger 2005
120 Goldschmidt 2005
121 Crawford 2004
122 Sanger 2004
123 Albright and Hinderstein 2004a, 70
124 Sanger and Broad 2004a
125 Lewis and Di 1992
126 Kimball 2002
of the DF-2A. South Korea’s National Intelligence Service reported in 2005 that North Korea lacked the technology to put warheads on missiles. Even though other methods could still be used for delivery (e.g., from an aircraft, in a shipping container, in a truck), all of these methods are much less desirable for these states. For example, if Iran wishes to deter a state with advanced air defenses such as Israel, a ballistic missile is much more likely to get through than these other methods of transport and has significant command-and-control advantages as well.

### 6.5 Past and Future Counterproliferation Efforts

Many past strategies for dissuading proliferants and dissolving networks have been attempted; few have been successful. Threatening regime change has been minimally effective against proliferants. A policy in rhetoric or practice of isolating or containing “rogue” states has been counterproductive, coinciding with the growth of networks between them. By contrast, offering benefits that closely mirror some of the core motivations of these states to proliferate has been useful in the past.

A policy of regime change is unlikely to encourage cooperation and is very likely to convince proliferators that they need nuclear weapons to deter the United States. It is, in some sense, self-defeating: U.S. threats of forcible regime change are likely to increase the number of states that seek a nuclear capability and bolster existing proliferators’ programs as a defensive reaction. North Korea reacted to the invasion of Iraq by claiming that it was reprocessing all of its 8,000 fuel rods in late April 2003, then in late August 2003 threatened to test a nuclear device. The Bush administration touts Libya’s disarmament as an example of the threat of regime change working, yet this argument doesn’t hold up under scrutiny. Libya had been attempting to rehabilitate itself for years, and a final agreement was well in the works before the invasion of Iraq or the interception of the BBC China.

Indeed, one Western diplomat suggested that Libya tipped off the United States...
on the shipment; others have speculated that Libya made the order expecting or intending it to be intercepted.\textsuperscript{123}

A policy of isolation or containment, such as that applied to Iran and Iraq by past U.S. administrations, is a strategy that falls short of regime change. Indeed, the threat of isolation itself can be an important bargaining tool. Yet like economic coercion,\textsuperscript{124} the threat of isolation is more effective than carrying out the threat. The immense efforts made by the United States to isolate and contain Iran through preventing completion of the Bushehr nuclear reactor in the 1990s proved successful in delaying that project, but gave Iran no incentive to cooperate and did little to prevent the transfer of technology from second-tier suppliers.

The practice of isolation can even be counterproductive. Many of the states in the current second-tier proliferation networks (as well as past networks such as South Africa-Israel)\textsuperscript{125} are isolated from the rest of the international system, whether through their own choices or through deliberate policies by the United States and other powerful actors. Isolation has been identified as a possible correlate of nuclear weapons programs.\textsuperscript{126} If rogues are stopped from connecting with the rest of the world, they will be likely to connect instead with each other—with potentially disastrous consequences. U.S. policy has assisted connections between isolates by marginalizing states in U.S. rhetoric and policy and grouping them together as “rogues,” “pariahs,” or “outlaws” since the Reagan administration.\textsuperscript{127} The Clinton administration slowly moved away from this policy after the appointment of Madeleine Albright as secretary of state in 1997, who shifted U.S. rhetoric to “states of concern” in June 2000.\textsuperscript{128} The Bush administration quickly returned to the “rogue state” rhetoric, then escalated even further by referring to Iran, Iraq, and North Korea as members of an “axis of evil.”\textsuperscript{129} The “axis” was later expanded to include Libya, Syria, and Cuba by Bolton.\textsuperscript{130} This uncompromising rhetoric limits U.S. policy options and places the U.S. in

\begin{footnotesize}
\begin{tabular}{ll}
123 & Crawford 2004, Roston 2004 \ 
124 & Drezner 2003 \ 
125 & Albright and Hibbs 1993 \ 
126 & Jo and Gartzke 2003 \ 
127 & See Litwak 2000, 2003 \ 
128 & Albright 2000 \ 
129 & Bush 2002 \ 
130 & Bolton 2002a
\end{tabular}
\end{footnotesize}
a difficult negotiating position. The United States and the United Kingdom could not come to a deal with Libya until the Bush administration complied with a request by high-level British officials for removal of Bolton from the U.S. negotiating team; Bolton’s unwillingness to compromise was preventing Libya from agreeing to a deal.

By contrast, diplomatic incentives such as recognition and membership in international organizations as well as economic benefits including aid and suspension of sanctions have been quite successful in the past in an unexpected place—North Korea. The DPRK might seem to be a “hard case” for using these tools for counterproliferation, given North Korea’s security relationships. Yet two of North Korea’s three main demands for eliminating its nuclear program are for the United States to “recognize the DPRK’s sovereignty” and “not hinder the economic development of the DPRK.” North Korea has consistently responded positively to U.S. diplomatic overtures, economic benefits, and threats of economic sanctions—when seen as credible by the DPRK, and when combined with clear red lines. For example, during the 199394 crisis, threats of sanctions were met with North Korean bellicosity. The North Koreans knew that with China on the Security Council, multilateral sanctions would never pass—until China warned them that it might not veto sanctions on June 10, 1994, and the United States clearly delineated a specific red line that would trigger sanctions—reprocessing the spent fuel rods. Similarly, diplomatic and symbolic gestures—making joint statements with the DPRK after meetings, swapping the gas-graphite nuclear plants for light-water nuclear rather than conventional power plants—were key to North Korean concessions during the crisis. These gestures were effective because they allowed the North Koreans to maintain their status as an equal of the United States and a nuclear state, albeit not a nuclear-weapons state.

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131 Hirsh 2005
132 North Korea is unique in the world; it is geographically surrounded by two nuclear powers (Russia and China) and two latent countries (Japan and South Korea), and has U.S. troops deployed on its border.
133 Korean Central News Agency 2002b
134 On China’s threat, see Oberdorfer 2001. On establishing clear red lines, see Wit et al. 2004
135 See Montgomery 2004
6.6 Conclusion

States are neither as determined nor as advanced in their capabilities as proliferation determinists suggest. This is in part due to the tacit knowledge required to create nuclear weapons, which restricts the structure of nuclear proliferation networks. Two main implications flow from this analysis. First, the existing networks should be shut down by eliminating the hubs while preventing new ones from arising. Second, a full range of incentives instead of the threat of regime change should be used to convince hub states to stop nuclear transfers.

Both time and diplomatic energy are short, however; the immediate need is to cap and roll back the networks that have been created by Pakistan and North Korea and to keep new hubs, such as Iran, from taking their places. Tailored incentives and disincentives need to be applied to these states. These policies require both carrots and sticks, and need to be broadened beyond security-minded proposals to include diplomatic, symbolic, and economic incentives and disincentives.

This does not mean that policymakers can become proliferation procrastinators and wait until the time is ripe to stop these networks. Neither does it mean that policymakers should become proliferation determinists clamoring for regime change and taking drastic steps (such as military action against North Korea, Iran, or Pakistan) that could have severe consequences. Policymakers have both the time and the tools to stop these hubs and keep new ones from forming, but they need to act now as proliferation pragmatists to dismantle them before new connections between previously distant participants are created, forming a dense network of ties that will be impossible to pull apart.
Chapter 7

Conclusion

Over the last 15 years, the United States has taken a leading role in attempting to slow, halt, and roll back nuclear weapons programs. Out of the four states that were thought to have new active nuclear weapons programs, two are no longer a concern: Iraq and Libya. Unfortunately, these may have been the easy cases; Iraq never reconstituted its nuclear weapons program after the 1990-1991 Persian Gulf war, and Libya’s program seemed to be a half-hearted effort that was quickly converted into a bargaining chip. The other two cases, Iran and North Korea, have proven to be much more difficult, and remain unresolved. However, lessons can be drawn from the effects of US counterproliferation policy in these cases not only for future proliferation but for future policy toward both.

7.1 Policy Implications

The administration should adopt a policy of proliferation pragmatism that balances credible threats of force with promises of benefits to convince the current hubs of North Korea and Pakistan and potential new hubs such as Iran to cooperate. Incentives must deal with states' underlying motivations for proliferation. For these states, the United States should offer them what they are lacking, using diplomatic incentives such as recognition and membership in international organizations as well as economic benefits including aid and suspension of sanctions.
These recommendations may have effects on other states than the three targeted, however. Although it is unlikely that other states would wish to develop nuclear programs for the sole purpose of being paid off, it is possible that other states such as Brazil and Argentina or Japan and Germany may wish to gain additional benefits from remaining non-nuclear states. However, some of the benefits that I propose should be offered are unlikely to be desired by these states, simply because they already possess the benefits of international prestige and status. Other benefits, such as technological support of a nuclear infrastructure, are already part of the NPT bargain. Additionally, if these benefits succeed in convincing nuclear aspirants to roll back their programs, this will help reinforce existing nonproliferation norms as well, making it more difficult for other states to demand benefits for doing what is expected of them in any case.

7.1.1 North Korea

North Korea should be offered a “grand bargain” in which its security, economic, and diplomatic concerns are treated as legitimate rather than secondary matters to be resolved after disarmament[1] the United States has not yet attempted to test North Korea in this way. Convincing North Korea that the United States is not going to invade is more likely to get them to voluntarily give up its program than threatening regime change.

The North Korean declaration on February 10, 2005 that they had “manufactured nukes for self-defence” on seemed to be a new twist in the North Korean crisis[2]. Rather than being an abrogation of the talks, this statement was largely a set of requirements for continuing the talks, which were elaborated by North Korea’s representative to the UN on February 19[3]. The South Korean government also played down the announcement as being short of declaring nuclear weapons state status[4].

While some argue against rewarding North Korea or other states for bad behavior for fear of emulation[5], it is unlikely that any other country would ever aspire to be in North Korea's position.
Koreas position, isolated from the rest of the world, dependant on others for basic needs, and desperate enough to attempt to sell its security. Moreover, with a lack of other credible options, making a deal with North Korea is better than threatening regime change or relying on China to pressure North Korea. As Robert Gallucci, the Clinton administration’s chief negotiator with the North Koreans during the 1993–1994 crisis, put it, “Listen, I’m not interested in teaching other people lessons. I’m interested in the national security of the United States. If that’s what you’re interested in, are you better off with this deal or without it? You tell me what you’re going to do without the deal, and I’ll compare that with the deal.”

South Korea’s offer in June 2005 to provide electricity to North Korea (despite previous objections from the Bush administration to adding additional inducements), is widely credited with bringing North Korea back to the six-party talks. Others argue that agreements such as the Agreed Framework can be easily violated since covert programs can be continued on the side. Yet this argument simply highlights the problem that countries must ultimately comply willingly in disarmament—and therefore inducements must be offered that tackle the fundamental incentives that countries have to proliferate. As U.S. State Department official Paula DeSutter admitted, “If we go into this and North Korea has not made such a decision, this is going to be like pulling teeth and our confidence at the end may not be what we would like it to be.”

Unlike North Korea’s plutonium program, even a production-scale centrifuge facility would be difficult to detect via technical means. With these difficulties in remote sensing, willing compliance is necessary for disarmament.

Threats of force alone cannot stop North Korea from trading either its missile or nuclear technologies. It is not a member of the MTCR, and its missile exports do not violate any laws; a shipment of Scuds from the DPRK was stopped by Spanish commandos acting on U.S. intelligence in December 2002, but had to be permitted to reach its destination of Yemen. Now that the DPRK is no longer a de facto member of the NPT, it is similarly unconstrained to trade in nuclear technology, although recipients that are members of the NPT would be in violation if they accepted nuclear technology for the purpose of pursuing

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6 Quoted in Stossel 2005
Brinkley 2005
7 Bolton 2004b
8 Quoted in Staines 2005
9 Shanker 2002
Yet the DPRK has been willing to trade both its nuclear and missile programs for recognition, symbolic rewards, and economic development. North Korea should be tested to see if it will accept a credibly-backed bargain including these three elements.

In order to accept a bargain, North Korea must be convinced that the United States does not seek regime change. After the signing of the Agreed Framework, relations with the Clinton administration improved markedly. However, a series of social snubs by the Bush administration convinced North Korea that the United States was seeking regime change. Until the United States makes a series of symbolic gestures that convince North Korea to reciprocate instead of reject offers, it will be difficult to get North Korea to commit to a new agreement. The dropping of extreme rhetoric in recent months is a good first step, but is probably insufficient to convince North Korea to sign up to a new Agreed Framework.

7.1.2 Pakistan

The Bush administration has claimed success in shutting down the A.Q. Khan network that supplied both Pakistan and other proliferators, but a lack of cooperation with the IAEA and an unwillingness to push Pakistan have hampered U.S. efforts. Pakistans network has continued to operate nonetheless, and may be re-creating parts of it with new middlemen; Joseph Cirincione, director of nonproliferation at the Carnegie Endowment for International Peace, argues, “The network hasn’t been shut down. It’s just gotten quieter. Perhaps it’s gone a little deeper underground.” Pakistan continues to seek parts for its nuclear program abroad; Swiss authorities stopped two attempts by the A.Q. Khan network in 2004 to purchase aluminum tubes from Russia for Pakistan’s use. The existence of any network of suppliers not within Pakistan’s direct control makes proliferation more likely; suppliers who fill orders for Pakistan’s program can fill the same orders for other proliferants. A strong U.S. effort to establish a fissile material cutoff treaty (FMCT) that includes Pakistan would undercut these suppliers; if Pakistan stops producing fissile materials, demand for

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11 On North Korea’s willingness to trade its nuclear program, see Harrison 2004. On its missile, program, see Oberdorfer 2001 439–440
12 Sanger and Broad 2004a
13 Charbonneau 2005b
14 Associated Press 2005
centrifuge parts will drop significantly.

Although Pakistan is unlikely to roll back either its nuclear or missile programs, the United States and the other members of the MTCR should make it a high priority to ensure that it joins the MTCR and adopts domestic controls on nuclear and missile technologies. Pakistan (as well as India and Israel) should be brought inside the nuclear nonproliferation regime, possibly by relaxing the membership standards for nuclear export control consortia, including the Zangger Committee and the Nuclear Suppliers Group. More information about the extent of the A.Q. Khan network and other potential buyers (as well as the actual recipients) is also needed; the United States should push Pakistan to discover the identity of the “fourth country” that Khans network may have supplied or demonstrate that this country is fictional\footnote{Evidence exists among shipping records that indicate a possible fourth country beyond North Korea, Iran, and Libya.\cite{Gellman and Linzer 2004}}

Pakistan is much less isolated internationally than Iran or North Korea; yet its relations with other states and domestic political situation created the conditions for an entrepreneur like A.Q. Khan to exploit. Pakistan may respond to economic and social benefits well, but such offers may need to be made in parallel to both Pakistan and India in order to be effective. The recent US–India nuclear deal may undercut efforts to convince Pakistan to join the nonproliferation regime unless Pakistan is offered a similar deal.

\subsection{Iran}

If the North Korean and Pakistani hubs are effectively shut down, the next logical step would be to turn to nodes that could emerge as new hubs. The advanced state of Irans missile and nuclear programs, as well as its active participation in both networks, would suggest that it is a likely candidate to take over the central role of spreading nuclear and/or missile technologies. Indeed, as is seen in Figure 6.3, Iran has already formed a mini-hub of missile proliferation between Libya, North Korea, and Syria. The positive response of Iran to potential diplomatic and economic benefits offered by the EU in exchange for the temporary suspension of its uranium enrichment program in November 2004 pending a final agreement is another indication that these tools can be very useful in a context that
is normally dominated by security considerations. Arguments that claim that the United States should continue to play a ‘bad cop’ to Europe’s ’good cop’ role with respect to Iran miss the point of the analogy: the good cop is convincing only if he can credibly restrain the bad cop; without a clear U.S. signal that it will accept the outcome of negotiations and not to take military action, Iran is unlikely to accept an offer from the EU.

The United States should send such a signal—and soon, before Iran gives up on negotiations irrevocably. Bush’s assurance, “this notion that the United States is getting ready to attack Iran is simply ridiculous,” was completely undermined when he continued with, ”and having said that, all options are on the table.” The minor concessions of airplane parts and support for World Trade Organization membership offered by Secretary of State Rice are insufficient; these gestures appear to be “hawk engagement,” where offers are made in order to legitimize later coercive action. Instead, the United States should take seriously feelers sent out by former Iranian president and head of the influential Expediency Council Hashemi-Rafsanjani to open diplomatic channels and deal directly with Iran. The election of Mahmoud Ahmadinejad as president of Iran instead of Rafsanjani in June 2005 should not be used by the United States as a reason to avoid talks. The election does not change Iran’s underlying reasons for pursuing nuclear technology, which is intertwined with international prestige and national pride as much as any other concerns. As a result, it will be difficult to eliminate Iran’s nuclear programs completely (just as North Korea required nuclear power reactors in 1994 to save face), but creative applications of technology and diplomacy could produce a lasting compromise that keeps Iran short of the nuclear weapons threshold.

Possible solutions that Iran may find acceptable include collaborations with other states on uranium enrichment that would allow for tighter monitoring of its program. Iran still has a stake in the Eurodif consortium; internationalizing Iran’s enrichment facilities by splitting them between Iran and France would bind Iran more tightly to other states, giving them additional leverage should Iran appear to be pursuing nuclear weapons more overtly.

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7.2. RESEARCH IMPLICATIONS

A similar enrichment deal with Russia may also be possible. For the United States to make a significant difference, it would have to drop negative rhetoric just as it has started to do with North Korea, and participate more actively in nuclear negotiations.

7.2 Research Implications

Realism, liberalism, and constructivism specify sources for state action: respectively, military, economic, and social motivations. Accordingly, I analytically divided “carrots and sticks” (benefits and sanctions) into social (e.g. those that affect prestige, social status, or recognition) and material (e.g. those that affect economic or military status) types in order to determine what combination of social benefits/sanctions and material benefit/sanctions succeeds. While some have argued that military carrots and sticks are most effective for convincing states to give up existing nuclear programs, others have claimed that economic sanctions or benefits are optimal, while still others contend that social status and recognition are the keys to rollback.

None of these answers was sufficient to account for either the trajectory of interaction processes or net outcomes of proliferation. The United States has followed a very different policies in North Korea and Iran. With respect to North Korea, the primary strategy was to decrease North Korea’s demand for nuclear weapons, whether through military threats, economic sanctions, and harsh rhetoric, or through security guarantees, trade benefits, and diplomatic recognition. Strategies involving the use of social incentives (e.g. diplomatic recognition, social marginalization) or material tools (e.g. military deterrent threats, economic aid) alone are were only unsuccessful but were actually counterproductive in North Korea. North Korea’s responses to these strategies varied, from reciprocal cooperation in the latter half of the 1993–1995 crisis to almost constant negative responses during the 2002–2003 crisis. This transformation most likely occurred due to a change in the social relationship between the United States and North Korea over time. While the most important aspects of the 1994 Agreed Framework for North Korea had to do with diplomatic recognition and saving face, these aspects were never completely implemented due in part to domestic politics in the United States. Once North Korea was rhetorically targeted by the
United States, this altered the relationship significantly. The threat of use of force and economic sanctions against North Korea were indeed successful in June 1994, but only once these threats became credible. By contrast, the threats made in 2002–2003 were neither well-defined nor credible.

The case of Iran tells a similar story, even though policy toward Iran focused primarily on limiting Iran’s supply of nuclear technologies from third parties. Iran responded to US attempts to cut off its supplies of nuclear technology in two ways: it developed domestic capabilities to supplant reliance on foreign suppliers, and constantly sought out new suppliers of technology. Although the United States was very successful in blocking most attempts by foreign countries to assist Iran, it was unsuccessful in blocking either Russian aid with the Bushehr reactor or help from the A.Q. Khan network. Yet the Bushehr reactor was the least important nuclear technology, and the assistance from the Khan network may have only somewhat improved Iran’s program. Sharing information with and diplomatic pressure on foreign suppliers proved to be useful in convincing technology suppliers to sever contracts; the economic benefits of cooperation helped to convince the remainder. As for direct interactions, the economic sanctions on Iran and its suppliers were ineffective, and led to support for Iran from the non-aligned states. The one overture from the US was undermined on both sides by domestic politics. By contrast, potential diplomatic and economic carrots from the European Union, combined with the threat of Security Council referral, froze its program; however, this may unravel if the relationship promised by the EU3 fails to materialize.

Although the A.Q. Khan network did succeed in transferring plans and in some cases parts to Iran, Libya, and North Korea, they have had significant problems with using these plans and parts to achieve progress in their nuclear programs. This is in part due to the high tacit knowledge requirements of nuclear weapons construction and design, which makes it difficult to transfer knowledge in an efficient manner. These requirements also structure nuclear proliferation networks. The ring structure of these networks makes them vulnerable to being shut down through strategies aimed at the hubs of these networks.

The solutions to the supply and demand problems are quite similar; social benefits can alleviate both of them. Such benefits can prevent a hub from distributing technology and
can prevent isolated suppliers from aspiring to be new hubs. Similarly, these benefits can temporarily freeze a proliferant’s program while attacking the underlying motivations for proliferation. Since prestige is a powerful underlying motive, even for states that might be motivated by military needs, social benefits can play a dual role, both stopping and rolling back a program.

Some differences do exist between the solutions for supply and demand, however. Social benefits are useful for both, but the promise of material benefits varies. Economic benefits are more useful for supply, since often suppliers are primarily motivated by the prospect of monetary gain, while military benefits are mostly useful with respect to suppressing demand. However, the power of social incentives should not overshadow the sometimes crucial role that clear and credible material threats can play in the initial freezing of a proliferator’s program.

These results are in line with the literature on coercive diplomacy; credible threats combined with positive inducements that allow a target to “save face” are considered to be crucial to success, while domestic political considerations can undermine coercion. However, my work goes beyond these findings in two ways by highlighting the role played by social action in determining success or failure, identifying what measures help to save face, and examining the role of networks in determining the rate of proliferation. The symbolic social benefits of a long-term deal such as integration into the world system or gaining prestige through retaining nuclear infrastructure are just as crucial to success as accompanying material incentives. The particular balance of incentives must have a good fit with the underlying reasons that a particular state wishes to continue its nuclear program; military incentives don’t work well for a program that is primarily motivated by social factors like prestige, while an artfully crafted approach that allows for a state to gain more prestige without nuclear weapons than with them will succeed. The North Korean and Iranian cases, which at first glance may seem to be primarily cases of military need, turn out to be influenced by prestige and pride issues.

These findings have important implications for re-evaluating past cases of proliferation.
In particular, they imply that Libya’s disarmament may have had much more to do with re-
joining the international community and a desire for prestige than fear of regime change. 
Research should find evidence that diplomatic recognition by the United States was a key 
factor in convincing Libya to give up its programs, and that Libya required various “sav-
ing face” measures in order to make the deal. As was mentioned in Chapter 6, Libya’s 
disarmament appears to have been a process that took several years to complete, and so 
was started long before regime change became a major counterproliferation policy of the 
United States.

Finally, I contend that in order to defeat supply networks and minimize the probability 
of further proliferation, counterproliferation efforts must be focused on the hubs of supply 
networks rather than being dispersed in an attempt to cover all possible states. Due to tacit 
knowledge restrictions, nuclear supply networks are shaped like star networks, and are thus 
highly vulnerable to being dissolved through dismantling the central nodes. This finding 
also has research implications: as more nodes of the A.Q. Khan network are found, these 
nodes should conform to the same structure and exhibit the same phenomena as existing 
parts. In particular, supplier states should be involved in parts that require relatively low 
levels of sophistication; any recipient states should be experiencing similar difficulties to 
the ones that have plagued Libya and Iran.

Together, these insights into the roles of social action and network structure are im-
portant additions to the proliferation literature that generate both policy recommendations, 
research implications, and predictions for the future.
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