THE NUCLEAR MARKETPLACE AND GRAND STRATEGY:

CIVILIAN NUCLEAR COOPERATION AND THE BOMB

by

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(Under the Direction of Gary Bertsch and Jaroslav Tir)

ABSTRACT

This dissertation consists of two principal sections. The first portion explores the relationship between nuclear energy and nuclear weapons. Building on the "technological momentum" hypothesis, it argues that civilian nuclear cooperation increases states' willingness to start nuclear weapons programs because it establishes a nuclear-related bureaucracy and a scientific knowledge-base. It also advances a related argument that states receiving nuclear assistance are more likely to acquire nuclear bombs. Statistical analysis using new data on civilian nuclear cooperation reveals robust support for both of these arguments. Given the relationship between nuclear weapons and civilian cooperation, the majority of this project seeks to explain why suppliers provide civilian nuclear assistance to other states. The argument is that supplier states use civilian nuclear cooperation as an instrument of their grand strategies. This leads to several hypotheses, including that military alliances and having a shared enemy increase the probability of nuclear commerce while militarized conflict reduces it. These hypotheses are also tested using statistical analysis and the new data on civilian nuclear cooperation agreements and robust empirical support is found. Normative considerations limiting the spread of nuclear weapons have little effect on civilian nuclear cooperation. States that are pursuing nuclear weapons are actually *more* likely to receive nuclear technology and states that make legal commitments foreswearing nuclear weapons are *less* likely to do so. To further test hypotheses on nuclear cooperation, the project examines three cases that are successfully predicted by my statistical model and 10 cases that are not. The analysis of successfully predicted cases reveals that the connections between the explanatory variables and civilian nuclear cooperation are consistent with the logic driving the hypotheses. The analysis of outlying cases reveals two alternative hypotheses: (1) new suppliers behave differently from established suppliers; and (2) oil producing countries are more likely to receive nuclear assistance. Further statistical analysis fails to yield significant support for either alternative hypothesis, which inspires further confidence in my argument. This study contributes to the literature on nuclear proliferation by enhancing scholarly understanding of how and why nuclear weapons spread.

INDEX WORDS: Civilian nuclear cooperation, Nuclear energy, Nuclear weapons, Nuclear Non-proliferation, International security

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nuclear proliferation more times than she probably cares to admit and was always there for support. I dedicate this dissertation to her.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

On July 18, 2005 U.S. President George W. Bush and Indian Prime Minister Manmohan Singh reached a historic agreement on civilian nuclear cooperation. The terms of the deal permit the sale of nuclear fuel and reactor components to India, reversing a moratorium on such trade.[1] The agreement has met staunch criticism because it threatens to undermine the nuclear nonproliferation regime. India is not a signatory to the nuclear Nonproliferation Treaty (NPT) and possesses nuclear weapons, which call its nonproliferation record into question. Further, India's status outside the NPT undermines a long-established norm that requires a legal commitment forswearing nuclear weapons as a precondition for the supply of nuclear technology. Despite this controversy, the United States has clear and compelling motivations for striking this deal. In justifying the agreement before Congress, U.S. Secretary of State Condoleezza Rice (2006) stated: "India is a rising global power that we believe can be a pillar of stability in a rapidly changing Asia...India is a natural partner for the United States." Rice's statement reveals that the United States believes that nuclear cooperation with India will help maintain a regional balance of power. Specifically, it will help Washington counter the rising power of China in the region.

This illustrates that there is a link between international trade in nuclear technology and national security/grand strategy. At first glance, this relationship may not seem all that surprising. But it becomes more interesting once one recognizes that almost all of the goods that

[1] For more on the U.S.-India nuclear pact see Perkovich (2005); Graham, Tomero, Weiss (2006); Pan (2006).

permit significant advances in states' military capabilities, including those required to manufacture nuclear weapons are dual-use in nature (Beck and Gahlaut, 2003; Jones, 2005; Brooks, 2005; Fuhrmann, 2006). In short, they have both civilian and military applications. The line between civilian and military technology is becoming increasingly blurred (Brooks, 2005), making it more difficult to determine the end-use of advanced technology. This predicament is often referred to as the "dual-use dilemma."

The most obvious illustration of this is the distinction between nuclear energy and nuclear weapons. Swedish Nobel Prize-winning physicist Hannes Alven once described the peaceful and military uses of the atom as "Siamese twins." The history of nuclear proliferation reveals that civilian nuclear energy aids nuclear weapons production by: (1) allowing states to acquire technology for "peaceful purposes" and then diverting it to weapons applications; and (2) producing an indigenous base of knowledge and expertise (Bunn, 2001). In addition, almost all of the individual items needed for a nuclear weapons program have civilian and military applications. For example, hospitals around the world use machines called lithotripters to rid patients of kidney stones. The lithotripter destroys the stones inside the patient's body, without surgery. To operate, the machine requires a high-precision electronic switch to trigger a jolt of electricity and break-up the stones. These switches are dual-use in nature because *the same item can be used to detonate a nuclear weapon.*[2]

This predicament means that states exporting nuclear technology cannot be certain whether it will ultimately be used in a civilian or military application. History is rife with examples of states acquiring dual-use items for "peaceful purposes" and then employing them in military applications. It is often the case that states originally intend to use the imported

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[2] These electronic switches are often referred to as nuclear "triggers."

technology for civilian purposes but later change their minds and employ the technology or knowledge to build weapons of mass destruction. For example, in the 1960, the United States supplied Iran with a research reactor and weapons-grade uranium to power it. This was, of course, intended for a legitimate and peaceful use but today this technology may be helping Iran make nuclear weapons (Roe, 2006). States also sometimes use a commercial front to acquire dual-use technology with the intention of ultimately using it for military purposes. For example, suspicions were aroused in 1998 when Iraq purchased several lithotripters and 120 extra electronic switches for "spare parts" (Milhollin, 1999). Iraq was prohibited from purchasing many items due to a United Nations embargo but was permitted to import medical equipment. Ultimately, Germany authorized the export of the lithotripters to Iraq—but the spare parts were never delivered.

The dual-use dilemma is evident in current thinking in the United States about Iran's nuclear program. In the late-1980s, Iran began pursuing the capability to enrich uranium, presumably because this material can be used to trigger a nuclear explosion. But enriched uranium can also be used to fuel nuclear power reactors, which enabled Tehran to assert that its intentions were entirely peaceful.[3] To this day, the dual-use nature of nuclear technology and materials creates ambiguities about Iran's intentions. A much-publicized U.S. National Intelligence Estimate (NIE) issued in November 2007 concluded with "high confidence" that Iran halted its nuclear weapons program in fall 2003. However, the NIE also stated that "Iranian entities are continuing to develop a range of technical capabilities that could be applied to

[3] Uranium enriched to 2-3 percent can be used in power reactors while weapon-grade uranium needs to be enriched to 90 percent. Nevertheless, once a country has the capability to enrich reactor-grade uranium, it is not much more difficult to enrich weapon-grade uranium

producing nuclear weapons, if a decision is made to do so. For example, Iran's civilian uranium enrichment program is continuing." What this means is that countries can use "peaceful" nuclear technology in military applications with relative ease.

These short stories raise a number of important research questions. What is the relationship between nuclear energy and nuclear weapons? Does nuclear energy contribute to weapons proliferation? Why do states engage in civilian nuclear cooperation? This project theoretically and empirically explores these questions.

THE ARGUMENT IN BRIEF

This dissertation consists of two principal sections. In the first portion, I explore the relationship between nuclear energy and nuclear weapons. Building on the "technological momentum" hypothesis (e.g. Scheinman, 1965), I argue that civilian nuclear cooperation *pushes* states to pursue nuclear weapons because it spreads dual-use technology and expertise that invites exploration into nuclear explosives. It also argues that civilian nuclear cooperation *enables* states to acquire nuclear weapons because it provides necessary technology and establishes an indigenous knowledge-base in nuclear matters, making the development of atomic bombs more feasible. This indicates that states unknowingly facilitate nuclear proliferation when they assist other states' peaceful atomic energy programs. This argument is novel because it suggests that even seemingly "innocuous" assistance such as training scientists or providing research reactors contributes to proliferation.

Given the relationship between nuclear weapons and civilian cooperation, the majority of this dissertation seeks to explain why suppliers provide civilian nuclear assistance to other states. My argument is that supplier states use civilian nuclear cooperation as an instrument of their grand strategies.[4] This general proposition leads to four specific hypotheses. First, building on arguments advanced in the literature on international trade (e.g. Gowa and Mansfield, 1993; Skalnes, 2000), supplier states are more likely to provide nuclear technology to their allies in order to keep their alliances strong. Maintaining strong alliances is important because it puts states in a better position to meet important strategic objectives such as deterring third party aggression (Farber and Gowa, 1995). Second, supplier states are less likely to provide nuclear assistance to their enemies because doing so strengthens the capabilities of an adversary and makes discrimination in favor of allies less meaningful.[5] Third, states are more willing to provide nuclear aid to those that they share an enemy with. In international politics, states have incentives to constrain the power of those they are threatened by (e.g. Waltz, 1979; Mearsheimer, 1994/95) and they often do so by cooperating with threatening states' enemies. State A and State B might form an alliance, for example, if both are threatened by State C (Walt, 1987). By engaging in nuclear cooperation with enemies of enemies, states can forge a closer relationship with those that can best help it balance the power of its adversaries. Further, this behavior can constrain the capabilities of the threatening state because it makes it more difficult for that state to exert influence or aggression against the recipient state. It also forces the threatening state to consider the possibility that one of its enemies might acquire nuclear weapons or experience gains to an existing arsenal. This benefits the supplier state because it diverts the threatening state's attention away from other objectives that it might find threatening. Fourth, since states are especially threatened by the most powerful states in the system, suppliers are particularly

[4] I adopt Posen's (1984) definition of grand strategy as a "means-end chain," embodying "a state's theory about how it can best 'cause' security for itself. Following Skalnes (2000), I consider a broad definition of grand strategy that encompasses political, military, and economic tools as part of the "means-end chain."

[5] Similar logic is advanced by Gowa (1994) and Skalnes (2000) to explain international trade.

likely to provide nuclear aid to countries that are enemies of the superpowers (e.g. the most powerful states).

To summarize, civilian nuclear cooperation is aimed at keeping alliances strong and forging strategic partnerships with countries that can assist in balancing the capabilities of threatening states. I argue that these strategic factors are more salient than normative considerations limiting the spread of nuclear weapons. What this suggests is that the nuclear nonproliferation regime—especially its anchor, the NPT—has little effect on civilian nuclear cooperation. Although Article IV of the NPT states that countries who sign the treaty are entitled to nuclear technology for peaceful purposes nuclear suppliers ignore this stipulation unless it is otherwise in their interest to offer nuclear aid to treaty members. Further, states will be willing to provide nuclear technology to those that have weak nonproliferation commitments or that are pursuing nuclear weapons if doing so allows it to achieve strategic objectives.

THE EVIDENCE IN BRIEF

The empirical tests of my hypotheses are based in part on a new dataset I created of more than 2,000 bilateral civilian nuclear cooperation agreements (NCAs) signed by countries between 1950 and 2000. This dataset, which is based on a list of NCAs compiled by James Keeley (2003), identifies cases when supplier states signed agreements pledging to exchange nuclear technology, materials, and knowledge with recipient states for "peaceful purposes."[6] NCAs are an appropriate measure of civilian nuclear cooperation because they need to be in place in almost all cases before trade in nuclear technology, materials, or knowledge can take place.

[6] Keeley's (2003) list is useful for my purposes because it identifies all nuclear agreements signed between 1950 and 2003. But for my purposes, the list alone was insufficient. I consulted the text of the agreements and a variety of other primary and secondary sources to determine: (1) who the supplier is and who the recipient is with respect to each agreement; and (2) what is being exchanged as part of the terms of the agreement.

I use statistical analysis and the new dataset on NCAs to test my hypotheses on the relationship between nuclear energy and nuclear weapons. The results reveal that countries receiving civilian nuclear assistance are more likely to begin nuclear weapons programs and more likely to actually acquire atomic bombs. I find strong support for these arguments even when accounting for the potentially endogenous relationship between nuclear cooperation and nuclear weapons.

To test my argument on when states engage in civilian nuclear cooperation, I adopt a "nested" research design (Lieberman, 2005). I begin by using statistical analysis to estimate the effects that independent variables have on the probability that one country will offer nuclear technology, materials, or knowledge to another country in a particular year. The statistical tests yield robust empirical support for all four of the hypotheses I articulate above. I find especially strong support for my argument in the Cold War era, although states behaved according to my expectations in the post-1991 period as well. Based on my quantitative results, I analyze two types of cases. First, I consider three cases of nuclear cooperation that were successfully predicted by my argument: (1) U.S. nuclear cooperation with Iran between 1957 and 1979; (2) Soviet nuclear cooperation with Libya between 1975 and 1986; and (3) Canadian nuclear cooperation with India between 1955 and 1976. The purpose of examining these cases is to determine whether the causal mechanisms operate as I expected in particular cases. It is important to conduct this type of analysis since multiple causes can lead to the same outcome (Most and Starr, 1989; King, Keohane, and Verba, 1994). My examination of these case studies confirms that the logic driving my argument is very powerful in explaining the behavior of the supplier states.

The second type of case I consider is those that were not successfully predicted by my argument. The purpose of examining these outliers is to determine whether there is a variable that is important in explaining nuclear cooperation but that I had excluded from my analysis. The outlying cases analyzed are nuclear cooperation agreements between: (1) the United States and Indonesia between 1960 and 1965; (2) Brazil and Iraq in 1980; (3) the United Kingdom and South Korea in 1991; (4) Canada and Romania in 1977; (5) China and Algeria between 1983 and 1993; (6) France and Iraq in 1974; (7) Germany and Iraq in 1975; (8) India and Vietnam in 1999; (9) Italy and Iraq in 1975; and (10) the Soviet Union and Yugoslavia between 1956 and 1967. These 10 cases reveal two potential alternative explanations for civilian nuclear cooperation. The first is that nuclear suppliers offer assistance in exchange for a stable oil supply, suggesting that they should be more likely to engage in cooperation with oil-producing countries. The oil-for-nuclear technology consideration was especially salient in Brazilian, French, and Italian cooperation with Iraq, but was also evident in U.S. cooperation with Iran—a case that was successfully predicted by my argument. The second alternative explanation is that states offer nuclear assistance due to pressures to become a key player in the nuclear marketplace. This suggests that new suppliers should behave differently from established suppliers. I use statistical analysis to test each of these alternative hypotheses and do not find significant support for either of them. Ultimately, this offers further evidence in favor of my strategic theory of nuclear cooperation.

CONTRIBUTIONS TO THEORY AND POLICY

This study contributes to international relations theory and policy in a number of ways. To begin with, it addresses a question that the extant literature has largely neglected. Although civilian nuclear cooperation can have a profound effect on international security, there is a relative paucity of analysis on this subject in both scholarly and policy circles. Most governments have not done adequate analysis on nuclear trade. Even the United States—arguably the country most likely to do so—has not systematically considered where its nuclear exports are going. According to a recent report issued by the Government Accountability Office (GAO) (2005), Washington "has not comprehensively analyzed available data to determine what dual-use items [relevant for nuclear, chemical, and biological weapons programs] have actually been exported."

There has been some important scholarly work related to civilian nuclear cooperation. Much of this literature considers the controls governments have in place to restrict nuclear-related trade, rather than the actual exchange of such commodities (Bertsch, Cupitt, and Elliott-Gower, 1994; Bertsch and Grillot, 1998; Cupitt, Grillot, and Murayama, 1999; Cupitt, 2000). A related body of work focuses on the role the Coordinating Committee (COCOM) on multilateral export controls played in restricting trade in strategic items such as nuclear technology during the Cold War (Bertsch, 1988; Forland, 1991; Mastanduno, 1992; Martin, 1992; Lipson, 1999). A few studies analyze trade in nuclear-related items. Much of this effort involves case studies that seek to explain the nuclear exports of a single country (Duffy, 1976, 1979; Lowrance, 1976; Paul, 2003; Corera, 2006; Bratt, 2006). Potter (1990) investigates the nuclear exports of a handful of "emerging suppliers" and Boardman and Keeley (1983) analyze the nuclear export policies of a few countries.[7] These studies make valuable contributions, but they are largely policy-oriented and do not explicitly seek to explain state behavior. Kroenig (2007) fills an important gap in the literature by systematically analyzing nuclear trade, but his study is limited

[7] Cupitt (2001) examines U.S. exports of a limited number of dual-use commodities to a small sample of countries, but he does not examine nuclear items.

to 13 cases of "sensitive nuclear assistance."[8] As far as I am aware, my study is the first systematic, large-n analysis seeking to explain why states engage in civilian nuclear cooperation.

This study contributes to the rich literature on nuclear proliferation. Traditionally, this literature has sought to explain why states pursue (or do not pursue) nuclear weapons (Quester, 1973; Solingen, 1994, 2007; Sagan, 1996/97; Paul, 2000; Singh and Way, 2004; Jo and Gartzke, 2007). My study contributes to these efforts by providing new evidence of the link between nuclear energy and nuclear weapons. By demonstrating that states receiving civilian nuclear assistance are more likely to begin nuclear weapons programs, I find support for the "technological momentum" hypothesis (e.g. Rosecrance, 1964; Scheinman, 1965). Until now, technological incentives for proliferation have not been subjected to rigorous empirical testing and they have been largely overshadowed by other arguments for why states proliferate. The implication of my analysis is that future studies of nuclear weapons proliferation must take greater stock of the role that civilian nuclear cooperation has on motivating states' decisions to pursue nuclear weapons.

Recently, studies on nuclear proliferation have turned their attention from *why* states proliferate to *how* they do so (Braun and Chyba 2004; Montgomery 2005; Kroenig, 2007; Fuhrmann, 2008). My study also contributes to these efforts. It reveals that states pursuing nuclear weapons are more likely to receive nuclear assistance for peaceful purposes. This suggests that countries are adept at using civilian nuclear programs as "fig leaves" for weapons acquisition efforts and that nuclear weapons spread along with the proliferation of civilian

[8] Kroenig (2007) defines sensitive nuclear assistance as help with the design and construction of nuclear weapons, the transfer of significant quantities of weapons-grade fissile material, or assistance in the construction of uranium enrichment or plutonium reprocessing plants.

nuclear technology. This makes understanding why states exchange technology, materials, and knowledge that could be used to build nuclear weapons particularly important. My analysis indicates is that suppliers provide nuclear technology to aid their strategic objectives, even if the long-term risks of spreading nuclear weapons are great. Thus, nuclear weapons may continue to spread as long as supplier states believe they can obtain short-term strategic advantages by offering-up civilian nuclear assistance.

This dissertation speaks to an important debate in international relations regarding the role of norms and institutions. Realist scholars (e.g. Mearsheimer, 1994/95) assert that international norms are epiphenomenal, meaning that any effect they have on state behavior is tied to power and material capabilities. In other words, institutions and norms cannot get states to cease behaving as "power maximizers." This perspective does *not* maintain that institutions and norms are irrelevant, just that they have no independent effect on a state's actions.[9] Alternatively, proponents of institutionalism (e.g. Keohane, 1984; Keohane and Martin, 1995) argue that institutions and norms can change state behavior because they alter incentives for states to cheat, lower transaction costs, and provide focal points for cooperation. These benefits of institutions make cooperation possible in circumstances where the anarchic international system otherwise would not allow it (Keohane and Martin, 1995).

The NPT has been hailed as the "most successful treaty ever devised" (Williams and Wolfsthal, 2005). It has earned this title in large part because the number of states that possess nuclear weapons today is much fewer than the number predicted by many observers prior to the

[9] Institutions matter because states often use them to achieve strategic objectives. For example, the United States used NATO to balance against the Soviet Union because doing so was more efficient. But this does not mean that NATO forced its member states to behave in ways that they otherwise would not (Mearsheimer, 1995).

creation of the NPT. In the early 1960s, President Kennedy famously warned that 15 or 20 nations would have nuclear weapons by 1970. Since Kennedy's warning only six additional countries crossed the nuclear weapons threshold—China (1964), Israel (1967), India (1974), South Africa (1979), Pakistan (1987), and North Korea (2005). The NPT has also been considered to be successful due to the number of states that have signed-on to the treaty; today only India, Israel, Pakistan, and North Korea remain outside the NPT. In judging the success of the NPT, however, its proponents have failed to consider the two "grand bargains" of the treaty. The first bargain is that in exchange for giving up the pursuit of nuclear weapons, the five nuclear powers will make "good faith efforts" to move towards complete nuclear disarmament.[10] The second is that states who forgo the nuclear option are entitled to nuclear technology for "peaceful purposes." Specifically, Article IV of the NPT states that:

> "All the Parties to the Treaty undertake to facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy. Parties to the Treaty in a position to do so shall also co-operate in contributing alone or together with other States or international organizations to the further development of the applications of nuclear energy for peaceful purposes, especially in the territories of non-nuclear-weapon States Party to the Treaty, with due consideration for the needs of the developing areas of the world."

My study suggests that the Article IV compromise has been a failure. Those who sign the treaty are actually statistically *less* likely to receive nuclear technology for peaceful use. Further, my case study analysis reveals that suppliers are continually willing to provide nuclear

[10] This is codified in Article VI of the NPT.

technology to states that had not signed the NPT if doing so helps them achieve strategic objectives. This lends support to the realist argument (e.g. Mearsheimer, 1994/95) that institutions exert no independent effect on state behavior. It also casts serious doubt on the overall effectiveness of the NPT. The treaty may have achieved some successes, but the nuclear suppliers do not appear to be living up to their Article IV obligations.

My study contributes to realist thinking in another respect. A fundamental tenet of neo-realism is that states cooperate against common enemies to balance against the most powerful states in the system or the greatest threats they face (Waltz, 1979; Walt 1987; Mearsheimer, 1994/95). Although indirect relationships have influenced realist thinking for decades (e.g. an enemy of an enemy is my friend), they have not been subjected to much empirical testing until very recently (Maoz et al, 2006, 2007; Crescenzi, 2007). I find robust empirical support for my argument that supplier states are more likely to provide nuclear assistance to those that share a common enemy with in order to forge a strategic partnership aimed at balancing the power of the common enemy. Thus, my study lends further support to the argument that indirect relationships can shed light on old and new puzzles in international relations (Maoz et al, 2006, 2007).

While my argument is rooted in realism, this study is an attempt to build bridges between the economics and security literatures in international relations. Edward Mead Earle (1943) and Albert Hirschman (1945) suggested long ago that economics and security are inexorably linked. Therefore, it makes sense to study these two dimensions in an integrated manner. A number of important studies have done so—especially in recent years. The intersection of economics and security is a primary issue for research on the political determinants of international trade (e.g. Pollins 1989; Gowa & Mansfield 1993; Morrow, Siverson & Tabares, 1998), economic sanctions and incentives (e.g. Baldwin 1985; Martin, 1992; Drezner, 1999), interdependence and militarized conflict (e.g. Russett & Oneal 2001), and grand strategy (e.g. Gilpin, 1981; Skalnes 2000). While this work is welcome, the division in international relations scholarship between international political economy (IPE) and security studies continues to persist (Mastanduno, 1998).

This project is in part a response to the need for a greater understanding of the relationship between economics and security. Civilian nuclear cooperation is a domain well-suited to explore this relationship because it stands directly at the intersection of economics and security. This means that governments have clear, and often competing, preferences in each of these areas. The free exchange of such commodities can be very lucrative, although doing so can indirectly contribute to another state's military capabilities.[11] As a result, nuclear proliferation, grand strategy, and other security considerations can influence how states exchange dual-use items. But these factors are often at odds with economic imperatives. For example, the United States currently has strong economic incentives to relax dual-use trade controls to China but doing so runs counter to foreign policy considerations, especially the perceived need to stymie China's military development (Crescezni, 2005: 92-93). By studying dual-use trade, I am able to shed light on whether states are motivated by the pursuit of power, the pursuit of plenty, or both.[12]

Finally, this project has a great deal of policy relevance. Although civilian nuclear cooperation has important implications for proliferation and international security, it is scantily understood. In a general sense, this study represents an attempt to raise awareness about the

[11] In a recent study, Duane Bratt (2006) finds that the transfer of civilian nuclear reactors generates hundreds of millions of dollars for the Canadian economy.

[12] The pursuit of power and the pursuit of plenty are, of course, Viner's (1947) words.

causes and implications of peaceful nuclear cooperation. This is especially important because we are in the midst of a major renaissance in nuclear power. In the Middle East alone, 11 countries have recently expressed a newfound interest in nuclear power. This is problematic because civilian nuclear assistance could encourage recipient states to pursue nuclear weapons, even if their intentions are entirely peaceful at the outset. Suppliers should be especially cautious when engaging in civilian nuclear cooperation—especially with countries in conflict-prone regions like the Middle East. France's recent pledges to aid the civilian programs of Libya, Algeria, Saudi Arabia, and the United Arab Emirates could facilitate nuclear proliferation in the region.[13]

The results of my study do not bode well for the future of the nonproliferation regime. The evidence presented in this dissertation suggests that supplier states often overlook proliferation concerns in pursuit of short-term strategic advantages. As I highlighted at the beginning of this chapter, the United States is currently facing widespread criticism for precisely this reason; it has pledged to supply nuclear technology to India even though New Delhi possesses nuclear weapons and has been one of the staunchest critics of NPT for more than 40 years. But the reality is that there is nothing new about U.S. behavior in the India case. For decades, nuclear suppliers have been willing to assist the nuclear programs of states with weak nonproliferation records if doing so achieves strategic objectives. As this type of behavior continues, it is likely to erode confidence in the NPT, perhaps leading to its collapse. There are signs that this is already happening. At the 2005 NPT Review Conference, representatives from Egypt, Indonesia, and a number of developing countries chastised the nuclear suppliers for illegally denying peaceful nuclear technology to NPT adherents.

[13] For reports of recent French activity in the Middle East see Jarry (2008).

My study also offers an ominous prediction for U.S. national security: enemies of the United States are especially likely to receive help with their nuclear programs in the coming years. Nuclear suppliers are likely to offer U.S. adversaries nuclear aid as a means to forge a strategic partnership aimed at balancing its power. Cooperating with such countries would also constrain U.S. capabilities by forcing it to cope with the possibility that one of its enemies might acquire nuclear weapons. Syria and Iran, two U.S. enemies in the Middle East, are especially likely candidates to receive nuclear aid. While Washington will try and prevent these transactions from happening, history suggests that their efforts will likely fail.[14]

THE ROADMAP OF THIS PROJECT

The following chapter articulates and tests hypotheses on the relationship between civilian nuclear cooperation and nuclear weapons. Chapter 3 advances a theory of nuclear cooperation and four hypotheses that flow from this general argument. It also outlines the research design and methodology used to test these hypotheses. My empirical strategy is to combine both qualitative and quantitative methods to benefit from the strengths of each approach. Chapter 4 presents the results of the quantitative tests of civilian nuclear cooperation. Since these results can only assess correlations, I present process tracing case studies in Chapters 5 and 6. Chapter 4 analyzes three cases where the statistical model made correct predictions to highlight the causal processes associated with nuclear trade. Chapter 6 looks at 10 cases not explained by the model. The intention here is to understand why these cases are not explained by the model and whether there is an important variable that I initially omitted from my

[14] There is evidence that this is already happening. In September 2007, Israel bombed a facility in Syria that many experts believed to be a partially constructed nuclear reactor (Sanger and Mazzetti, 2007).

statistical analysis. Chapter 7 concludes by summarizing the results, highlighting the implications of my research, and offering directions for future research.

CHAPTER 2

CIVILIAN NUCLEAR COOPERATION AND NUCLEAR WEAPONS

This chapter seeks to explain the relationship between civilian nuclear cooperation and nuclear proliferation. Building on earlier work, it argues that civilian nuclear cooperation *pushes* states to pursue nuclear weapons because it spreads dual-use technology and expertise that invites exploration into nuclear explosives. It also argues that civilian nuclear cooperation *enables* states to acquire nuclear weapons because it provides necessary technology and establishes an indigenous knowledge-base in nuclear matters, making the development of atomic bombs more feasible. This suggests that states unknowingly facilitate nuclear proliferation when they assist other states' peaceful atomic energy programs. To test these hypotheses, this study uses a new dataset on civilian nuclear assistance based on the coding of more than 2,000 bilateral civilian nuclear cooperation agreements (NCAs). Statistical results yield support for these arguments, even when accounting for the potentially endogenous relationship between nuclear cooperation and nuclear weapons. Theoretical and empirically, this study enhances scholarly understanding of nuclear proliferation by illustrating that even "proliferation-resistant" assistance—such as supplying power reactors or training scientists—encourages states to pursue nuclear weapons and ultimately increases the likelihood that they will acquire them.

INTRODUCTION

What is the relationship between nuclear energy and nuclear weapons? For fifty years, scholars have debated the answer to this question. In general, arguments on this topic can be divided into two camps. An early wave of research argued that nuclear power facilitates nuclear weapons proliferation because it legitimizes the pursuit of the technologies and materials necessary to produce nuclear weapons (Scheinman, 1965; Barnaby, 1969; Willrich, 1973; OTA, 1977; Gilinsky, 1978; Wohlstetter, 1978; Holdren, 1983; Meyer, 1984). More recent literature suggests that there is not a link between the two, essentially arguing that weapons proliferation is a political problem and/or that countries would have an easier time establishing a dedicated military facility than diverting material from a civilian program (deLeon, 1981; Spinrad, 1983; Sagan, 1996/97; Paul, 2000; Hymans, 2006; Solingen, 2007). Despite extensive debate, the literature has yet to achieve a consensus on this question (Gallucci, 2002).

This chapter moves this debate forward by examining how civilian nuclear cooperation—the transfer of nuclear technology, materials, or knowledge from one state to another for peaceful purposes—contributes to nuclear proliferation.[15] Scholars are beginning to systematically consider the relationship between peaceful nuclear assistance and nuclear weapons proliferation (Kroenig, 2007, 2008), but they have yet to explore the cumulative effects that nuclear aid has on the likelihood that a state will pursue and acquire nuclear weapons over time. Building on earlier work, I argue that receiving peaceful nuclear assistance over time *pushes* states to pursue nuclear weapons because it spreads dual-use technology and expertise that invites exploration into nuclear explosives. I also argue that the accumulation of civilian nuclear assistance *enables* recipient states to acquire nuclear weapons because it provides necessary technology and establishes an indigenous knowledge-base in nuclear matters, making the development of atomic bombs more feasible. This suggests that states inadvertently facilitate nuclear cooperation when they assist other states' peaceful atomic energy programs. To test these hypotheses, I produce a

[15] I use the terms "civilian nuclear cooperation," "nuclear assistance," and "cooperation in the peaceful uses of nuclear energy" interchangeably throughout this article.

new dataset on civilian nuclear assistance based on the coding of more than 2,000 bilateral civilian nuclear cooperation agreements (NCAs).[16] Statistical results yield support for these arguments, even when accounting for the potentially endogenous relationship between nuclear cooperation and nuclear weapons.

Why does this matter? Achieving a greater understanding of the nuclear energy—nuclear weapons nexus is imperative given that we are in the midst of a global renaissance in nuclear power. In recent years, dozens of non-nuclear weapon states, including 11 countries in the conflict-prone Middle East, have expressed an interest in developing or reviving civil nuclear programs.[17] Given the potentially destabilizing effects of nuclear proliferation, it is vital to consider whether cooperation in the peaceful uses of nuclear energy encourages countries to begin nuclear weapons programs and/or acquire atomic bombs. The results of this study suggest that supplier states should exercise great caution when assisting the peaceful nuclear program of another country. Although the expansion of nuclear energy has been offered as a potential solution to global climate change (e.g. Ferguson, 2007), it is highly unlikely that this benefit can be obtained without resulting in further nuclear proliferation.

This chapter contributes to the literature on nuclear proliferation (Quester, 1973; Sagan, 1996/97; Paul, 2000; Singh and Way, 2004; Jo and Gartzke, 2007; Solingen, 1994, 2007; Kroenig, 2008) in several respects. By coding new data on civilian nuclear cooperation I am able to conduct a comprehensive large-n analysis of the relationship between peaceful nuclear cooperation and the development of nuclear weapons. This allows me to make headway towards

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[16] These efforts build on Keeley's (2003) work and are described in more detail below.

[17] These countries include: Bahrain, Egypt, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Syria, Turkey, Yemen, and the United Arab Emirates. See Broad and Sanger (2006).

resolving the debate described above. The findings of this study enhance scholarly understanding of nuclear proliferation by demonstrating that civilian nuclear cooperation has a salient effect on states' decisions to begin nuclear weapons programs and acquire nuclear bombs. This analysis suggests that the link between peaceful nuclear cooperation and nuclear weapons is broader than previous research has acknowledged; even ostensibly "innocuous" cooperation such as training nuclear scientists or providing research or power reactors encourages states to pursue nuclear weapons and ultimately increases the likelihood that they will successfully build such weapons. This suggests that recent efforts to develop linkages between nuclear assistance and proliferation (Kroenig, 2007, 2008) are fruitful and that scholars should continue to explore this relationship.

This chapter proceeds by describing the existing research relevant to this study. Then I briefly describe the steps required to manufacture nuclear bombs. In the subsequent sections I advance two hypotheses related to the nuclear energy-nuclear weapons nexus, describe my empirical strategy to testing these hypotheses, and discuss the results. I conclude by summarizing the findings and underscoring the contributions of this study.

WHY DO STATES PURSUE NUCLEAR WEAPONS?

There is a rich literature on why states pursue nuclear weapons. In recent years this scholarship has turned its attention towards factors influencing a country's demand for nuclear weapons and treated technological considerations as a secondary concern. For example, Sagan (1996/97: 56) argues that scholars and practitioners should focus on "addressing the sources of the political *demand* for nuclear weapons, rather than focusing primarily on efforts to safeguard existing stockpiles of nuclear materials and to restrict the *supply* of specific weapons technology from the 'haves' to the 'have-nots.'" The extant literature identifies that a number of demand-side considerations are salient in explaining nuclear proliferation including: a state's security environment (e.g. Quester, 1973; Betts, 1977 Sagan, 1996/97); international norms (e.g. Epstein, 1977; Sagan 1996/97); domestic politics (e.g. Dunn and Khan, 1976; Kapur, 1979; Solingen, 1994, 2007); and intangible or symbolic motivations (e.g. Dunn and Khan, 1976; Hymans, 2006). These studies are often dismissive of supply-side approaches because several countries—most notably Germany and Japan—have the technical capacity to build nuclear bombs but have never chosen to do so. This critique fails to consider, however, that technology-based arguments are probabilistic, not deterministic.[18] Proponents of the supply-side approach suggest that countries with peaceful nuclear programs are *more likely* to pursue nuclear weapons, not that all countries with a civilian atomic infrastructure will attempt to build bombs.

A growing number of quantitative studies pay greater credence to technology-based arguments and typically treat it is a necessary but not sufficient condition of proliferation (Singh and Way, 2004; Jo and Gartzke, 2007). These studies find that indicators of economic capacity such as a state's gross domestic product (GDP) and the nuclear-related resources it possesses are correlated with weapons proliferation. While this work has made many contributions, it has not adequately addressed the links between civilian nuclear cooperation and weapons proliferation. In particular, it fails to sufficiently test the argument that the diffusion of knowledge and technology makes proliferation more likely. Jo and Gartzke (2007) include a variable in their model measuring the natural log of the number of years since 1938, which allows the authors to test the systemic effects of diffusion, but diffusion does not occur equally across all states.[19]

[18] For more on this point, see Singh and Way (2004).

[19] For example, a state that receives a significant amount of civilian nuclear assistance (e.g. India) will experience a great deal of diffusion while states that receive no assistance (e.g. Lebanon) will not experience the same effects.

They also include a variable measuring the number of years a nuclear weapons program has existed to test diffusion-related arguments. But this measure tests whether the continuation of military programs makes states more likely to eventually acquire nuclear weapons—not whether civilian programs lead to weapons programs.

Kroenig (2007, 2008) offers the most comprehensive quantitative treatment of the links between nuclear energy and nuclear weapons to date. He explores the relationship between nuclear assistance and the acquisition of nuclear weapons but does not explore how peaceful aid can encourage countries to pursue atomic bombs.[20] Kroenig (2007, 2008) argues that sensitive nuclear assistance helps states overcome technical and strategic hurdles, making it more likely that they will acquire nuclear weapons.[21] He finds strong empirical support for this argument but does not find support for the contention that non-sensitive, civilian aid enables the acquisition of nuclear bombs. The finding on non-sensitive assistance may be due to limitations in the way this concept is measured, which is a point that I will revisit below.

BUILDING THE BOMB

Nuclear weapons production requires three steps. The first is the production of nuclear materials that can sustain chain reactions to release enormous amounts of energy in a short time. The nuclear materials capable of doing so include plutonium-239 and enriched uranium-235. The second is weapon assembly. To convert the enriched uranium or plutonium into a weapon several components are needed including electronics to trigger chemical explosives and a neutron generator to start the nuclear detonation at the appropriate time. The third is integrating

[20] Since 1950, 12 countries have received sensitive nuclear assistance (Kroenig, 2008).

[21] He defines "sensitive nuclear assistance" as assistance in the design and construction of nuclear weapons, the supply of weapon-grade fissile material, or assistance in building uranium enrichment or plutonium reprocessing facilities. I will discuss this measure further in the methodology section below.

the weapon with a delivery system such as a ballistic missile or other military vehicle (OTA, 1993).

Of these stages the most difficult, by far, is the production of nuclear materials (OTA, 1993; Gardner, 1994; Cirincione et al, 2005). Therefore, it is worth considering how states might acquire such materials. One way to do so would be to steal them. Although theft of nuclear materials is rare, it has occurred. Most of these confirmed incidents involve poorly safeguarded facilities in the former Soviet Union and occurred in the absence of a readily identifiable buyer. Particularly alarming is the 2003 case where a Russian business man was offering $750,000 for stolen weapon-grade plutonium for sale to a foreign client (Bunn and Weir, 2006). Some have alleged that 100kg of highly enriched uranium was stolen from a facility in the United States in the 1960s and eventually transported to Israel (Hersh, 1991).[22] Although the international community remains concerned about the potential for the theft of nuclear materials, history suggests that other strategies are more viable.

As second approach to acquiring weapon-grade uranium or plutonium is to directly purchase it. States may supply highly enriched uranium (HEU), for example if the importing state has a research reactor that uses HEU for fuel.[23] As part of a civilian nuclear cooperation agreement with Iran, the United States exported 6kg of HEU to Iran for use in a reach reactor located in Tehran (Roe, 2006). Today, there are roughly 160 research reactors worldwide that use HEU for fuel, although the United States and the Soviet Union stopped producing such reactors decades ago and efforts are underway to further reduce this number (GAO, 2004).[24]

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[22] This allegation should be viewed skeptically since the evidence to support it is limited at best.

[23] HEU is also used by hospitals to treat illnesses such as breast cancer.

[24] The United States exported 10.3 tonnes of HEU (3-4 times as much as Russia) during this same period.

Exports of fissile material are subject to strict scrutiny, making it difficult for potential proliferators to easily purchase such materials for direct use in nuclear weapons.[25] This does not stop potential proliferators from attempting to purchase HEU. Western intelligence agencies have substantiated claims that Iran has attempted to purchase fissile material from parts of the former Soviet Union (Albright, 1995).

Fissile material can also be produced indigenously. Neither uranium-235 nor plutonium exists readily in nature, which means that they must be produced artificially. The processes required for doing so are depicted in Figure 2.1. To produce either material, the first step is to mine uranium ore from the earth's crust. The excavated uranium ore must then be milled and processed into a chemical form called yellowcake.[26] These mining and milling processes are standard in the mining industry and many states have facilities capable of implementing them (OTA, 1993). From there, the material must be converted to a form usable in a nuclear reactor. Most of the time, this means that it needs to be converted to the gas uranium hexafluoride (HF_6).[27]

Next, the concentration of the desired isotope, uranium-235, must be increased through enrichment. To be used in a nuclear weapon, the uranium should be enriched to at least 90 percent U-235, although it is possible to use lower concentrations. For use in a nuclear reactor,

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[25] Since 1992 the United States has placed severe limits on exports of HEU. It is difficult to obtain reliable data on HEU exports for Russia, the other major supplier. Available estimates suggest that Russia exported between 2.5 and 3.5 tonnes of HEU through 2002 (Albright, 2004).

[26] The name yellowcake comes from the amber color of this material.

[27] If plutonium production is the goal and the material is going to be used in a heavy water reactor, which burns non-enriched uranium, then it can be converted to uranium dioxide or uranium metal.

the uranium needs to be enriched to around 2-3 percent U-235.[28] Enriching uranium is a highly technical process that necessitates overcoming many engineering challenges. The two most common enrichment methods are the gaseous diffusion and gas centrifuge methods (Cirincione et al, 2005). The gaseous diffusion method relies on different weights of the isotopes to separate U-235 from the heavier U-238. Uranium hexafluoride gas is pumped through special porous filters; since the U-235 diffuses faster through this barrier (due to its lighter weight) it can be separated from the U-235. To obtain enough enriched uranium suitable for use in a reactor or bomb, this process must be repeated many times.[29] To successfully enrich uranium using this technique, states must purchase large quantities of specialized equipment and make/maintain a suitable barrier capable of separating the isotopes. To date, six countries—the United States, Soviet Union, United Kingdom, China, France, and Argentina—have implemented successful gaseous diffusion programs. The average amount of time it took these states from the initiation of these programs to the first successful enrichment of uranium was 4.8 years (Zentner, Coles, and Talbert, 2005).

The gas centrifuge enrichment technique has received considerable attention in recent years because the Pakistan-based A.Q. Khan network sold centrifuge-related technology to Iran, Libya, North Korea, and possibly others (Albright and Hinderton, 2005; Corera, 2006). Like gaseous diffusion, this technique also relies on the varying weights of the uranium isotopes. Uranium hexafluoride gas is fed into a cylindrical rotor, which spins at very high speeds. The centrifugal force pushes the heavier U-238 molecules closer to the wall than the lighter U-235

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[28] While weapon-grade uranium has thirty times more U-235 than reactor-grade uranium, it is not thirty times more difficult to produce (Gardner, 1994: 16).

[29] The process of repetition is often referred to as a cascade of stages. To enrich uranium to 90% U-235, between 3,500 and 4,000 stages are required (Zentner, Coles, and Talbert, 2005).

molecules, partially separating the isotopes. The partially enriched uranium is then fed into another rotor and this process is repeated until enough material is produced. Compared to the gaseous diffusion technique, this technique is a highly efficient way to produce enriched uranium (Cirincione et al, 2005). Eighteen countries have expressed interest in acquiring centrifuge technology.[30] Of these, seven successfully developed it indigenously (Brazil, Germany, India, Japan, the Soviet Union, the Netherlands, the United Kingdom, the United States), one acquired it covertly (Pakistan), and one purchased the technology openly (China) (Zentner, Coles, and Talbert, 2005). The others, for a variety of reasons, never successfully developed or otherwise obtained the technology.

Other enrichment techniques include: electromagnetic isotope separation (EMIS); chemical and ion exchange enrichment; aerodynamic isotope separation; and laser enrichment (Zentner, Coles, and Talbert, 2005). EMIS, which is very expensive and comparatively inefficient, relies on the principal that ions of different masses have different trajectories in a magnetic field. Consequently, when uranium tetrachloride (UCl4) is fed into a tank with a strong magnetic field, the U-235 can be separated from the U-238. At various points, three countries had active EMIS programs designed to produce HEU: the United States, the Soviet Union, and Iraq. Iraq's EMIS program is noteworthy because it went undetected by the international community, in large part because it relied on imported technology that was comparatively low-tech and often not controlled by governments. Presently, no state uses chemical and ion exchange technology to produce enriched uranium, although France and Japan experimented with the approach at one point in time. Similarly, Germany, Brazil, and South

[30] These countries include Australia, Brazil, China, France, Germany, India, Iran, Iraq, Japan, Libya, Pakistan, North Korea, South Africa, Soviet Union, Syria, Netherlands, United Kingdom, United States.

Africa used aerodynamic isotope separation technology previously but no state does so today to enrich uranium. Finally, laser enrichment technology is still in the research and development stages and it has not yet been successful in producing enriched uranium (Zentner, Coles, and Talbert, 2005).

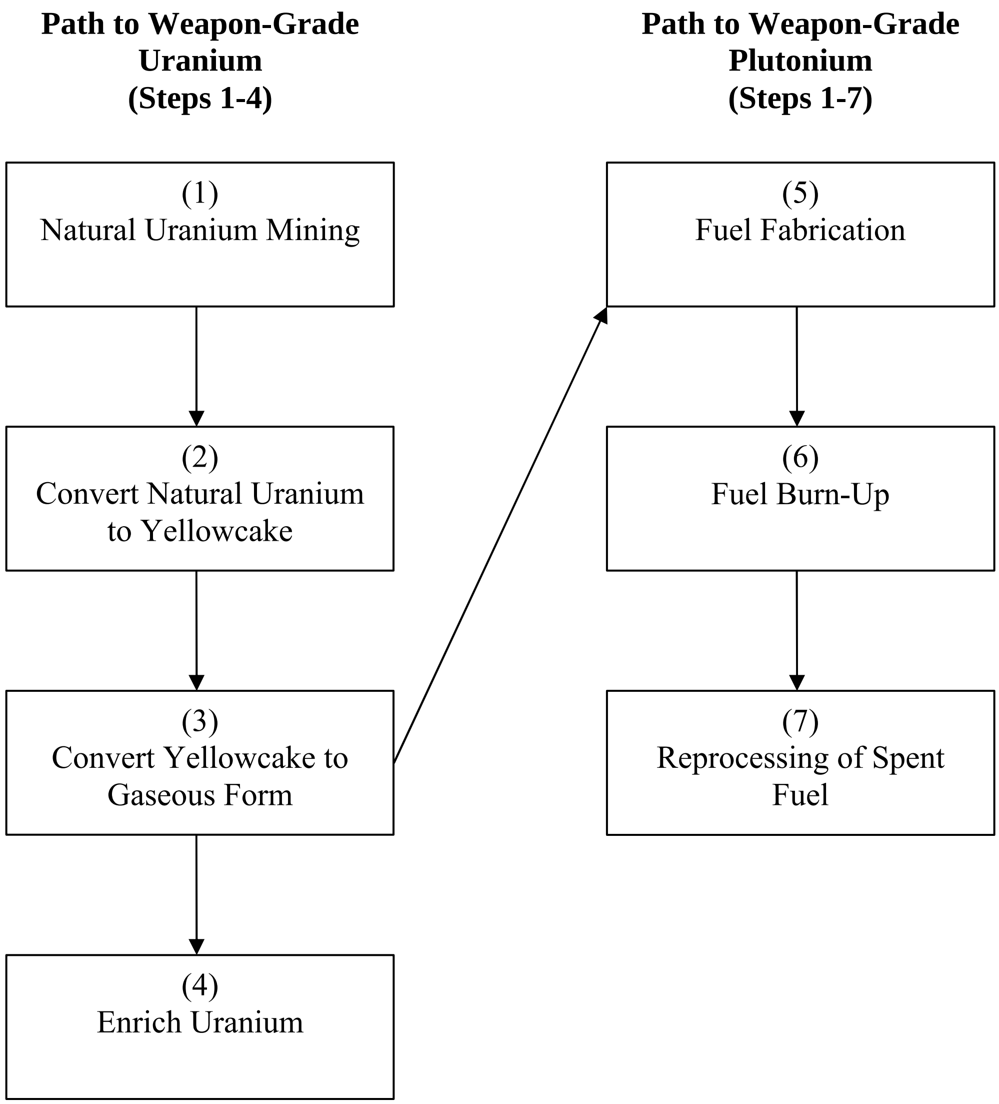

Figure 2.1: Paths to the Production of Weapon-Grade Materials

Plutonium, the other material that can be used in nuclear weapons, must be created in nuclear reactors. The history of proliferation suggests that states are most likely to produce plutonium using a research reactor or a power reactor moderated by heavy water or graphite that uses natural uranium fuel (Zentner, Coles, and Talbert, 2005). Using a reactor that can operate on natural uranium is advantageous because mastering the difficulties of uranium enrichment is no longer necessary. Just as is the case with HEU production, plutonium production begins with uranium mining, milling, and conversion to a gaseous form suitable for use in a reactor. From there, the material must be fabricated into fuel rods. The uranium is shaped into cylindrical pellets that are placed into tubes called fuel rods. These fuel rods are then bundled together and prepared for use in the reactor (Gardner, 1994: 16-17). Once in the reactor, the uranium fuel creates a controlled nuclear chain reaction that releases neutrons. These neutrons attach to U-238 and produce new isotopes that can eventually be converted into weapon-grade plutonium (P-239). However, before that can happen, the fuel rods containing these isotopes must be separated from other radioactive byproducts. This process of separation is often referred to as "reprocessing."

Reprocessing involves a series of complex procedures whereby plutonium is separated from other materials through a series of chemical reactions.[31] The plutonium resulting from this process can be converted to a form usable in nuclear weapons. Like uranium enrichment, plutonium reprocessing plants have legitimate civilian purposes since plutonium can be used as fuel in nuclear reactors. Recognizing the proliferation consequences of using plutonium in civilian nuclear reactors, many countries ceased doing so in the 1970s and 1980s. France, Japan, and Russia, however, continue to advocate the use of plutonium for civilian purposes and are

[31] The most common form of reprocessing is the Plutonium Uranium Recovery by Extraction (PUREX) method.

continuing to develop "breeder" reactors, which produce more plutonium than they consume (Cirincione et al, 2005). To date, 20 countries have reprocessed plutonium or have attempted to construct reprocessing facilities (Zentner, Coles, and Talbert, 2005).[32]

Since reprocessing facilities are crucial for states seeking to acquire bomb-related material it is worth considering how they obtain them. India and Taiwan are the only nations that successfully developed these facilities indigenously. India accomplished this between 1958 and 1964 by purchasing chemical processing equipment from the United States and Europe. They were able to readily do so since concerns regarding its nuclear weapons development were not salient. India also received training from the United States that significantly aided the reprocessing efforts (Zentner, Coles, and Talbert, 2005). In other cases, states purchased processing equipment directly. This was quite easy to do before India's peaceful nuclear test in 1974 because it was widely believed that reprocessing of spent fuel would only be done for civilian purposes. Today, because of regulations now in place, it would be much more difficult to overtly acquire reprocessing technology.

CIVILIAN NUCLEAR COOPERATION AND THE BOMB

The argument advanced in this chapter is that the accumulation of civilian nuclear assistance pushes states to pursue nuclear weapons over time and ultimately enables them to produce atomic bombs. Importantly, it suggests that seemingly "harmless" cooperation invites exploration of nuclear bombs and enables their successful construction. This indicates that the links between civilian nuclear cooperation and nuclear proliferation are much more expansive than previous research has acknowledged. In this section, I draw on previous work on the

[32] These countries include: Algeria, Argentina, Belgium, Brazil, China Czech Republic, France, Germany, India, Iraq, Israel, Italy, Japan, North Korea, Pakistan, Soviet Union, Taiwan, United States, United Kingdom, Yugoslavia.

supply-side of proliferation to theoretically explore how peaceful nuclear assistance facilitates nuclear proliferation.

What makes nuclear technology unique is that everything related to a nuclear weapons program has a legitimate civilian application. For example, uranium enrichment and plutonium reprocessing facilities are dual-use in nature because they can be used to produce fuel for power reactors or material for nuclear weapons. What this means is that civilian nuclear technology and nuclear weapons are inexorably linked. In the 1960s and 1970s, scholars offered a "technological momentum" hypothesis, suggesting that countries are more likely to pursue nuclear weapons once they obtain civilian nuclear technology and expertise in nuclear matters (Scheinman, 1965; Dunn and Kahn, 1976; Rosecrance, 1977; Potter, 1982). The logic driving this hypothesis is that the accrual of nuclear technology and knowledge leads to incremental advances in the field of nuclear engineering that ultimately makes progress towards a nuclear weapons capability before a formal decision to "go nuclear" is actually made (Potter, 1982). As John Holdren (1983) states, the proliferation of nuclear power represents the spread of an "attractive nuisance." Indeed, countries can "drift toward a military capability without any intention of arriving at it…[by adopting] a civilian program that ultimately places them within days of acquiring material for nuclear explosives" (Wohlstetter, 1978). Once states accumulate knowledge and technology related to nuclear-matters they are tempted to at least explore the possibility of pursuing nuclear weapons (Lavoy, 1993). This logic is reflected in a statement made by Robert Oppenheimer, the head of Manhattan Project, in 1954: "When I saw how to [develop a nuclear bomb], it was clear to me that one had to at least make the thing. Then the only problem was what would one do about them when one had them" (Lavoy, 1993: 195).

Peaceful nuclear programs typically begin with assistance from other countries. Thus, building on the rationale advanced above, I expect that the accumulation of civilian nuclear cooperation will encourage countries to pursue nuclear weapons over time. The Indian and South African experiences provide fitting illustrations of this. India received assistance in developing a peaceful nuclear program from the United States and Canada. Ultimately, this cooperation invited Indian exploration into nuclear explosives. As Roberta Wohlstetter writes (1978): "Canadian and U.S. help—transfers of facilities, equipment and material, advisory scientific and engineering services, training of Indian personnel, financial subsidies and loans—formed a major ingredient of the Indian [nuclear] program…And this help was given before…the Indians revealed a strong interest in nuclear explosives." South Africa began peaceful uranium enrichment and nuclear explosives programs in the 1960s, with assistance from the United States. Once South African scientists made sufficient progress, Pretoria initiated a weapons program in the 1970s. In the words of South African policy-makers, the nuclear weapons program "came out of South Africa's technological can-do mentality" (Albright, 1994), which emerged as a byproduct of cooperation with the United States.[33]

Most of the literature linking civilian nuclear assistance and nuclear weapons argues that the two are linked because "peaceful" aid enhances a state's *opportunity* to develop nuclear weapons (e.g. Singh and Way, 2004; Jo and Gartzke, 2007; Kroenig, 2008). The preceding logic suggests that civilian nuclear cooperation also enhances states' *willingness* to begin a nuclear weapons program. This leads to my first hypothesis:

[33] Another motivation for initiating the program was increased international isolation and fears about Cuban forces in neighboring Angola (Albright, 1994). While these motivations were present, the "can-do" mentality described above was especially salient.

Hypothesis 1: The accumulation of civilian nuclear assistance over time increases the likelihood that states will begin nuclear weapons programs.

There are strong theoretical reasons to also expect a relationship between civilian nuclear cooperation and the *acquisition* of nuclear weapons. The history of nuclear proliferation suggests that civilian nuclear energy cooperation can aid nuclear weapons production by providing the technology and items necessary to produce fissile material (Bunn, 2001). The goods related to the nuclear fuel cycle—including uranium enrichment and plutonium reprocessing facilities—are dual-use in nature because they can be used to produce nuclear materials for civilian power generation or nuclear weapons. As noted above, Kroenig (2008) finds that 12 countries that received sensitive nuclear assistance were statistically more likely to acquire nuclear weapons because the technical and strategic barriers to producing atomic bombs were lowered. For example, French nuclear assistance to Israel between 1958 and 1965 significantly enhanced Israel's ability to assemble a nuclear weapon (Kroenig, 2008; Cohen, 1998).[34] There are other instances where civilian nuclear exports not deemed to be the most sensitive directly contributed to states' weapons acquisition efforts. For example, a research reactor provided by Canada and heavy water from the United States facilitated the indigenous development of India's first nuclear device, which it tested in 1974 (Perkovich, 1999; Bunn, 2001).

Additionally, civilian nuclear cooperation builds-up a knowledge-base in nuclear matters. This knowledge can then be used to construct nuclear weapons. Civilian nuclear programs

[34] Additionally, Pakistan received sensitive nuclear assistance from China and then aided the nuclear weapons programs of Iran, Libya, and North Korea through the elaborate A.Q. Khan network (Corera, 2006; Kroenig, 2007). All of these efforts lowered important barriers to the development of nuclear weapons.

necessitate familiarity with: the handling of radioactive materials; processes for fuel fabrication and materials having chemical or nuclear properties; and the operation and function of reactors and electronic control systems. It also provides experience in other crucial fields such as metallurgy and neutronics (MacKenzie and Spinardie, 1995).[35] These experiences provide "a technology base upon which a nuclear weapon program could draw" (OTA, 1993: 153). This base of knowledge played a major role in enabling numerous countries to manufacture nuclear bombs (Bunn, 2001). For example, U.S. training of South African nuclear engineers increased technical competence in weapon-relevant matters, ultimately enhancing its ability to build a small nuclear arsenal (MacKenzie and Spinardi, 1995).[36] Further, Soviet assistance to North Korea contributed to Pyongyang's ability to produce nuclear bombs. The Soviet Union trained North Korean nuclear scientists beginning in the late 1950s and completed construction of a research reactor at Yongbyon in 1965. This technical aid provided a sufficient base of knowledge in nuclear matters to help the North Koreans build an "experimental nuclear installation" in the 1980s (Zhebin, 2000; Kaurov, 2000).[37] Pyongyang used this facility to produce plutonium, which it used to explode a nuclear bomb in October 2006 (Flam, 2006).

[35] Neutronics is the study of the behavior of neutrons in fissile materials. It is important from a weapons design standpoint because expertise in this field helps ensure that bombs explode rather than fissile and that a critical mass is not prematurely formed during the assembly of fissile material (MacKenzie and Spinardi, 1995).

[36] The transfer of knowledge is one of the reasons states object to civilian nuclear cooperation. U.S. officials worried in the mid 1990s that civilian nuclear cooperation between Russian and Iran would "create major connections between their programs" that could enable Iran to quietly obtain nuclear expertise from Russian experts that could ultimately benefit Tehran's secret weapons program (Albright, 1995: 23).

[37] The Soviet Union is believed to have trained more than 300 North Korean nuclear scientists during the period of cooperation (Kaurov, 2000).

This case is unique because it demonstrates that a country can collect technology and expertise under the auspices of a peaceful program and then abrogate their nonproliferation commitments, making it difficult for international regulatory agencies (e.g. the International Atomic Energy Agency) to monitor activities.[38]

While receiving sensitive assistance makes states more likely to acquire nuclear weapons (Kroenig, 2008), the preceding logic suggests the accumulation of *all* nuclear cooperation over time does so as well because it facilitates indigenous development of key technologies and establishes a technical knowledge-base that permits advances in nuclear explosives and related fields. This leads to the second hypothesis:

Hypothesis 2: The accumulation of civilian nuclear assistance over time makes states more likely to acquire nuclear weapons.

METHODOLOGY

The hypotheses stated above propose two ways that civilian nuclear assistance and nuclear weapons are linked. To test these hypotheses I use statistical analysis to estimate the effect that receiving nuclear assistance has on beginning a nuclear weapons program and on acquiring nuclear bombs. For both of these analyses, I use a dataset compiled by Singh and Way (2004) that is used to identify the determinants of nuclear proliferation. I adopt a standard time-series cross-sectional data structure for the period 1950 to 2000 and the unit of analysis is the country (monad) year. For my analysis of nuclear weapons program onset, a country exits the

[38] North Korea joined the NPT and received nuclear assistance for "peaceful purposes" from the Soviet Union but withdrew from the treaty in 2003. A fear about Tehran's eventual withdrawal from the NPT was also one of the principal reasons why the United States and others objected to civilian nuclear cooperation between Russia and Iran in the mid-1990s (Albright, 1995).

dataset once it initiates a weapons acquisition campaign. Similarly, for my analysis of nuclear weapons acquisition a country exits the dataset once it obtains at least one nuclear bomb.

Dependent Variables

I seek to identify the determinants of beginning a nuclear weapons program and acquiring nuclear weapons. For my analysis of the former, I create a dependent variable *Nuclear Weapons Program Onset,* which measures the time between 1950 and the year when a state begins a nuclear weapons program. To code this variable I consult a list of nuclear proliferation dates compiled by Singh and Way (2004) and Jo and Gartzke (2007). For the sake of robustness, I code the dependent variable based on both the Singh and Way (2004) and Jo and Gartzke (2007) proliferation dates. Table 2.1 lists the dates offered by both of these sources. For my analysis of acquisition, I create a dependent variable *Nuclear Weapons Acquisition* that measures the time between 1950 and the year when a state obtains at least one nuclear bomb. These dates are also obtained from Singh and Way (2004) and Jo and Gartzke (2007).

Table 2.1: Dates of Nuclear Weapon Programs for Non-Nuclear-Weapon States, 1945-2000

Country	**Nuclear Weapons Program**	
	Singh & Way (2004)	**Jo & Gartzke (2007)**
Argentina	1978 - 1990	1976 – 1990
Brazil	1978 - 1990	1978 – 1990
China	1955 – 1964	1956 – 1964
France	1954 – 1960	1954 – 1960
India	1964 – 1988	1964 – 1965; 1972 – 1988
Iran	1985 -	1974 – 1978; 1984 -
Iraq	1982 – 2003	1973 – 2003
Israel	1958 – 1971	1955 – 1966
Korea, North	1980 – 2003	1982 – 2003
Korea, South	1970 – 1978	1971 – 1975
Libya	1970 – 2003	--
Pakistan	1972 – 1987	1972 – 1987
Romania	--	1981 – 1989
South Africa	1974 – 1979	1971 – 1990
Soviet Union	1945 – 1949	1945 – 1949
Sweden	--	1946 – 1969

Taiwan	--	1967 – 1976
United Kingdom	1947 - 1952	--
United States	1945	1945
Yugoslavia	--	1948 – 1963; 1982 – 1987

Notes: The end dates indicate that the state either acquired nuclear weapons (in the cases of China, France, India, Israel, North Korea, Pakistan, South Africa, the Soviet Union, the United Kingdom, and the United States) or ended their nuclear weapons programs. Sources: Singh and Way (2004); Jo and Gartzke (2007)

Independent/Control Variables

I hypothesized above that the accumulation of civilian nuclear assistance makes states more likely to begin nuclear weapons programs and more likely to acquire atomic bombs. To operationalize civilian nuclear assistance, I collect and code new data on bilateral nuclear cooperation agreements (NCAs) signed between 1950 and 2003. NCAs are an appropriate independent variable for this analysis because they are necessary to be in place in virtually all cases before the exchange of nuclear technology, materials, or knowledge can take place. To produce these data, I consult a list compiled by James Keeley (2003) of more than 2,000 NCAs that have been signed since 1950.[39] I create an independent variable *Nuclear Cooperation Agreements* that measures the aggregate number of NCAs that a state has signed in a given year entitling it to nuclear technology, materials, or knowledge from another country.[40] This variable

[39] See Keeley (2003) for a more detailed explanation of NCAs. I conduct further research on all of the agreements included in Keeley's list to ensure that I only include deals that actually provide the basis for the exchange of nuclear technology, materials, or knowledge. This mirrors the procedure taken by Fuhrmann (2008).

[40] This is appropriate since technology, materials, and knowledge cannot be taken away once they are provided. For example, if a country received assistance in 1970, this aid would still be around in 1980 (and in subsequent years). In very rare cases, states can launch military campaigns to destroy nuclear infrastructure, as the Israel raid of Osiraq in 1981 illustrates. But even this strike did not take away the knowledge-base that had been provided to Iraq by France and other nuclear suppliers.

is different from the measures of assistance used by Kroenig (2007, 2008) because it measures the cumulative effect of nuclear aid over time.[41] Table 2.2 lists the 30 countries that received the most nuclear assistance via these agreements between 1950 and 2000.[42]

Table 2.2: Top Recipients of Nuclear Cooperation Agreements, 1950-2000

Country	Total Number of Agreements
United States	396
France	221
Germany	171
Russia	136
United Kingdom	133
Japan	122
Italy	112
Belgium	93
Argentina	92
Netherlands	80
Canada	77
Brazil	70
Spain	70
Switzerland	68
Luxembourg	63
Sweden	56
Denmark	55
China	53
South Korea	49
India	39
Ireland	36
Romania	35
Portugal	33
Czechoslovakia (1950-1991)	30

[41] Kroenig (2008) includes a dummy variable that is coded as 1 beginning in the first year that a state receives assistance in constructing a research or power reactor.

[42] The purpose of this table is to provide an illustration of the states that received the most civilian nuclear assistance between 1950 and 2000. Note, however, that some of these countries are only included in my sample for a limited number of years since states exit once they pursue or acquire nuclear weapons. So while the United States received the most assistance via nuclear agreements, it is not included in my sample since it acquired nuclear weapons prior to 1950.

Greece	30
Egypt	29
Finland	29
Poland	28
Australia	25
Indonesia	22
Summary Statistics: N= 186; Mean = 15.34; Minimum = 0; Maximum = 396	

For my analysis of both nuclear weapons program onset and nuclear weapons acquisition I include all of the variables used by Singh and Way (2004) and adopt their same measurements to allow for cross-study comparison. To control for technological capacity I include a variable measuring a country's gross domestic product (GDP) per capita and a squared term of this measure to allow for the possible curvilinear relationship between economic development and nuclear weapons pursuit.[43] To measure a state's industrial capacity, I also include a dichotomous variable that is coded 1 if it produces steel domestically and has an electricity generating capacity greater than 5,000MW and 0 otherwise. A state's security environment can also affect whether it pursues nuclear weapons. I include a dichotomous variable that is coded 1 if the state is involved in at least one enduring rivalry in a particular year and 0 otherwise and a variable measuring the 5-year moving average of the number of militarized interstate disputes (MIDs) per year a country is involved in.[44] A dichotomous variable that is coded 1 if a state shares a defense pact with one of the nuclear-capable great powers and 0 otherwise is also included since security

[43] In other words, there may be a "threshold effect" at play. Additional technological development could encourage states to begin nuclear weapons programs, but additional increments of wealth beyond a certain threshold are unlikely to have the same effect (Singh and Way, 2004: 868).

[44] Singh and Way (2004) code this variable based on Bennett's (1998) list of rivalries. They use version 3.0 of the militarized interstate dispute dataset (Ghosn and Palmer, 2003) to calculate the 5-year moving average.

guarantees of this magnitude could reduce states' incentives to develop nuclear weapons of their own.[45]

There are a number of "internal determinants" that could affect incentives to proliferate. I include three variables related to democracy. The first measures the country's score on the Polity IV (Beardsley and Gleditsch, 2003) scale.[46] The second variable, which measures whether a state is democratizing, calculates movement toward democracy over a five year time span by subtracting a state's Polity score in year t-5 from its Polity score in year t. A variable measuring the percentage of states in a particular year that receive a score of at least 7 on the Polity scale is also included to measure the prevalence of democracies in the system. To control for a state's exposure to the global economy, I include a variable measuring the ratio of exports plus imports as a share of GDP.[47] I also include a measure of trade liberalization that mirrors the democratization measure described above.

For the sake of robustness, I include two variables that Singh and Way (2004) exclude for their model. The first is a variable measuring whether the state has signed the nuclear Nonproliferation Treaty (NPT). This could be salient in explaining decisions to proliferate since states make legal pledges not to pursue nuclear weapons when they sign this treaty. I create a dichotomous variable and code it 1 if the state has signed the NPT in year t and 0 otherwise. Second, Kroenig (2008) argues that sensitive nuclear transfers are salient in explaining the

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[45] Singh and Way (2004) rely on version 3.0 of the Correlates of War alliance data set (Gibler and Sarkees, 2002) to code this variable.

[46] The Polity IV data are based on a 21-point scale that measures the relative openness of political institutions (Beardsley and Gleditsch, 2003).

[47] Singh and Way (2004) take their GDP data from version 6.1 of the Penn World Tables (Heston, Summers, and Aten, 2002).

acquisition of nuclear weapons.[48] Following Kroenig (2008) I include a dichotomous variable that is coded 1 beginning in the first year that a state receives sensitive nuclear assistance. The inclusion of this variable allows me to control for the possibility that a limited number of sensitive transfers are driving my results.

Methods of Analysis

The analyses seek to estimate the effect of civilian nuclear assistance on nuclear weapons program onset and nuclear weapons acquisition. I test both of the hypotheses using event history analysis to consider the duration of time before nuclear weapons programs begin and nuclear weapons are acquired as a function of independent variables (Box-Steffensmeier and Jones, 2004). I use a Cox proportional hazard model, which is preferred to parametric models (e.g. Gompertz or Weibull) because I am interested in the effects of both time-invariant and time-varying covariates on the likelihood of a state beginning a nuclear weapons program (Box-Steffensmeier and Jones, 2004). I use clustering over states to control for heterosketastic error variance.

RESULTS

Tables 2.3 and 2.4 present the results of the Cox regression analysis where the dependent variable is the number of years that lapse between 1950 and year t without a country beginning a nuclear weapons program.[49] Positive coefficients indicate that an increase in the independent

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[48] Kroenig (2008) defines sensitive transfers as those that include one of the following: (1) assistance in the design and construction of nuclear weapons; (2) significant quantities of weapons-grade fissile material; or (3) assistance in the construction of uranium enrichment or plutonium reprocessing facilities.

[49] Logit analysis—using a dichotomous dependent variable that is coded 1 if a country is pursuing nuclear weapons in year t and 0 otherwise and the same independent variables included in Table III—produces virtually identical results.

variable will increase the hazard or reduce the time that passes before nuclear weapons programs begin. Alternatively, negative coefficients suggest that an increase in the independent variable will decrease the hazard and increase the time that passes before commencement of a nuclear weapons program. The Models presented in Tables 2.3 and 2.4 are identical except they code the dependent variable based on data compiled by Singh and Way (2004) and Jo and Gartzke (2007), respectively. Column 1 includes only the *Nuclear Cooperation Agreements* variable in the model while Column 2 adds this variable to the exact model estimated by Singh and Way (2004). Column 3 adds the *NPT* variable to the model estimated by Singh and Way (2004). Column 4 is identical to Column 3 except it adds Kroenig's (2008) sensitive assistance measure. Finally, Column 5 is a trimmed model that includes only variables that were statistically significant in Column 4. Table 2.5 displays the substantive effects that statistically significant variables have on the likelihood of a state beginning a nuclear weapons program.

A number of interesting results emerge from these analyses. Most importantly, the coefficient on the variable measuring the number of nuclear cooperation agreements a state has received is positive and statistically significant and this result is robust to alternate model specifications. Receiving nuclear cooperation agreements also has a substantively significant effect on the likelihood that states will begin a nuclear weapons program. As Table 2.5 illustrates, receiving one additional nuclear cooperation agreement increases the hazard rate for beginning a weapons program by 11%. For example, Argentina had a hazard rate of beginning a weapons program in 1978—the year it actually began its military program—that was 88% higher than it was in 1968.[50] As I will highlight below, other variables have stronger substantive effects on the likelihood of beginning a weapons program, but this is a large effect nevertheless. These

[50] In 1968, Argentina had received 15 NCAs; by 1978, it had received 23.

results lend support to the "technological momentum" hypothesis (e.g. Scheinman, 1965; Dunn and Kahn, 1976; Rosecrance, 1977) and my argument that receiving nuclear technology for peaceful purposes over time tempts states to at least explore nuclear weapons. Turning to the sensitive assistance variable, the results in one model (Column 4, Table 2.3) suggest that states receiving sensitive nuclear assistance are more likely to begin nuclear weapons programs but this finding is not robust to alternate model specifications. While states that receive sensitive assistance may be more likely to acquire nuclear weapons (Kroenig, 2008), my results fail to yield robust support for the argument that such aid encourages states to begin weapons programs. Collectively, these findings are noteworthy because they suggests that assistance often perceived to be "proliferation-resistant" such as providing training in nuclear fields or supplying research/power reactors actually invites states to explore the nuclear weapons option. This is a finding that carries significant practical and theoretical implications, which I will discuss further in the conclusion.

Table 2.3: Cox Regression Analysis of Nuclear Weapons Program Onset, 1945-2000

	(1) NCAs	(2) Singh & Way Replication + NCAs	(3) Singh & Way Replication + NCAs + NPT	(4) Singh & Way Replication + NCAs + NPT + Sensitive Assistance	(5) Trimmed Model
Nuclear Cooperation Agreements	0.017**	0.106*	0.092*	0.084*	0.103**
	(0.009)	(0.054)	(0.052)	(0.046)	(0.050)
GDP per Capita	--	0.001***	0.001***	0.001***	0.001***
	--	(0.000)	(0.000)	(0.000)	(0.000)
GDP per Capita Squared	--	-0.000***	-0.000***	-0.000***	-0.000***
	--	(0.000)	(0.000)	(0.000)	(0.000)
Industrial Capacity	--	1.447**	1.763**	1.820**	1.429**
	--	(0.681)	(0.740)	(0.796)	(0.604)
Rivalry	--	2.270***	2.177**	1.916**	2.233***
	--	(0.759)	(0.875)	(0.867)	(0.759)
MID	--	0.409***	0.425***	0.426***	0.392***
	--	(0.133)	(0.142)	(0.124)	(0.109)

Nuclear Power Alliance	--	-0.459	-0.242	0.060	--
	--	(0.775)	(0.837)	(0.978)	--
Democracy	--	0.067*	0.053*	0.070**	0.046
	--	(0.034)	(0.030)	(0.033)	(0.031)
Democratization	--	-0.083	-0.080*	-0.078	--
	--	(0.052)	(0.048)	(0.052)	--
Percentage of Democracies	--	-0.215	-0.223	-0.342	--
	--	(0.162)	(0.221)	(0.240)	--
Economic Openness	--	-0.007	-0.000	-0.008	--
	--	(0.010)	(0.010)	(0.011)	--
Economic Liberalization	--	0.052**	0.053*	0.071**	0.048**
	--	(0.024)	(0.029)	(0.031)	(0.516)
NPT	--	--	-2.280***	-2.639***	-2.315***
	--	--	(0.726)	(0.642)	(0.019)
Sensitive Assistance	--	--	--	2.473**	1.177
	--	--	--	(1.207)	(1.172)
Observations	6868	5597	5597	5597	5597

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 2.4: The Determinants of Nuclear Weapons Program Onset—Alternate DV Coding

	(1) NCAs	(2) Singh & Way Replication + NCAs	(3) Singh & Way Replication + NCAs + NPT	(4) Singh & Way Replication + NCAs + NPT + Sensitive Assistance	(5) Trimmed Model
Nuclear Cooperation Agreements	0.016*	0.109**	0.102**	0.098**	0.109**
	(0.008)	(0.049)	(0.051)	(0.046)	(0.055)
GDP per Capita	--	0.001***	0.001***	0.001***	0.001***
	--	(0.000)	(0.000)	(0.000)	(0.000)
GDP per Capita Squared	--	-0.000***	-0.000***	-0.000***	-0.000***
	--	(0.000)	(0.000)	(0.000)	(0.000)
Industrial Capacity	--	1.212**	1.257**	1.268**	1.153**
	--	(0.576)	(0.577)	(0.581)	(0.543)
Rivalry	--	2.141***	1.972***	1.891***	2.173***
	--	(0.598)	(0.653)	(0.673)	(0.602)
MID	--	0.269***	0.274***	0.280***	0.280***
	--	(0.094)	(0.097)	(0.093)	(0.091)
Nuclear Power Alliance	--	-0.506	-0.471	-0.260	--
	--	(0.556)	(0.566)	(0.641)	--
Democracy	--	-0.003	-0.006	0.000	--
	--	(0.037)	(0.036)	(0.038)	--

Democratization	--	0.047	0.043	0.052	--
	--	(0.049)	(0.047)	(0.046)	--
Percentage of Democracies	--	-0.244***	-0.232**	-0.281**	-0.230**
	--	(0.094)	(0.102)	(0.116)	(0.097)
Economic Openness	--	-0.013	-0.012	-0.015*	-0.014
	--	(0.011)	(0.011)	(0.009)	(0.010)
Economic Liberalization	--	0.049***	0.049***	0.054***	0.047**
	--	(0.018)	(0.019)	(0.015)	(0.021)
NPT	--	--	-0.806	-0.838	--
	--	--	-	(0.565)	--
Sensitive Assistance	--	--	--	1.388	--
	--	--	--	(0.913)	--
Observations	6868	5597	5597	5597	5999

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

The GDP per capita, GPD per capita squared, industrial capacity, rivalry, MID, and economic liberalization variables all have statistically significant effects on the likelihood of beginning a nuclear weapons program. These results, which are robust to alternate model specifications, are largely consistent with the findings of Singh and Way (2004) and Jo and Gartzke (2007). Like previous work on nuclear proliferation, they support the contention that economic/technological development (e.g. Schwab, 1969; Barnaby, 1969) and a threatening security environment (e.g. Quester, 1973; Betts, 1977; Sagan, 1996/97) are especially salient in explaining nuclear proliferation. Of all the variables included in the model, rivalry involvement has the strongest substantive effect on the likelihood that a state will begin the pursuit nuclear weapons. The hazard rate for initiating a nuclear weapons program is 868% greater for states that have a rival than for similar states that do not. Industrial capacity also has a strong substantive effect on the likelihood of starting a nuclear program although, unlike Singh and Way (2004), I find that the effect produced by the rivalry involvement variable is stronger. The hazard rate for beginning a nuclear program is 325% greater for states that are industrially developed than for similar states that are not.

The finding that liberalizing states are more likely to begin a nuclear weapons program fails to support Solingen's (1994, 2007) innovative argument that "liberalizing coalitions" are less likely to jeopardize the opportunity to make money by pursuing nuclear weapons. The substantive effect produced by the economic liberalization variable is fairly modest; increasing the change in economic openness ratio by 1 produces only a 5% increase in the likelihood that a country will begin a weapons program. Other quantitative work reaches a similar conclusion (Singh and Way, 2004; Kroenig, 2008). Consistent with the extant literature, I find that an alliance with a nuclear power, democratization, and economic openness do not have statistically significant effects on nuclear proliferation.

There are some noteworthy differences between my study and other quantitative analyses of nuclear proliferation. Jo and Gartzke (2007: 20) find that membership in the NPT "tends modestly to encourage states to maintain pledges of nonproliferation." The results of my analysis fail to offer robust support for this argument; the NPT variable attains statistical significance when I use Singh and Way's (2004) proliferation dates, but not when I use Jo and Gartzke's (2007) dates. This casts doubt on the assertion that normative considerations influence states' proliferation choices. Existing work also finds that democracies are more likely to pursue nuclear weapons and that more democratic states in the system discourages proliferation (Singh and Way, 2004; Jo and Gartzke, 2007).[51] I find some support for the argument that democracy encourages proliferation by offering leaders the opportunity to pander to nationalist constituencies in an attempt to improve public opinion (e.g. Snyder, 2000). But support for this

[51] Jo and Gartzke (2007) find that democracy deepens proliferation once a weapons program is in place but find no difference between democracy and autocracy in terms of initiating such a program.

line of thinking is not robust across model specifications. I find no support for the argument that an increase in the percentage of democracies in the system reduces proliferation.

Table 2.5: Substantive Effects of Statistically Significant Explanatory Variables on the Likelihood of Starting a Nuclear Weapons Program

Variable	Percentage Change in Baseline Hazard Rate (Singh & Way Coding)	Percentage Change in Baseline Hazard Rate (Jo & Gartzke Coding)
Nuclear Cooperation Agreements (increase in one /year)	+11	+12
GDP per Capita (increase in $500)	+62	+60
GDP per Capita Squared (increase in $250,000)	-3	-3
Industrial Capacity Threshold	+325	+236
Involvement in Rivalry	+868	+751
MIDs (increase in one/year)	+51	+31
Democracy (one unit increase in Polity scale)	+7	--
Percentage of Democracies in the System	--	-22
Liberalization (one unit increase in trade ratio over five years)	+5	+5

Notes: Estimates are based on Column 2 in Table 2.3 and Column 2 in Table 2.4, respectively.

Tables 2.6 and 2.7 present the results of the Cox regression analysis where the dependent variable is the number of years that lapse between 1950 and year t without a country acquiring nuclear weapons.[52] Mirroring Tables 2.3 and 2.4, Tables 2.6 and 2.7 are identical except they code the dependent variable based on the Singh and Way (2004) and Jo and Gartzke (2007) data, respectively. Column 1 includes only the *Nuclear Cooperation Agreements* variable. Column 2

[52] Logit analysis—using the same independent variables used in Tables VI and a dichotomous dependent variable coded 1 if a country has acquired nuclear weapons (or is actively pursuing these weapons) in year t and 0 otherwise—produces virtually identical results.

adds the *Nuclear Cooperation Agreements* variable to the model estimated by Singh and Way (204). Column 3 is identical to Column 2 but it adds Kroenig's (2008) measure of sensitive nuclear assistance. Finally, Column 4 is a trimmed model that only includes variables that were statistically significant in Column 2.[53] Table 2.8 displays the substantive effects that statistically significant variables have on the likelihood of nuclear weapons acquisition.

Table 2.6: The Determinants of Nuclear Weapons Acquisition

	(1) NCAs	(2) Singh & Way Replication + NCAs	(3) Singh & Way Replication + NCAs + Sensitive Assistance	(4) Trimmed Model
Nuclear Cooperation Agreements	0.015*	0.116*	0.122*	0.091**
	(0.008)	(0.060)	(0.074)	(0.038)
GDP per Capita	--	0.001*	0.001	0.001*
	--	(0.001)	(0.001)	(0.000)
GDP per Capita Squared	--	-0.000*	-0.000*	-0.000**
	--	(0.000)	(0.000)	(0.000)
Industrial Capacity	--	5.091**	5.953**	3.587***
	--	(2.049)	(2.673)	(1.331)
Rivalry	--	2.352*	2.681	2.527**
	--	(1.259)	(1.745)	(1.234)
MID	--	0.564**	0.459	0.424***
	--	(0.257)	(0.353)	(0.133)
Nuclear Power Alliance	--	-2.058	-2.628	--
	--	(1.723)	(2.100)	--
Democracy	--	0.003	0.044	--
	--	(0.044)	(0.046)	--
Democratization	--	-0.083	-0.146	--
	--	(0.155)	(0.210)	--
Percentage of Democracies	--	-0.168	-0.231*	--
	--	(0.154)	(0.139)	--
Economic Openness	--	0.015**	0.015*	0.010***
	--	(0.006)	(0.008)	(0.003)
Economic Liberalization	--	0.014	0.021*	--

[53] I do not include the NPT variable in these models because it predicts failure perfectly; no state has ever acquired nuclear weapons while it was a member of the NPT.

	--	(0.011)	(0.012)	--
Sensitive Assistance	--	--	2.046**	--
	--	--	(0.939)	--
Observations	7053	5782	5782	6212

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 2.7: The Determinants of Nuclear Weapons Acquisition—Alternate DV Coding

	(1) NCAs	(2) Singh & Way Replication + NCAs	(3) Singh & Way Replication + NCAs + Sensitive Assistance	(4) Trimmed Model
Nuclear Cooperation Agreements	0.015*	0.079***	0.079**	0.076***
	(0.008)	(0.029)	(0.033)	(0.029)
GDP per Capita	--	0.001*	0.001*	0.001
	--	(0.000)	(0.000)	(0.000)
GDP per Capita Squared	--	-0.000**	-0.000**	-0.000*
	--	(0.000)	(0.000)	(0.000)
Industrial Capacity	--	4.329***	4.522***	4.142***
	--	(1.010)	(0.739)	(1.279)
Rivalry	--	2.594*	2.589	2.589**
	--	(1.384)	(1.625)	(1.251)
MID	--	0.433***	0.371***	0.344**
	--	(0.082)	(0.101)	(0.143)
Nuclear Power Alliance	--	-1.985**	-2.218*	-1.696*
	--	(0.804)	(1.190)	(0.866)
Democracy	--	0.058	0.095*	--
	--	(0.049)	(0.057)	--
Democratization	--	0.070	0.032	--
	--	(0.125)	(0.132)	--
Percentage of Democracies	--	0.107	0.020	--
	--	(0.125)	(0.139)	--
Economic Openness	--	0.016*	0.019*	0.008***
	--	(0.008)	(0.010)	(0.003)
Economic Liberalization	--	-0.012	-0.018	--
	--	(0.015)	(0.015)	--
Sensitive Assistance	--	--	1.721*	--
	--	--	(1.004)	--
Observations	7062	5791	5791	6221

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

There are some noteworthy findings that emerge from this analysis. The coefficient on the variable measuring the cumulative number of nuclear cooperation agreements a country has received is positive and statistically significant in all four columns. Interestingly, the substantive effect of *Nuclear Cooperation Agreements* on acquisition is similar to its effect on nuclear weapons program onset. As Table 2.8 illustrates, receiving one additional agreement increases the hazard rate of acquiring nuclear weapons by 12% (compared to 11% for onset). This is interesting because it suggests that countries benefit from the dual-use nature of nuclear technology. Not only does the accumulation of peaceful nuclear assistance encourage exploration into nuclear explosives, it also increases the likelihood that a country will be able to acquire nuclear weapons, which is consistent with the logic of my second hypothesis. Like Kroenig (2007, 2008) I find that states receiving sensitive assistance are more likely to acquire nuclear bombs, which suggests that these exchanges are troubling from a nonproliferation standpoint. Yet, even when controlling for the most sensitive transfers my results reveal civilian nuclear cooperation agreements enable proliferation over time. This offers further support for my contention that the links between the peaceful and military uses of the atom are much broader than was previously believed. Again, this is a point that I will revisit below.

Table 2.8: Substantive Effects of Statistically Significant Explanatory Variables on the Likelihood of Acquiring Nuclear Weapons

Variable	Percentage Change in Baseline Hazard Rate (Singh & Way Coding)	Percentage Change in Baseline Hazard Rate (Jo & Gartzke Coding)
Nuclear Cooperation Agreements (increase in one /year)	+12	+8
GDP per Capita (increase in $500)	+650	+31
GDP per Capita Squared (increase in $250,000)	-3	-3
Industrial Capacity Threshold	+16,200	+7500

Involvement in Rivalry	+900	+1200
MIDs (increase in one/year)	+76	+54
Nuclear Alliance	--	-86
Trade Openness	+1	+2

Notes: Estimates are based on Column 2 in Table 2.6 and Column 2 in Table 2.7, respectively.

Other than the *Nuclear Cooperation Agreements* variable, the only factors that have robust and statistically significant effects on both onset and acquisition are *GDP per Capita* and *GDP per Capita Squared.* I turn now to the key differences between my analysis of nuclear weapons program onset and nuclear weapons acquisition. Other than the variable operationalizing my hypotheis, the factors that were especially salient in explaining onset were those related to a country's security environment (*Rivalry* and *MIDs*). These variables produce statistically significant effects on acquisition in some of the models displayed in Tables 2.6 and 2.7 but these results are sensitive to alternate model specifications. In particular, when accounting for the number of nuclear cooperation agreements a state receives and whether it is a recipient of sensitive nuclear assistance, *Rivalry* no longer has a statistically significant effect on the likelihood of acquisition. This suggests that technological considerations are more salient in explaining nuclear weapons acquisition than previous work has acknowledged (e.g. Sagan, 1996/97; Singh and Way, 2004; Jo and Gartzke, 2007; Solingen, 2007). This claim is further substantiated by the large substantive effect that industrial capacity has on acquisition. As Table 2.8 reveals, crossing the industrial capacity threshold increases the hazard rate for acquiring nuclear weapons by 16,000%, by far the strongest effect of any independent variable. Singh and Way (2004) also find that *Industrial Capacity* has a stronger effect on acquisition than it does on onset, although they find that it produces a weaker effect than this.[54]

[54] Specifically, they find that *Industrial Capacity* increases the hazard rate for acquiring nuclear weapons by 2,340%.

I find some support for the argument that states sharing an alliance with a nuclear power are less likely to acquire nuclear weapons. This suggests that states with a nuclear protector might flirt with acquiring weapons but ultimately do not, either because of pressure from their powerful ally or technological constraints. Variables related to regime type (*Democracy, Democratization,* and *Percentage of Democracies*) have little effect on weapons acquisition. Some of these variables had statistically significant effects on the likelihood of beginning a weapons program, but their effects were not robust to alternate model specifications. My analysis of onset revealed that *Economic Liberalization* had a significant effect but *Economic Openness* did not. In my analysis of acquisition, I find that the coefficient on the variable measuring *Economic Openness* is statistically significant but the sign is negative, contrary to expectations.

Further Robustness Checks

My argument is that the accumulation of nuclear cooperation agreements encourages states to begin nuclear weapons programs and that receiving atomic aid ultimately enables states to acquire nuclear weapons. But it is also possible that states seek out nuclear assistance when they are pursuing nuclear weapons. Thus, nuclear cooperation may be endogenous to nuclear weapons pursuit. As a further robustness check, I estimate two endogenous equations simultaneously. The first equation represents the total number of nuclear cooperation agreements a state has received in a particular year and the second estimates the likelihood that it is pursuing nuclear weapons. As was the case above, the proliferation equation parallels the work of Singh and Way (2004). The nuclear cooperation equation that I employ is based on the analysis I conduct in Chapter 4. To estimate these equations simultaneously, I use a technique originally developed by Maddala (1983) and practically implemented by Keshk (2003).[55] This method is designed for simultaneous equation models where one of the endogenous variables is continuous and the other is dichotomous—which is precisely the nature of the variables in this case. The two-stage estimation technique generates instruments for each of the endogenous variables and then substitutes them in the respective structural equations. The first equation (with the continuous variable) is estimated using ordinary least squares and the second (with the dichotomous variable) is estimated using probit.[56]

Since I already described the proliferation equation in detail, I turn my attention to the nuclear cooperation equation. This equation draws from that offered in Chapter 4:

$$\textit{Total Number of Nuclear Cooperation Agreements}_{i,t} = \beta_0 + \gamma(\textit{Nuclear Weapons}_{i,t}) + \beta_1(\textit{Superpower Rival}_{i,t}) + \beta_2(\textit{Democracy}_{i,t}) + \beta_3(\textit{Others}_{i,t}) + \beta_4(\textit{Rivalry}_{i,t}) + \beta_5(\textit{GDP}_{i,t}) + \beta_6(\textit{N\_CAP}_{i,t}) + \beta_7(\textit{Oil Exporter}_{i,t}) + \beta_8(\textit{Oil Price}_{i,t}) + \beta_9(\textit{Energy Demand}_{i,t}) + \beta_{10}(\textit{NPT}_{i,t}) + \varepsilon,$$

where:

$\textit{Nuclear Weapons}_{i,t}$ is a dichotomous variable that equals 1 for every year that a state is pursuing nuclear weapons and 0 otherwise. This variable is coded as missing once states acquire nuclear weapons since these countries are excluded from this analysis. I code one variable based

[55] For yet another robustness check, I create a dichotomous variable *Nuclear Cooperation* that equals 1 if a state received at least 1 nuclear cooperation agreement in year t and 0 otherwise. Then I estimate the joint distribution of this variable and *Nuclear Weapons Pursuit* with a recursive simultaneous equations model. To do so, I follow Greene's (1998) advice and use bivariate probit. This technique produces identical results with respect to my independent variables of interest. The other results also remained largely unchanged.

[56] For other work in political science that uses this approach see Keshk, Pollins, and Reuveny (2004); Kim and Rousseau, (2005); Thies (2007).

on the Singh and Way (2004) coding and a second based on the Jo and Gartzke (2007) coding (see Table 2.1).

Superpower Rival$_{i,t}$ is a dichotomous variable that is coded 1 if the country is a rival of the United States (1950-2000) or the Soviet Union (1950-1991) in year t and 0 otherwise. To determine who is a rival of these two countries I consult the New Rivalry Dataset compiled by Klein, Goertz, and Diehl (2006). States that are enemies of superpowers should be more likely to receive nuclear assistance since nuclear suppliers have incentives to constrain the capabilities of more powerful countries (Waltz, 1979; Mearsheimer 1995/95).

Democracy$_{i,t}$ is a variable measuring a state's score on the Polity IV scale in year t (Beardsley and Gleditsch, 2003) and 0 otherwise. This measure is taken directly from Singh and Way (2004) and is identical to the variable included in the proliferation equation. Democracy is included in the nuclear cooperation equation because the transparency of democratic institutions (e.g. Gaubatz, 1996) could inspire greater confidence among suppliers that their exports will not contribute to proliferation.

Others$_{i,t}$ is a dummy variable that is coded as 1 if a state within 150 miles imports nuclear technology in year t and 0 otherwise.[57] This could be an important variable in explaining nuclear cooperation because states may be more likely to demand nuclear technology if one of their neighbors does so as a result of relative gains concerns (e.g. Waltz, 1979).

Rivalry$_{i,t}$ is a dichotomous variable that is coded 1 if the recipient is part of at least one rivalry in year t and 0 otherwise. This measure is identical to the one adopted by Singh and Way (2004) and used in the proliferation equation. It could be salient in explaining nuclear assistance because it enhances a state's demand for nuclear technology.

[57] Distance data are generated using EUGene (Bennett and Stam, 2000).

$GDP_{i,t}$ is a variable measuring a state's GDP in year t.[58] Countries with a higher GDP are likely to have a greater demand for nuclear technology (e.g. Anderson, 1979).

$N\_CAP_{i,t}$ measures the state's existing nuclear resources in year t using Jo and Gartzke's (2007) nuclear production data.[59] I expect that states with greater existing nuclear-related resources will have a higher demand for civilian nuclear technology.

$Oil\ Exporter_{i,t}$ is a dichotomous variable that is coded 1 if a state's oil exports exceed one-third of its total export revenues in year t and 0 otherwise.[60] Oil producing states should have less of a demand for nuclear energy.

$Oil\ Price_t$ is a variable measuring the price of a barrel of oil in year t measured in U.S. dollars (Carter et al, 2006). Theoretically, states should have a greater demand for nuclear energy when the price of oil is high.

$Energy\ Demand_{i,t}$ is a variable measuring the ratio of a state's energy production capacity to its population in year t.[61] Countries with greater energy needs should have a higher demand for nuclear technology.

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[58] GDP is measured in current US dollars. These data come from Gleditsch (2002).

[59] The Jo and Gartzke (2007) index measures nuclear production capacity based on seven measures including: domestic nuclear deposits; metallurgists; chemical engineers; nuclear engineers; electronic/explosive specialists; nitric acid production capabilities; and electricity production capabilities. They code each measure 1 if the capability is present and 0 if it is absent for each of these seven measures and then sum the number of 1s to construct their index.

[60] This measure is taken from Fearon and Laitin (2003).

[61] Data on energy production and population are obtained from the Correlates of War's National Military Capabilities Dataset (Singer, Bremer, and Stuckey, 1972).

$NPT_{i,t}$ is a dichotomous variable that equals 1 if the state has signed the NPT in year t and 0 otherwise. Data on NPT membership are obtained from a list compiled by the Center for Nonproliferation Studies (2006). States that sign the NPT might be more likely to receive nuclear technology since Article IV of the treaty explicitly states that those who sign it are entitled to nuclear technology for peaceful purposes. Further, suppliers might be more likely to provide aid to states that sign the NPT because it decreases the likelihood that their exports will contribute to proliferation.

Table 2.9: Results from the Simultaneous Equations Model

	(1) Two-Stage Probit Results: Singh and Way Coding	(2) Two-Stage Probit Results: Jo and Gartzke Coding
Nuclear Cooperation Agreements	1.70***	0.568*
	(0.30)	(0.263)
GDP per Capita	.0006***	0.00028**
	(.00013)	(0.000093)
GDP per Capita Squared	-5.44e-8***	-2.14e-8**
	(1.12e-8)	(6.85e-9)
Industrial Capacity	.0458	.293
	(.284)	(.234)
Rivalry	.960***	.609***
	(.200)	(.180)
MID	0.205***	0.176***
	(0.0400)	(0.044)
Nuclear Power Alliance	-.256	.0414
	(0.192)	(0.183)
Democracy	-0.0434**	-.019
	(0.0137)	(0.013)
Democratization	0.0148	0.0042
	(0.019)	(0.018)
Percentage of Democracies	-.113***	-.115***
	(0.0340)	(0.0277)
Economic Openness	0.0011	-.0040
	(0.0041)	(0.0040)
Economic Liberalization	.00074	.014*
	(0.0065)	(0.0060)
Weapon Free Years	-.739***	-.636***
	(.075)	(.057)
Spline 1	-.0051***	-.0029***
	(.00081)	(.00042)
Spline 2	.0032***	.0020***
	(.00081)	(.00053)
Spline 3	-.00079	-.00068
	(.00055)	(.00050)

Constant	.575	2.49**
	(.997)	(.821)
Observations	5274	5274

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Only the probit results are included here in the interest of space.

The results of the two-stage probit least squares model that addresses the simultaneity issue are presented in Table 2.9.[62] Column 1 codes the nuclear proliferation variable based on dates offered by Singh and Way (2004) while Column 2 codes the same measure based on the Jo and Gartzke (2007) data. The results reveal that nuclear cooperation has a positive and statistically significant effect on nuclear weapons pursuit even when controlling for the possible simultaneous relationship between these two measures. This result, which is robust to alternate model specifications, should inspire further confidence in my argument. As far as the other variables are concerned, the two-stage probit produces very similar results. The principal difference is that industrial capacity does not have a statistically significant effect on proliferation in either of the models displayed in Table 2.9; this variable had been significant in all of the previous model specifications.

CONCLUSION

In this chapter I argue that the accumulation of civilian nuclear assistance encourages states to begin nuclear weapons programs and ultimately enhances their ability to produce atomic bombs. This study makes a number of theoretical and practical contributions. The argument I advance in this chapter is novel because it suggests that peaceful nuclear cooperation affects both a state's opportunity to proliferate *and* its willingness to do so.[63] By generating a new dataset on

[62] Since my interest is on the nuclear proliferation equation, I focus on that equation here. The results from the nuclear cooperation equation are not included in the interest of space.

[63] Previous arguments linking technology and proliferation focus almost exclusively on the former.

civilian nuclear cooperation agreements, I am able to show that the buildup of civilian nuclear assistance makes it more likely that states will pursue nuclear weapons and increases the probability that they will ultimately acquire them. The former finding is unique because previous research in this domain (Kroenig, 2007, 2008) focuses only on the link between nuclear assistance and the acquisition of nuclear weapons.

The finding that *all* types of civilian aid can lead to nuclear proliferation is significant because it suggests that even seemingly "innocuous" nuclear cooperation such as providing training to nuclear scientists or supplying power/research reactors could produce deleterious effects. This has implications for the literature on nuclear proliferation (e.g. Sagan 1996/97; Paul, 2000; Singh and Way, 2004; Jo and Gartzke, 2007; Solingen, 2007; Kroenig, 2008) because it suggests that the links between the peaceful and military uses of the atom are much broader than was previously believed. Like Kroenig (2008), I find that sensitive assistance makes states more likely to acquire nuclear bombs, but I do not find robust support for the argument that sensitive aid encourages states to initiate nuclear weapons programs. This suggests that the buildup of nuclear cooperation agreements is salient in explaining both stages of nuclear proliferation but the most sensitive transfers are more important in explaining acquisition than onset. Overall, this study lends further support to growing evidence (e.g. Kroenig 2007, 2008) that a comprehensive understanding of nuclear proliferation cannot be obtained without considering peaceful nuclear cooperation. Given the extraordinary stakes in this debate (e.g. the potential to inadvertently spread nuclear weapons), future research should continue to explore this issue.

This study also challenges the conventional wisdom regarding the effectiveness of the International Atomic Energy Agency (IAEA), the international organization tasked with reducing the likelihood that peaceful nuclear cooperation contributes to nuclear weapons development. The IAEA is widely perceived to be an effective organization because it institutes a system of safeguards capable of detecting illicit diversions of materials and/or technology from peaceful applications to weapons programs (e.g. Abbot and Snidal, 1998).[64] If we assume that an institution can be judged on whether it eliminates or "substantially ameliorates" the problem that led to its creation (Young, 1999), my study casts doubt on the overall effectiveness of the IAEA. The results presented in this chapter reveal that civilian nuclear cooperation enables proliferation, despite efforts by the IAEA to prevent this from happening. In short, we cannot have nuclear energy without nuclear weapons even if institutionalized technical and legal measures are put in place to separate the two. This seems to lend support to arguments that institutions are epiphenomenal (e.g. Mearsheimer, 1994/95), although this is certainly an issue that future research should explore further.

From a policy perspective, this study suggests that suppliers should be especially guarded when selling nuclear technology or materials, as these transactions could contribute to proliferation. IAEA safeguards and other technical/legal assurances do not appear to be sufficient to separate the peaceful and military uses of the atom. In recent years, nuclear suppliers including France and Russia have pledged to sell technology to Middle Eastern countries such as Algeria, Libya, Saudi Arabia, the United Arab Emirates, and Egypt. These sales raise cause for concern because they are likely to contribute to future proliferation in the world's most conflict-prone region.

[64] The effectiveness of IAEA safeguards hinges on the belief that the possibility of detection will deter states from unauthorized diversions. Violators of safeguards can be referred to the United Nations Security Council, where they could face economic or political sanctions.

CHAPTER 3

THEORETICAL FRAMEWORK AND RESEARCH DESIGN

The previous chapter presented compelling evidence in favor of my argument that civilian nuclear cooperation and nuclear weapons pursuit are linked. Specifically, it demonstrated that receiving civilian nuclear assistance encourages states to begin nuclear weapons programs and that countries manipulate "peaceful" nuclear cooperation to aid their weapons acquisition efforts once they make the decision to develop the bomb. These findings underscore the importance of understanding civilian nuclear cooperation. Indeed, understanding this is essential if we want to understand how nuclear weapons spread. This chapter presents my theory of civilian nuclear cooperation. I argue that states use nuclear assistance as a means to strengthen their alliances and forge strategic partnerships with other countries. This argument leads to five hypotheses, including that states are more likely to cooperate with their military allies, countries they share enemies with, and states that are superpower enemies. I further hypothesize that suppliers are less likely to offer assistance to their adversaries and more likely to cooperate with democracies. After presenting my theory and the hypotheses that flow from it, I describe the competing explanations for nuclear cooperation rooted in economics and nonproliferation. I end this chapter by discussing my empirical strategy to testing my hypotheses in Chapters 4, 5, and 6.

THEORETICAL FRAMEWORK

There has been some important scholarly work on nuclear trade. Much of this literature considers the controls governments have in place to restrict nuclear trade, rather than the actual exchange of such commodities (e.g. Bertsch, Cupitt, and Elliott-Gower 1994). A few studies analyze trade in nuclear-related items. Much of this effort involves case studies that seek to explain the nuclear exports of a single country (Lowrance 1976; Boardman and Keeley 1983; Potter 1990; Paul 2003; Corera 2006; Bratt 2006). Kroenig (2007) fills an important gap in the extant literature by systematically analyzing "sensitive nuclear assistance."[65] My study compliments Kroenig's (2007) work by considering *all* civilian nuclear trade, rather than just the most sensitive transfers.

This study offers the first generalizable and comprehensive theory of why states engage in civilian nuclear cooperation.[66] The argument I advance is based on two assumptions. The first is that nuclear trade directly and indirectly bolsters the capabilities of the importing state. For example, importing a nuclear power reactor improves a state's energy production capacity, which has a direct effect on its capabilities since energy production is an important element of national power (e.g. Singer, Bremer, and Stuckey 1972). Importing a power reactor also indirectly enhances the state's capabilities since enhanced energy production capacity frees up resources that can be used to bolster its military capabilities. Second, since all nuclear commodities are dual-use in nature, importing states can use the technology and knowledge they acquire to build nuclear weapons. Many states acquire nuclear technology for "peaceful purposes" and later employ it in military applications (Bunn 2001). Further, nuclear

[65] Kroenig (2007) defines sensitive nuclear assistance as help with the design and construction of nuclear weapons, the transfer of significant quantities of weapons-grade fissile material, or assistance in the construction of uranium enrichment or plutonium reprocessing plants.

[66] While the literature on nuclear trade is underdeveloped, there is an established literature on the political determinants of international trade (e.g. Pollins, 1989; Gowa and Mansfield, 1993). I draw in part from this literature to form my theoretical expectations.

commodities supplied to one state could be diverted or re-exported to a third party, as the A.Q. Khan network illustrates (Corera 2006).[67] The third party can use these commodities and knowledge to pursue nuclear weapons.

With these assumptions in mind, my theoretical argument is that supplier states export civilian nuclear technology to meet security-related objectives and that these considerations are more salient than normative concerns limiting the spread of nuclear weapons. A number of hypotheses flow from this general argument. What follows is a discussion of these hypotheses.

Hypotheses

A number of studies have found that military allies trade more than non-allies (Gowa 1994; Mansfield and Bronson 1997; Morrow, Siverson, and Tabares 1998; Long 2003; Long and Leeds 2006). While enemies may fear what one another will do with the gains from trade, allies are less concerned with this because they typically pursue similar ends. Based on related logic, I expect that supplier states are more likely to supply nuclear technology to their allies. Civilian nuclear trade among allies strengthens the overall alliance by augmenting the capabilities of the importing state and improving intra-alliance relations (Skålnes 2000). This benefits supplier states because it puts them in a better position to meet strategic objectives, such as deterring third party aggression (Farber and Gowa 1995).

An alliance also minimizes the potential that proliferation-related consequences will arise from nuclear trade. Although it is debatable whether a state ever wants its ally to acquire nuclear weapons, it is likely to feel comparatively less threatened by an ally's acquisition of nuclear weapons. Equally important, allies are more likely to protect the nuclear technology they import

[67] The A.Q. Khan network was a Pakistani-based operation that supplied nuclear technology to Iran, Libya, North Korea, and possibly a fourth customer (see Corera, 2006).

than are adversaries. In other words, allies are less likely to re-export sensitive technology if such a transfer is not authorized by the initial suppler. Such behavior could threaten the security of the supplier state and if repeated, result in the collapse of the alliance. Since states depend on an alliance to enhance their security, they are unlikely to intentionally jeopardize its existence. Thus, allies can exchange nuclear technology with a degree confidence.[68]

Hypothesis 1: *Suppliers are likely to export nuclear technology to states they share a defense pact with.*

States have incentives to constrain the power of those they find threatening (e.g. Waltz 1979; Mearsheimer 1994/95) and often do so by cooperating with threatening states' enemies. For example, State A and State B are likely to form an alliance if both actors are threatened by State C (Walt 1987). Drawing on this logic, states have incentives to exchange civilian nuclear technology with the enemies of states they are threatened by. This allows a supplier state to develop a closer relationship with the importing state, which improves its ability to balance the threatening state's power. For example, India's civilian nuclear assistance to Vietnam beginning in the late 1990s was intended to forge an Indo-Vietnamese partnership to counter the rising influence of China in the region (Singh, 2007).

Engaging in civilian nuclear cooperation with a threatening state's enemy also constrains the threatening state's power. It does so in two respects. First it makes it more difficult for the threatening state to exert influence or aggression against its enemy (e.g. the recipient). Second, nuclear cooperation under such circumstances diverts the threatening state's attention towards

[68] As Long (2003) has pointed out, there are good reasons to expect different types of alliances to have a different impact on trade. I expect that defense pacts provide the necessary assurances governments need to exchange nuclear goods with confidence, while other types of alliances may not

the recipient states nuclear energy program and away from other power-maximizing objectives. Since nuclear technology is dual-use in nature, the threatening state may worry that nuclear trade for peaceful purposes could enhance the recipient state's ability to build nuclear weapons—regardless of whether this is the intention of nuclear cooperation or not. For example, China's nuclear exports to Pakistan can be explained by a desire to "limit India's power capabilities to South Asia and thereby constrain New Delhi's aspirations to become a major power in Asia" (Paul 2003). From Beijing's perspective, if India is worried about a nuclear arms race with Pakistan it would be less concerned with its rivalry with China. This logic suggests that civilian nuclear trade can be conceived as an instrument of "soft balancing," which is involves "tacit cooperation short of formal alliances" designed to constrain the power of potentially threatening states (Paul, Wirtz and Fortmann 2004: 3).[69]

In addition to allowing the supplier to constrain its adversary, exporting technology to an enemy of a threatening state provides at least temporary assurances that nuclear items will not be used to construct nuclear weapons. Having shared strategic interests reduces the likelihood that states' cooperation will be exploited (Walt 1987). In the area of nuclear trade, this means that importing states are unlikely to carelessly re-export technology or explicitly use it to construct nuclear weapons. This is the case because importing states also depend on the supplier state to

[69] More specifically, Paul, Wirtz, and Fortmann (2004: 3) refer to soft balancing as "tacit balancing short of formal alliances. It occurs when states generally develop ententes or limited security understandings with one another to balance a potentially threatening state or a rising power. Soft balancing is often based on a limited arms buildup, ad hoc cooperative exercises, or collaboration in regional or international institutions; these policies may be converted to open, hard-balancing strategies if and when security competition becomes intense and the powerful state becomes threatening."

counter the shared adversary's influence and are unlikely to engage in behavior that might jeopardize this cooperation.

Hypothesis 2: *Suppliers are likely to export nuclear technology to enemies of enemies.*

In international politics, states are most threatened by the strongest countries in the international system (Waltz, 1979; Mearsheimer 1994/95). Consequently, nuclear suppliers are especially likely to provide nuclear assistance to those states that are enemies of powerful states. Such behavior allows the supplier to counter the dominant state's influence by forging a partnership with its enemy. It further constrains the powerful state's capabilities by making it more difficult for it to exert pressure or aggression against its enemy. For example, in the post-Cold War era Russia, China, and other nuclear suppliers have continually offered nuclear commodities to states that are enemies of the United States such as Iran and Syria (Keeley, 2003). These transactions are intended to forge partnerships aimed at limiting Washington's power (Pape, 2005).

Hypothesis 3: *Suppliers are likely to export nuclear technology to states that are enemies of the most powerful states in the international system.*

Previous studies have demonstrated that militarized conflict reduces trade within a dyad because governments generally forbid trade with enemies (Hufbauer, Schott, and Elliott 1990) and economic actors face too many risks for trade to be profitable (Pollins 1989a,b; Morrow, Siverson and Tabares 1998; Anderton and Carter 2001; Glick and Taylor 2005; Kastner 2007).[70] Civilian nuclear trade between adversaries imposes severe negative consequences on exporting states. It increases the likelihood that imported technology will be used to construct nuclear

[70] Barbieri and Levy (1999) find that war does not have a significant impact on trading relationships. Their study, however, is based on only seven dyads.

weapons since enemies are highly sensitive to relative gains and look for ways to bolster their capabilities (Paul 2000; Grieco 1988; Waltz 1979). This increases the likelihood that the gains from trade the importing state experiences will undermine the security of the exporting state. Further, supplier states have incentives to restrict nuclear trade with adversaries in order to make discrimination in favor of allies more meaningful (Skålnes 2000).

Hypothesis 4: *Suppliers export less nuclear technology to states they are engaged in militarized conflict with.*

Regime type, particularly the institutional features of democracy, also affects civilian nuclear cooperation. Previous research notes that democratic institutions are amenable to cooperation because they promote transparency (Fearon 1994; Gaubatz 1996). Fearon (1994), for example, argues that the open information channels in democracies make it easier to signal intentions and make credible commitments. The propensity of democracies to make more credible commitments ensures nuclear suppliers that their exports are less likely to be used for unauthorized purposes. Further assurances stem from the free-flow of information in democracies, which makes it more difficult for the importing state to employ technology in pursuit of nuclear weapons or divert it to a third party without the exporting state finding out. To avoid the consequences that are likely to ensue following these actions, democratic importers are unlikely to do either. In these respects, democracy reduces the likelihood that nuclear trade will undermine the supplier state's security.[71]

[71] Previous studies have also advanced the assertion that democratic partners trade more than non-democratic partners (Dixon and Moon, 1993; Bliss and Russett, 1998; Mansfield and Bronson, 1997; Mansfield, Milner, and Rosendorff, 2000). These arguments typically draw from the democratic peace theory (e.g. Doyle, 1983), which suggests that democratic states are unlikely to engage in militarized conflict with one another. I test the hypothesis

Hypothesis 5: *Supplier states are more likely to export nuclear technology to democratic states than non-democratic states.*

ALTERNATIVE EXPLANATIONS

Nonproliferation

Desire to limit the spread of nuclear weapons could affect civilian nuclear cooperation. Although there may be cases when states prefer to see nuclear weapons spread (Waltz and Sagan, 1995; Mearsheimer, 1993), states generally prefer to limit their spread. For example, recently declassified documents reveal that the United States exerted considerable effort to dissuade Taiwan (an ally) from pursuing nuclear weapons (Burr, 2007). Additionally, despite being allies and engaging in civilian nuclear cooperation, Russia does not want to see Iran acquire nuclear weapons because such an outcome could trigger a nuclear arms race in the Middle East and inflame relations with Russia and the United States (Sokov, 2006). And despite being on friendly terms, Canada did not want India to use Canadian civilian nuclear technology to develop nuclear weapons—which New Delhi ultimately did, embarrassing Ottawa domestically and internationally in the process (Bratt, 2006).[72] This may explain why there are so few cases where states export military-related nuclear technology (Kroenig, 2007).

Civilian nuclear commodities are among the most sensitive that can be traded given their dual-use nature. The re-export of nuclear-related goods to an unauthorized third party can undermine the security interests of the supplier state. For example, Israel re-exported U.S. technology to China and Iran on a number of occasions during the 1990s (Clarke, 1995;

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that joint democracy increases the likelihood of civilian nuclear cooperation but find only mixed support for it (see note 28).

[72] In particular, Canadian civilian nuclear technology made it possible for India to conduct a peaceful nuclear explosion (PNE) at Pokhran in 1974. See Bratt (2006).

Fuhrmann and Young, 2006). In addition to threatening American commercial interests, these re-exports undermined U.S. security because they enhanced the military capabilities of its rivals, compromised intelligence, upset regional stability (Clarke, 1995).

This suggests that the importing state's nonproliferation pledges could influence nuclear cooperation by increasing suppliers' confidence that exported commodities will not be used for unauthorized purposes. States that ratify the nuclear Nonproliferation Treaty (NPT) make formal commitments not to manufacture, control, or acquire nuclear weapons and institute measures to verify that these pledges kept. They also pledge not to provide any assistance that allows other states to manufacture or acquire nuclear weapons.[73] Likewise, membership in the Nuclear Suppliers Group (NSG) requires states to institute strong domestic export control systems and full compliance with the norms of nonproliferation (CNS, 2006). Both NPT and NSG commitments on the part of an importing state provide assurances to suppliers that nuclear technology they export will not be used to develop nuclear weapons or enhance the military capabilities of an adversary. This means that suppliers might be more likely to export civilian nuclear technology to states that have made such pledges.

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[73] Article I of the NPT states: "Each nuclear-weapon State Party to the Treaty undertakes not to transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly, or indirectly; and not in any way to assist, encourage, or induce any non-nuclear-weapon State to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices." Article II of the treaty states: "Each non-nuclear-weapon State Party to the Treaty undertakes not to receive the transfer from any transferor whatsoever of nuclear weapons or other nuclear explosive devices or of control over such weapons or explosive devices directly, or indirectly; not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices; and not to seek or receive any assistant in the manufacture of nuclear weapons or other nuclear explosive devices."

Exporting nuclear technology to states that have made nonproliferation commitments also benefit the supplier state by demonstrating to others that such commitments are rewarded. This in turn creates an additional incentive for states to take measures to enhance their nonproliferation records.[74] Indeed, previous work has found that states improve their nonproliferation records if they believe that they might be granted access to civilian nuclear technology (or high-technology more generally) (Long, 1996). There are a number of examples of this. The promise of greater access to nuclear technology from Western markets induced many of the former Soviet bloc countries to improve their export control and nonproliferation commitments (Bertsch, Cupitt, and Elliott-Gower, 1994). Similarly, in the mid-1990s the United States induced Russia to enter the Missile Technology Control Regime (MTCR) and improve its national export control system by allowing Moscow to participate in the International Space Station (ISS) and facilitating the flow of some nuclear technology (Mistry, 2002). And Washington attempted to promote nuclear trade with China in the mid-1980s in order to induce Beijing to enter key nonproliferation arrangements (Brenner, 1990: 254).

The logic advanced above also suggests that supplier states are unlikely to offer nuclear technology to states that are pursuing nuclear weapons. When this is the case it is likely that exported technology would be used directly in military applications, which is something that suppliers seek to avoid because it may undermine their security. Indeed, states often impose economic sanctions against those that pursue nuclear weapons that explicitly limit the export of nuclear technology (Joseph, 2005).

Exporting civilian nuclear technology to state that is pursuing nuclear weapons could also have adverse effects on the supplier state's security because it creates the perception of

[74] This logic assumes that states are generally interested in promoting nonproliferation.

rewarding bad behavior (Drezner, 1999; Baldwin, 1985). This could harm the supplier's reputation and create disincentives for other states to make nonproliferation commitments by blurring the link between such commitments and access to civilian nuclear technology. As I highlighted in the introduction, the United States has faced a great deal of criticism for engaging in civilian nuclear cooperation with India when New Delhi possesses nuclear weapons and is not a signatory of the NPT.

Supply and Demand

A number of economic variables could influence the supply and demand for civilian nuclear commodities. It remains widely accepted that a state's capacity to supply exports as well as a state's demand for imports is directly related to its GDP (Anderson 1979). The distance between countries affects nuclear commerce because of the transportation and transaction costs associated with trade. These costs are expected to rise as the distance between two countries increases. The nuclear-related resources of the supplier and recipient states may also affect the supply and demand for civilian nuclear commodities. States with more nuclear-related resources are both more likely to supply and more likely to demand nuclear assistance. Additionally, the importing state's energy demand could affect nuclear aid because states with greater energy needs are more likely to turn to nuclear power. Finally, the price of oil might affect a state's demand for nuclear energy. The higher the price of oil, the more likely states are to be attracted to nuclear energy.

Importing State's Security Environment

Chapter 2 demonstrated that countries attempt to manipulate civilian nuclear cooperation to aid their weapons acquisition efforts. This suggests that a state's security environment might affect its demand for nuclear technology. Since states involved in rivalries are the most likely candidates to pursue nuclear weapons (Singh and Way, 2004; Jo and Gartzke, 2007), countries in dangerous neighborhoods might seek out peaceful nuclear assistance wherever they can find it. Thus, civilian nuclear cooperation might be more about "demand-pull" than "supply-push."

Temporal Variation

There may be temporal variation in the extent that suppliers' security considerations affect nuclear trade. System polarity may affect the extent that states employ linkage strategies. Gowa (1994) finds that states are more likely to tie trade to the flag when the international system is bipolar because alliances are more stable.[75] During the Cold War, international trade, particularly dual-use trade, reflected the political/military division of the world into two distinct blocs. The Coordinating Committee for Multilateral Export Controls (COCOM)—the "economic arm" of the North Atlantic Treaty Organization—restricted dual-use trade between East and West to stymie the economic and military power of the Soviet Union and its allies. A number of important studies have documented how and why the United States and its European allies used dual-use trade as a strategic instrument during the Cold War (Bertsch, 1988; Forland, 1991; Mastanduno, 1992). With the collapse of the international system's bipolar structure, it is unclear whether states' dual-use trade policy will be as heavily influenced by international security. In a multi-polar world, there may be less of a strategic need to link trade and security (Skålnes, 2000). Greater opportunity to form alliances means that alliance patterns are more unstable (Gowa, 1994) and states may be less certain about who they can trust with dual-use technology. Thus, we might expect variation in the extent that security affects nuclear cooperation between the Cold War and post-Cold War periods.

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[75] On the stability of alliances in a bipolar system see Duncan and Siverson (1982).

Ideational-based arguments suggest that states can learn based on the emergence of new facts, which can lead them to redefine their interests (Nye, 1987; Checkel, 2001). When it comes to dual-use trade, a certain amount of learning has taken place. Indeed, the link between dual-use trade and security has not always been as obvious as it is today and states' understanding of this relationship has evolved over time. In the 1950s, U.S. President Dwight D. Eisenhower launched the Atoms for Peace program, which was designed to share atomic energy for peaceful purposes. While it was recognized at the time that nuclear technology was dual-use in nature—meaning that it could be used to produce atomic energy or nuclear weapons—there was a sense of naiveté regarding states ability to use such technology for military purposes. This changed on May 18, 1974, when India exploded a nuclear device in the Rajasthan desert. The Indian test was shocking for a number of reasons. Most importantly, it demonstrated that a *developing* country was capable of developing nuclear weapons using technology supplied for "peaceful purposes." This event led to the strengthening of the nonproliferation regime (including the formation of the Nuclear Suppliers Group) and encouraged many states to be more aware of security considerations when exporting dual-use technology. For example, after learning that India was able to detonate a nuclear device using plutonium diverted from a Canadian-supplied research reactor, Canada required all of its customers to provide binding assurances that nuclear technology would be used solely for peaceful purposes (Bratt, 2006: 119-120). This suggests that we might expect to see differences in the saliency of security on nuclear commerce in the pre-regime and post-regime periods.

RESEARCH DESIGN

This study considers states' motivations for trading nuclear-related commodities. Specifically, it explores how and why states engage in civilian nuclear cooperation. To test the hypotheses articulated above I use a "nested" research design (Lieberman, 2005), meaning that I use both quantitative and qualitative methods to strengthen my theoretical framework and enhance the robustness of my empirical results.[76] In adopting this approach I attempt to bridge the gap between two distinct cultures.[77] Large-n quantitative analysis allows researchers to minimize the risks of sample selection bias and can be useful because it provides the average effect of each variable on the dependent variable—which cannot be ascertained via alternative methods (Moore, 2006: 93). The downsides of large-n analysis include imprecise measurement and an inability to explain outlying cases or provide detailed context to cases that are accounted for. These pitfalls can cause researchers to miss important causal mechanisms. Qualitative analysis of cases that fit the statistical analysis *and* outlying cases can counter these potential pitfalls. By using process tracing to analyze cases where empirical predictions held true, researchers can do more to confirm whether the outcomes are attributable to the hypothesized mechanisms or some other explanation (Bennett and Braumoeller, 2006; George and Bennett, 2005; Reiter, 1996: 122).[78] Analysis of outlying cases can shed light on variables that are important but were left out of the initial statistical model (Bennett and Braumoeller, 2006).

The following sections outline the data, variables, coding rules, and methods used in the quantitative tests. Subsequently, I describe the research design for the process-tracing case studies.

[76] Use of nested analysis in international relations is surprisingly rare. For important examples see Huth (1988) and Reiter (1996).

[77] See Mahoney and Goertz (2006) for more on this cultural divide.

[78] Qualitative researchers often refer to the notion that there are multiple paths to the same outcome as "equifinality" (Mahoney and Goertz, 2006).

Statistical Analysis

I adopt a cross-section time-series data structure for the period 1950 to 2000. The unit of analysis is the directed dyad year. Included in the dataset are all major nuclear suppliers and all potential recipient dyads in the international system. Major suppliers include the "traditional exporters" and the "emerging suppliers" as defined by Potter (1990).[79] All major suppliers are included in the dataset beginning in the first year subsequent to 1950 that they acquire a nuclear engineering or uranium production capability. To determine when this occurred, I consult data on nuclear production capabilities compiled by Jo and Gartzke (2007).[80] These data include latent nuclear weapon production capability estimates for 192 countries between 1938 and 2002 based on seven components. Two of these components are uranium production—whether a country is known to have uranium deposits or produced uranium—and nuclear engineering capabilities. Table 3.1 provides a list of the major nuclear suppliers including the first year they acquired this capability. It also specifies whether the state has uranium export capabilities, nuclear engineering capabilities, or is an advanced supplier, meaning it operates a domestic plutonium reprocessing or uranium enrichment facility.[81] All states in the system are potential recipients of nuclear-related commodities.

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[79] Potter's (1990) list includes: Argentina, Belgium, Brazil, Canada, China, France, Germany, India, Israel, Italy, Japan, Netherlands, Pakistan, Russia, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, UK, US, Yugoslavia. I exclude Taiwan due to data limitations and add North Korea, which became a significant supplier subsequent to Potter's work.

[80] See also Meyer (1984).

[81] On this latter point see Kroenig (2007).

Table 3.1: List of Nuclear Suppliers, 1950-2000

Country	Year of First Capable Supply	Country	Year of First Capable Supply
Argentina	1950	North Korea	1950
Belgium	1950	Pakistan	1963
Brazil	1950	Russia	1950
Canada	1950	South Africa	1950
China	1950	South Korea	1961
France	1950	Spain	1950
Germany	1959	Sweden	1950
India	1950	Switzerland	1957
Israel	1950	United Kingdom	1950
Italy	1961	United States	1950
Japan	1959	Yugoslavia	1959
Netherlands	1950		

Dependent Variable and Measurement

To determine whether states are trading nuclear commodities, I consult a list of bilateral civilian nuclear cooperation agreements (NCAs) compiled by James Keeley (2003). NCAs are bilateral treaties signed by states or non-commercial state agencies that authorize the exchange of nuclear goods and services. Keeley (2003) includes NCAs in his list based on a few key criteria. Above all, the agreement must deal with nuclear power and related issues. He includes agreements that call for: (1) the exchange of goods and knowledge related to nuclear power; (2) the exploration of uranium; or (3) assistance in the areas of nuclear safety, safeguards, and waste management. Excluded are: (1) agreements that are explicitly defense-related; (2) financial agreements, (3) agreements dealing solely with agricultural or industrial agreements not related to nuclear power; (4) agreements dealing with the leasing of nuclear material; (5) liability agreements; and (6) multilateral agreements.[82] Since 1950, more than 2000 agreements meet these criteria (Keeley, 2003). Figure 3.1 plots the number of nuclear deals that have been signed over time. As Figure 1 reveals, the number of agreements signed has fluctuated over time, with peaks in the late 1980s and the mid 1990s.

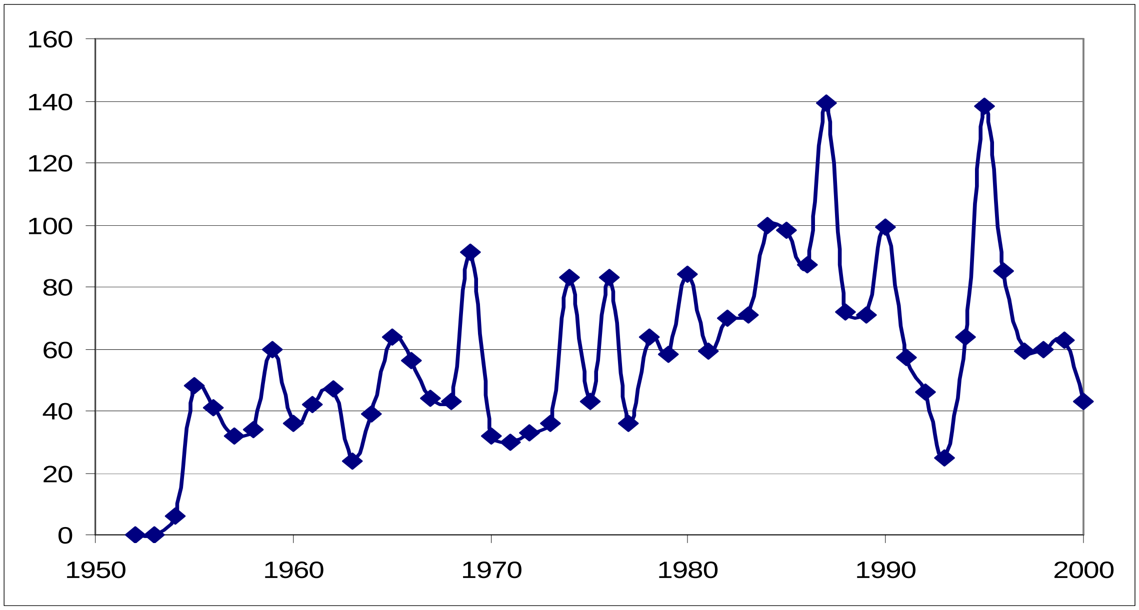

Figure 3.1: Number of Nuclear Cooperation Agreements, 1950-2000

There are a few different types of NCAs. The most common are general NCAs, which typically include provisions dealing with the supply of nuclear goods/knowledge, nuclear safety, and nonproliferation assurances. General NCAs also include reciprocal commitments; in other words, both states agree to supply nuclear commodities and maintain appropriate nonproliferation commitments. A second type of NCA is a general agreement in which only one state supplies nuclear commodities. Sometimes the treaty text makes it clear that only one state

[82] There are a few key exceptions to this. Agreements involving the European Atomic Energy Community (EURATOM) and the Belgo-Luxembourg Economic Union are included.

is the supplier.[83] Other times, an NCA is written in such a way to imply reciprocity of supply but in reality only one state is doing the supplying (Keeley, 2007). A third type of NCA includes authorizations of specific transactions. For example, two states might sign an NCA to construct a nuclear reactor or supply nuclear materials rather than agree to an open-ended, general supply commitment. A fourth class of NCAs deal explicitly with nuclear safety, environmental/physical protection or waste management. A fifth group of NCAs deal explicitly with nonproliferation commitments. These typically involve a pledge on the part of the importing state not to re-transfer technology to a third party. Finally, NCAs may simply represent a commitment to initiate future nuclear cooperation.

The relationship between NCAs and nuclear trade is not always entirely clear. As Keeley (2003) notes, the presence of an agreement does not necessarily imply that a substantial degree of nuclear trade is taking place. Similarly, nuclear trade can take place in the absence of an NCA. Nevertheless, the existence of an NCA is very likely to be indicative of nuclear trade (Keeley, 2003). Since time series data on nuclear trade including all states is not available, analyzing NCAs is an appropriate alternative. Only the first four types of NCAs described above involve the supply of nuclear technology or knowledge. Safety agreements are included because they permit the exchange of goods and information that improve the functioning of nuclear facilities. NCAs dealing only with nonproliferation or commitments to initiate future cooperation are excluded from this analysis.

[83] For example, a NCA signed by the United States and Lebanon in 1955 states: "Lebanon desires to pursue a research and development program looking toward the realization of the peaceful…uses of atomic energy and desires to obtain assistance from the government of the United States of America."

Among those NCAs that involve the exchange of nuclear commodities, it is not always clear who the supplier is based on the information included in the treaty text.[84] Making a determination on this point is important. To do so, I adopt the following coding rules. In cases of specific supply arrangements (e.g. an NCA signed to authorize the construction of a particular nuclear facility) it is easy to identify the supplier and what is being exchanged based on the treaty's title or text. For the general NCAs, identifying suppliers is a bit more difficult because of the language used in these agreements. States party to an NCA that have supply potential (according to the criteria established above) at the time the agreement was signed are assumed to supply nuclear goods while states that lack either capability at the time the agreement was signed are considered to be only recipients of such commodities.[85] NCAs that involve EURATOM or the Belgo-Luxembourg Economic Union are classified as bilateral agreements between each state party to these arrangements and the other party to the NCA.[86] Based on these criteria, I construct a dichotomous dependent variable and code it annually. This variable measures

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[84] For more on this and related challenges associated with coding NCAs see Keeley (1985).

[85] It is not always possible to access the NCA treaty text. The Keeley (2003) list includes some NCAs based only on the mention of such an agreement in some secondary source. Thus, in some cases little information beyond the date of the agreement, the parties, and the treaty's title is available. In these cases, I assume that the agreement is a general agreement and that if both states have supply capability then both states are supplying nuclear goods/knowledge under the terms of the NCA.

[86] From 1952-1972, EURATOM members included Belgium, France, West Germany, Italy, Luxembourg, and the Netherlands. Denmark, Ireland, and the UK joined in 1973. Greece, Portugal, and Spain joined in 1986. Austria, Finland, and Sweden joined in 1995. As the name implies, the Belgo-Luxembourg Economic Union includes Belgium and Luxembourg.

whether a state signed a NCA that involves the supply of nuclear items in a given year.[87] Table 3.2 lists the dyads that signed the most NCAs between 1945 and 2003.

Table 3.2: Dyads That Signed the Most NCAs, 1945-2003

Rank	Dyad	Number of NCAs (% of all NCAs)
1	France – United States	55 (1.81)
2	Germany – United States	53 (1.76)
3	Japan – United States	51 (1.69)
4	United Kingdom – United States	34 (1.13)
5	Italy – United States	30 (1.0)
6	Netherlands – United States	29 (.96)
7	Belgium – United States	26 (.86)
8	Russia/USSR – United States	26 (.86)
9	France – Japan	26 (.86)
10	France – Russia/USSR	25 (.83)
11	Brazil – United States	24 (.80)
12	Germany – Brazil	20 (.66)
13	Switzerland – United States	18 (.60)
14	Denmark – United States	17 (.56)
15	Spain – United States	17 (.56)
16	Germany – Russia/USSR	17 (.56)
17	Argentina – Brazil	16 (.53)
18	Ireland – United States	16 (.53)
19	Brazil – France	15 (.50)
20	France – United Kingdom	15 (.50)

[87] If a dyad signs more than one NCA in the same year, only the first agreement is included.

21	France – Germany	14 (.46)
22	United States – Finland	13 (.43)
23	United States – South Korea	13 (.43)
24	Russia/USSR – United Kingdom	13 (.43)
25	France – Switzerland	13 (.43)

Independent Variables and Measurement

A number of independent variables are employed to operationalize the hypotheses described above. Shared enemies, superpower enemies, military alliances, and democracy all increase the likelihood of nuclear cooperation while militarized conflict reduces it. Data on shared enemies and superpower enemies were self-coded from the New Rivalry Dataset compiled by Klein, Goertz, and Diehl (2006).[88] I create a dichotomous variable and code it 1 if two states are part of a rivalry with the same state in year t-1 and 0 otherwise. I create a second dichotomous variable and code it 1 if the importing state is a rival of either the Soviet Union between 1950 and 1991 or the United States between 1950 and 2000 in year t-1 and 0 otherwise. To determine whether states are military allies, I consulted version 3.0 of the Correlates of War (COW) Formal Alliance Data (Gibler and Sarkees forthcoming). I include a dummy variable that equals 1 if the supplier and recipient share a formal defense pact in year t-1 and 0 otherwise. Democracy data were obtained from the Polity IV dataset (Beardsley and Gleditsch 2003).[89] I include a dummy variable and code it 1 if the recipient state has a score of at least 7 on the Polity

[88] Klein, Goertz, and Diehl (2006: 335-340) consider two states in a dyad to be rivals if they experience at least three militarized interstate disputes over the period 1816-2001 that are fought over related issues.

[89] Seven has been identified as a “natural cutpoint” on the Polity scale and it has become fairly standard to use this threshold (Reiter, 2001).

scale in year t-1 and 0 otherwise. Data on militarized conflict are taken from version 3.0 of the COW Militarized Interstate Dispute (MID) dataset (Ghosn, Palmer, and Bremer 2004).[90] I include a dummy variable and code it 1 if the supplier and recipient states were involved in a MID in year t-1 and 0 otherwise.

Table I: Summary of Hypotheses and Measurement

Variable	Measurement	Expected Direction
Shared Enemy	Rivalry with common state according to Klein, Goertz, and Diehl's (2006) rivalry dataset.	+
Superpower Enemy	Rivalry with the United States between 1950-2000 or the Soviet Union between 1950-1991 based on Klein, Goertz, and Diehl's (2006) rivalry dataset.	+
Alliance	Formal defense pact between the supplying and importing states based on the Correlates of War (COW) Formal Alliance Data (Gibler and Sarkees forthcoming).	+
Democracy	A score of at least 7 on the Polity IV scale (Beardsley and Gleditsch 2003).	+
Militarized Conflict	Militarized Interstate Dispute (MID) between supplying and importing states (Ghosn, Palmer, and Bremer 2004).	-

Control Variables

A number of economic variables could influence the supply and demand for civilian nuclear commodities. For example, the resources of the exporting and importing states could affect nuclear trade (Anderson 1979). I include variables measuring the GDP of the exporting

[90] These data are supplied by *EUGene* (Bennett and Stam, 2000).

state and the GDP of the importing state in year t-1.[91] I also include variables measuring the supplier and importing states' nuclear resources in year t-1 using Jo and Gartzke's (2007) nuclear production data.[92] The distance between countries might influence nuclear commerce because of the transportation and transaction costs associated with trade. I include a variable measuring the "great circle" distance between the capitals of states.[93] To control for the importing state's energy demand, I include a variable measuring the ratio of the country's energy production capacity to its population. These data are obtained from the COW's National Military Capabilities dataset (Singer, Bremer, and Stuckey 1972). Finally, to control for the price of oil I include a variable measuring the price of a barrel of oil measured in U.S. dollars in year t-1.[94]

Factors related to nuclear nonproliferation might also affect civilian nuclear cooperation. States that are at least exploring nuclear weapons might be less likely to be on the receiving end of a nuclear cooperation agreement since supplier states generally do not want their exports to contribute to proliferation. I create a dichotomous variable and code it 1 if the recipient state is at least "exploring" nuclear weapons in year t-1 based on Singh and Way's (2004) proliferation data. Nonproliferation pledges on the part of the importing state might enhance suppliers'

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[91] GDP is measured in current US dollars. These data were obtained by consulting Gleditsch (2002).

[92] The Jo and Gartzke (2007) index measures nuclear production capacity based on seven measures including: domestic nuclear deposits; metallurgists; chemical engineers; nuclear engineers; electronic/explosive specialists; nitric acid production capabilities; and electricity production capabilities. They code each measure 1 if the capability is present and 0 if it is absent for each of these seven measures and then sum the number of 1s to construct their index.

[93] Border countries are coded as one mile (Fitzpatrick and Modlin, 1986). These data were acquired using the EUGene program (Bennett and Stam, 2000).

[94] Data on oil prices come from the *Historical Statistics of the United States* (2006).

confidence that exported commodities will not be used for unauthorized purposes. I include two dummy variables measuring whether the importing state in part of the NPT or Nuclear Suppliers Group (NSG), respectively, in year t-1. To classify membership in these institutions I consult lists compiled by the Center for Nonproliferation Studies (du Preez 2006).

I also control for security-related variables that could affect the demand for civilian nuclear technology. I include a dummy variable that is coded 1 if the recipient state is involved in a rivalry in year t-1 and 0 otherwise. To code this variable, I consult the aforementioned Klein, Goertz, and Diehl (2006) rivalry dataset. Whether a state's neighbors are importing nuclear technology might also influence a state's willingness to do so due to relative gains considerations (e.g. Waltz 1979). I create a dummy variable and code it 1 if a state's neighbor imports nuclear technology in year t-1 and 0 otherwise.[95]

Method of Analysis

Since the dependent variable is dichotomous, I use logistic regression analysis (logit) to estimate the effect that these independent variables have on the probability of nuclear-related trade. All independent variables are lagged one year to control for endogeneity. I employ clustering across dyads to control for heteroskedastic error variance and use white robust estimation to correct the standard errors for spatial dependence. Additionally, I introduce a variable measuring the number of years since 1950 that lapse without a dyad signing a NCA and three cubic splines to control for autocorrelation in the dependent variable (Beck, Katz, and Tucker 1998).

[95] A neighbor is a state within 150 miles. Distance data are obtained using EUGene (Bennett and Stam, 2000).

Case Study Analysis

To compliment the large-n statistical analysis I conduct several process tracing case studies. The process tracing method attempts to identify the causal chain and causal mechanism between independent variables and the outcome of the dependent variable (George, 1979; George and Bennett, 2005: 206). This approach compliments the statistical analysis by providing another basis for causal inference (George and Bennett, 2006: 208). The theory section (above) revealed that there are multiple reasons why states might link nuclear trade to their security interests. By analyzing specific cases in detail I can be sensitive to the possibility of equifinality—the notion that different processes can lead to the same outcome—and determine which causal mechanisms seem to be at work. Further by using process tracing to understand what causes states *not* to tie nuclear-related trade to the flag, I am able to greater understand cross-national variation in states willingness to do so (King, Keohane, and Verba, 1994).

Theory Building Research Objectives

It is important for researchers to clearly identify their theory building research objectives because these goals guide the research design (George and Bennett, 2005). I conduct *heuristic* and *theory testing* case studies. Heuristic case studies typically analyze outlier cases to identify new variables, hypotheses, or causal mechanisms (Lijphart, 1971; George and Bennett, 2005). Theory testing case studies are designed to assess the validity of one or several competing theories. Process tracing is an appropriate method to meet these objectives because it allows researchers to narrow the list of potential explanatory variables and consider the alternative paths that could have led to the same outcome (e.g. the notion of equifinality) (George and Bennett, 2005: 207). In doing so, it is possible to determine the validity of theoretical predictions in cases successfully predicted by the large-n analysis and in outlying cases.

Case Selection

In selecting the cases for individual analysis I adopt three criteria similar to those used by Huth (1988). First, the cases analyzed include those that fall in to two groups: (1) those that were successfully explained by the large-n analysis; and (2) those that deviate from the expected results.[96] Second, I select cases that are historically important. Important cases are defined as those trading relationships that ultimately contributed to the proliferation of nuclear weapons or have been identified by experts as threatening to the nonproliferation regime.[97] In addition to being theoretically and historically interesting, the most information is available on these cases, which makes it easier to identify the underlying causal processes. Third, a desire to analyze a diverse set of cases motivates selection. I examine trading relationships involving major powers and non-major powers, major suppliers and emerging suppliers, democracies and non-democracies, and those that occurred in the Cold War and post-Cold War periods.

These criteria lead me to select the following "successfully predicted" cases of civilian nuclear cooperation for analysis: (1) Canadian nuclear cooperation with India between 1956 and 1976; (2) Soviet nuclear cooperation with Libya between 1975 and 1986; and (3) U.S. nuclear cooperation with Iran between 1957 and 1979. I analyze 10 cases that were not successfully predicted by my argument. The outlying cases I examine include nuclear cooperation between:

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[96] To identify such cases, I examine the predicted probability that a supplier state will sign a nuclear cooperation agreement with a recipient state in a particular year. Dyads with low predicted probabilities but where nuclear exchange actually took place can be classified as outliers. Dyads with high predicted probabilities where nuclear trade occurred are successfully explained by the statistical model.

[97] To make a determination on this point I consult the Center for Nonproliferation Studies' Country Profiles Database, which provides data on states' WMD-related policies. See http://www.nti.org/e_research/profiles/index.html.

(1) the United States and Indonesia between 1960 and 1965; (2) Brazil and Iraq in 1980; (3) the United Kingdom and South Korea in 1991; (4) Canada and Romania in 1977; (5) China and Algeria 1983 and 1993; (6) France and Iraq in 1974; (7) Germany and Iraq in 1975; (8) India and Vietnam in 1999; (9) Italy and Iraq in 1975; and (10) the Soviet Union and Yugoslavia between 1956 and 1967.

Causal Process Observations

Causal process observations (CPOs) are "smoking guns" that confirm causal inferences (Brady and Collier, 2004). It is important to identify CPOs because doing so permits researchers to determine when certain theoretical predictions are correct. My general argument is that states channel nuclear exports in a way that produces positive security externalities and minimizes the potential for negative security externalities to arise. This basic proposition leads to a number of testable hypotheses. To determine whether the cases of nuclear cooperation lend support to these hypotheses, I consider how leaders and other key foreign policy decision-makers justify the government's actions. What follows is a brief description of the justifications that would support each expectation.

Military Alliance. I hypothesized that states are more likely to export nuclear commodities to their military allies than their non-military allies. Several justifications from foreign policy decision-makers would lend support to this expectation. The first would be that the exports will strengthen the military alliance by bolstering the capabilities of the ally. The second would be that military allies can be trusted with nuclear technology because they are unlikely to use it to construct nuclear weapons. The third would be that allies are less likely to use the imported technology to help third states acquire nuclear weapons.

Conflict. Suppliers should avoid exporting nuclear technology to states they are fighting or might fight in the future. Empirical support for these hypotheses would include statements from government officials that exports would not contribute to the military capabilities of an adversary or potential adversary or facilitate nuclear proliferation.

Enemy of an Enemy/Superpower Enemy. Supplier states are likely to export nuclear commodities to states they share a common enemy with. The smoking gun confirming this hypothesis would be if governments justify their nuclear exports on the grounds that increasing the capabilities of the importing state will help them counter the interests of and/or threat posed by their enemy. Similarly, statements suggesting that nuclear cooperation was intended to forge a partnership aimed at balancing the capabilities of a the most powerful states in the system would lend support for my superpower enemy hypothesis.

*Democracy. S*uppliers should be more likely to export nuclear items to democracies. Reference to the transparency resulting from democratic institutions—which reduces probability that exports would undermine the supplier state's security—would lend support to this hypothesis.

It is also possible to identify causal process observations for the competing explanations. The following descriptions specify when and how I would know if competing explanations are salient in explaining nuclear cooperation.

NPT Membership. A competing explanation rooted in nonproliferation suggests that states channel nuclear exports to those that have made NPT commitments since technology is less likely to be used to construct nuclear weapons and re-exported to a third party under such circumstances. Additionally, Article IV of the NPT explicitly states that those who sign the treaty are entitled to nuclear technology for peaceful purposes. The smoking gun that would confirm this causal inference is justification of nuclear cooperation on the grounds that the importing state can be trusted with nuclear technology because it is a NPT member. Further, justification of nuclear cooperation as a means to meet Article IV obligations would also support this argument.

NSG Membership. A related competing explanation is that NSG members will be more likely to receive nuclear technology than non-NSG members. Evidence confirming this hypothesis would include government officials' references to the strong commitment to nonproliferation export controls in the recipient state, which inspire confidence that exports will not be used for military purposes.

Nuclear Weapons Pursuit. Arguments rooted in nonproliferation also suggest that states pursuing nuclear weapons should be less likely to receive civilian nuclear technology because exporting states will recognize that technology/knowledge will facilitate nuclear weapons acquisition. Justifying nuclear exports on the grounds that states are not pursuing nuclear weapons would lend support to this hypothesis.

Economic Profit. Arguments rooted in economics suggest that states engage in civilian nuclear cooperation because doing so is financially lucrative (e.g. Potter, 1990). In the quantitative model, I control for this by including variables measuring the national wealth and size of the domestic nuclear industry for both the supplier and recipient state. The smoking gun lending support for the financial gain hypothesis would include justification of nuclear assistance on the grounds that it would generate revenue and stimulate economic growth.

Data

I attempt to standardize the data for the qualitative analysis so that comparable data will be obtained for each case (George and Bennett, 2005: 86). I am interested in collecting information on how supplier states justify nuclear trade with a particular importing state. I consult a combination of primary and secondary sources, although an emphasis is on the former. Data are obtained from: (1) speeches and interviews given by leaders and other relevant foreign policy players; (2) press releases and white papers issued by relevant government agencies; (3) media reports; (4) memoirs of key decision makers (when they are available); and (5) commentary and analysis by proliferation and nonproliferation experts. By collecting data from multiple sources I am able to minimize the biases associated with particular evidence and obtain the most accurate picture of why events unfolded as they did.

CHAPTER 4

THE DETERMINANTS OF CIVILIAN NUCLEAR COOPERATION

In the previous chapter I argue that states trade civilian nuclear technology to meet security-related objectives and that these goals trump normative considerations dealing with the spread of nuclear weapons. This general framework leads to several hypotheses including that suppliers are more likely to offer nuclear technology to states that they share an enemy with, states that are enemies of the most powerful countries in the system, their military allies, and democracies. Additionally, suppliers are less likely to trade nuclear technology with states they are involved in militarized conflict with. I expect that these strategic considerations are more salient in explaining civilian nuclear commerce than variables rooted in nonproliferation, such as whether the importing state is pursuing nuclear weapons or has signed the NPT.

In this chapter, I test these theoretical expectations using statistical analysis and a new dataset I created based on the coding of more than 2,000 civilian bilateral civilian nuclear cooperation agreements (NCAs). This analysis lends robust support to my hypotheses. In the subsequent chapters I will analyze specific cases of nuclear cooperation to assess the empirical and theoretical validity of my argument.

STATISTICAL RESULTS

Table 4.1 contains the initial results. Column I displays a model that includes only the variables operationalizing the supplier state's security interests while Column II displays the fully specified model that includes control variables for supply and demand, the importing state's security environment, and nuclear nonproliferation. Column III presents the results of a trimmed model with the variables that were statistically insignificant in Column II removed. As Table 4.2 reveals, the results are consistent across model specifications.

Table 4.1: Effects of Independent Variables on Nuclear Cooperation Agreements

	(1) Supplier's Security	(2) Full Model	(3) Only Significant Variables
Supplier's Security			
Shared Enemy	0.641***	0.175*	0.181*
	(0.102)	(0.096)	(0.096)
Superpower Rival	0.774***	0.429***	0.442***
	(0.089)	(0.087)	(0.086)
Alliance	1.204***	0.686***	0.690***
	(0.096)	(0.089)	(0.090)
Democracy	1.087***	0.255***	0.258***
	(0.086)	(0.073)	(0.072)
Conflict	-0.732*	-0.974**	-0.971**
	(0.399)	(0.399)	(0.399)
Supply/Demand Controls			
Supplier GDP		0.000***	0.000***
		(0.000)	(0.000)
Importer GDP		0.000***	0.000***
		(0.000)	(0.000)
Supplier Nuclear		0.409***	0.405***
Resources		(0.057)	(0.057)
Importer Nuclear		0.386***	0.385***
Resources		(0.025)	(0.025)
Energy Demand		0.003	--
		(0.005)	--

Oil Price		-0.004	--
		(0.004)	--
Distance		-0.000***	-0.000***
		(0.000)	(0.000)
Importer's Security Controls			
Regional NCAs		0.264***	0.263***
		(0.096)	(0.096)
Rivalry Involvement		-0.211***	-0.216***
		(0.068)	(0.068)
Nonproliferation Controls			
Nuclear Weapons		0.425***	0.420***
		(0.101)	(0.101)
NPT		-0.235***	-0.256***
		(0.074)	(0.074)
NSG		0.564***	0.551***
		(0.083)	(0.077)
Constant	-3.637***	-8.112***	-8.104***
	(0.096)	(0.385)	(0.386)
Observations	140907	140884	140907

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parentheses. Results for years passing without signing of nuclear cooperation agreement and 3 cubic splines are not reported in the interest of space.

Some interesting results emerge from this analysis. The coefficient on the variable measuring whether the supplier and importer share a common enemy is positive and statistically significant, suggesting that states are statistically more likely to engage in nuclear cooperation with those that they share enemies with. Substantively, the results suggest that having a common enemy increases the probability that states in a dyad will sign a NCA by .0007, from .0035 to

.0042. In an average year, states that share enemies will sign roughly 12 NCAs while states that do not share enemies will sign only 10 NCAs. These results provide substantive and statistically significant support to my argument that states use civilian nuclear cooperation as a means to constrain the capabilities of their enemies, although the substantive effect produced by the shared enemy variable is the most modest of the explanatory variables.

Table 4.2: The Substantive Effects of the Statistically Significant Explanatory Variables on the Probability of NCAs

Independent Variable	Pr(Y=1) at Low Value	Pr(Y=1) at High Value	Pr. Change	Predicted Number of Annual Dyads Forming NCAs at Low Value	Predicted Number of Annual Dyads Forming NCAs at High Value	Change in Predicted Number of Annual Dyads Forming NCAs
Supplier's Security						
Shared Enemy	0.0035	0.0042	0.0007	9.66851	11.60221	1.933702
Superpower Rival	0.0034	0.0052	0.0018	9.392267	14.36464	4.972376
Alliance	0.0034	0.0067	0.0033	9.392267	18.50829	9.116024
Democracy	0.0033	0.0042	0.0009	9.116024	11.60221	2.486188
Conflict	0.0036	0.0013	-0.0023	9.944753	3.591161	-6.35359
Supply/ Demand Controls						
Supplier GDP	0.0033	0.0039	0.0006	9.116024	10.77348	1.657459
Importer GDP	0.0034	0.0036	0.0002	9.392267	9.944753	0.552486
Supplier Nuclear Resources	0.0029	0.0044	0.0015	8.011051	12.1547	4.143647
Importer Nuclear Resources	0.0009	0.0048	0.0039	2.486188	13.25967	10.77348
Distance	0.0037	0.0033	-0.0004	10.221	9.116024	-1.10497
Importer's Security Controls						
Regional NCAs	0.0031	0.004	0.0009	8.563537	11.04973	2.486188
Rivalry Involvement	0.0039	0.0032	-0.0007	10.77348	8.83978	-1.9337
Nonpro. Controls						
Nuclear	0.0034	0.0052	0.0018	9.392267	14.36464	4.972376

Weapons						
NPT	0.004	0.0032	-0.0008	11.04973	8.83978	-2.20995
NSG	0.0034	0.0059	0.0025	9.392267	16.29835	6.906078

Notes: All probabilities are generated using the estimates in the second column of Table 2.1. All variables are set to their mean. For dichotomous variables, the "low" value is 0 and the "high" value is 1. For continuous variables, the "low" value is ½ standard deviation below the mean and the "high" value is ½ standard deviation above the mean. Predicted annual number of agreements are calculated by multiplying the predicted probability of a dyad forming a NCA by the total number of observations in the sample (140.884) and then dividing that number by the number of years in the sample (51).

A related hypothesis is that states are likely to provide civilian nuclear assistance to those that are enemies of superpowers. The coefficient on the variable measuring whether the importing state is a superpower enemy is positive and statistically significant, indicating that suppliers are more likely to supply nuclear technology to those that are enemies of the most powerful states in the system. Being a superpower enemy also has a substantively significant effect on nuclear cooperation; it increases the probability that a supplier state will provide nuclear technology by .0018, from .0034 to .0052. In an average year, suppliers will sign roughly 14 NCAs with superpower enemies and 9 NCAs with states that are not superpower enemies. Collectively, these first two results lend support to my argument that civilian nuclear cooperation is a form of "soft balancing" (e.g. Paul 2005) that suppliers employ to counter the influence of threatening states.

The results reveal that a military alliance has a positive and statistically significant effect on the probability of a dyad signing a NCA in a particular year. Substantively, a military alliance increases the probability that a dyad will sign a NCA in a particular year by .0033, from .0034 to .0067. As Table 2.2 indicates, in an average year, we can expect around 9 non-allies and 19 allies to sign nuclear cooperation agreements. Thus, allies are more than twice as likely to engage in civilian nuclear commerce. Of the explanatory variables, only militarized conflict has a stronger substantive effect on the probability of nuclear cooperation. This result lends further empirical support to the notion that alliances affect foreign economic cooperation (Gowa and Mansfield 1993; Gowa 1994; Long 2003) and my argument that supplier states export nuclear technology to their allies to strengthen the overall alliance.

I find that the regime type of the importing state affects nuclear cooperation.[98] The coefficient on the variable measuring whether the importing state is a democracy is positive and statistically significant. Being a democracy increases the probability that a state will be on the receiving end of a NCA by .0009, from .0033 to .0042. In an average year, we can expect that non-democratic states will be on the receiving end of roughly 9 NCAs while democratic states are on the receiving end of roughly 12. This lends support to my argument that the transparency stemming from democratic institutions (e.g. Gaubatz 1996) decreases the likelihood that civilian nuclear exports will contribute to proliferation.

The coefficient on the variable measuring whether the exporting and importing states are involved in militarized conflict is negative and statistically significant, as expected.[99] Militarized conflict reduces the probability that states will sign a NCA by .0023, from .0036 to .0013. In an average year, states engaged in militarized conflict are expected to sign roughly 4 NCAs while

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[98] Substituting variables that use a different cutoff point on the Polity scale to classify a democracy (e.g. 6) does not change the results. Replacing the variable measuring whether the importing state is a democracy with a dummy variable measuring whether both the supplier and importer are democracies produces identical results. However, when the joint democracy variable is added to the existing model, only the importer democracy variable has a significant effect. The other results remain unchanged.

[99] I substituted variables measuring whether the states in the dyad were involved in a militarized interstate dispute that resulted in a least one fatality or were involved in a rivalry using definitions offered by Thompson (2001) and Klein, Goertz, and Diehl (2006). The fatal MID modification produces identical results; the rivalry substitutions do not change the results and themselves do not have statistically significant effects. I also included a variable measuring the dyad's S-Score (Signorino and Ritter, 1999), since the compatibility of states foreign policy interests could be a proxy for the likelihood of future conflict. Including this variable also does not change the results.

states not engaged in conflict are expected to sign roughly 10 NCAs. Thus, states are nearly three times less likely to engage in nuclear cooperation when they are involved in militarized conflict. This is the strongest substantive effect produced by any of the explanatory variables. These findings lend support to my argument that states avoid trading with their enemies because doing so harms their security interests.

The variables controlling for supply and demand behave largely as expected.[100] The supplying and importing states' GDP and nuclear-related resources have positive and statistically significant effects on the probability of civilian nuclear trade. The coefficient on the variable measuring the distance between the supplier and importer has a statistically significant and negative effect, as expected. The coefficients on the variables measuring the energy demand of the importing state and the price of oil are statistically insignificant, contrary to expectations. Of all the variables, the importing state's nuclear capability has the largest substantive effect on the probability of nuclear cooperation. Increasing the value of the importer's nuclear capability variable from ½ standard deviation above its mean to ½ standard deviation below its mean increases the probability of nuclear cooperation by .0039, from .0009 to .0048. This is, however, the only economic variable that has a stronger substantive effect than the security-related variables.

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[100] I estimated models including additional control variables that in theory could affect nuclear commerce. None of these variables changed the results. The variables I included were: (1) the total trade between the dyad; (2) the number of common memberships in intergovernmental organizations between the dyad; (3) the relative power between the exporting and importing states; (4) a squared term for the distance measure (to account for the potential inverse-u relationship); and (5) superpower dependence measured by the presence of a military alliance with a superpower.

Turning to the controls dealing with the importer's security environment, whether another state in the region receives nuclear technology has a positive and statistically significant effect on nuclear cooperation. This suggests that states are sensitive to relative gains concerns (e.g. Waltz 1979) and are more likely to seek civilian nuclear assistance when their neighbors do so. Contrary to expectations, the results reveal that states involved in a rivalry are less likely to receive nuclear assistance.

The most interesting results deal with the nonproliferation-related controls. The coefficient on the variable measuring whether the importing state is pursuing nuclear weapons is *positive* and statistically significant, suggesting that states with weapons programs are more likely to be on the receiving end of nuclear cooperation agreements. This finding contradicts the conventional wisdom that supplier states refrain from providing nuclear technology to those that are pursuing nuclear weapons because they do not want to contribute to proliferation. NSG membership has a positive and significant effect on the probability of nuclear cooperation but NPT membership has a negative effect on this probability, contrary to expectations.[101] The nuclear weapons pursuit and NPT membership findings have important theoretical and practical implications, which I will further discuss below.

ADDITIONAL ROBUSTNESS CHECKS

To further test the robustness of my results, I explore possible temporal variation in the determinants of civilian nuclear cooperation agreements. These results are depicted in Table 4.3. I limit the analysis to: the complete Cold War period (column 1); the period prior to the creation

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[101] This result does not change when a variable measuring whether *both* the supplier and importer are members of the NPT is substituted for the current measure. A similar substitution for the NSG variable also leaves that result unchanged.

of the nuclear nonproliferation regime (column 2); the Cold War period following the establishment of the nonproliferation regime (column 3); the entire period following the creation of the nonproliferation regime (column 4); and the post-Cold War period (column 5).[102] Many of the results are consistent across model specifications, but there are some noteworthy differences.

Table 4.3: Temporal Breakdown of Logit Analysis on the Effects of Independent Variables on Nuclear Cooperation Agreements

	(1) Cold War, 1950-1991	(2) Cold War & Pre-Regime, 1950-1969	(3) Cold War & Post-Regime 1970-1991	(4) Post-Regime 1970-2000	(5) Post-Cold War 1992-2000
Supplier's Security					
Shared Enemy	0.443***	0.405**	0.359***	0.104	0.130
	(0.112)	(0.161)	(0.122)	(0.097)	(0.150)
Superpower Rival	0.126	-0.361**	0.320**	0.586***	0.866***
	(0.107)	(0.168)	(0.128)	(0.092)	(0.203)
Alliance	0.873***	1.102***	0.581***	0.431***	-0.280**
	(0.100)	(0.129)	(0.112)	(0.093)	(0.141)
Democracy	0.256***	0.092	0.394***	0.376***	0.368*
	(0.075)	(0.115)	(0.089)	(0.083)	(0.188)
Conflict	-0.958*	-1.339*	-0.917	-1.028**	-1.359**
	(0.541)	(0.765)	(0.745)	(0.493)	(0.584)
Supply/Demand Controls					
Supplier GDP	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Importer GDP	0.000***	0.000***	0.000**	0.000***	0.000***

[102] I choose these cutoff points since the end of the Cold War and the creation of the nuclear nonproliferation regime—especially its anchor, the NPT—could affect patterns of civilian nuclear cooperation.

	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Supplier Nuclear	0.377***	0.392***	0.243***	0.319***	0.534***
Resources	(0.062)	(0.070)	(0.075)	(0.064)	(0.105)
Importer Nuclear	0.368***	0.345***	0.373***	0.406***	0.402***
Resources	(0.027)	(0.030)	(0.037)	(0.032)	(0.055)
Energy Demand	0.002	-0.009	0.002	0.004	-0.003
	(0.006)	(0.014)	(0.006)	(0.006)	(0.016)
Oil Price	-0.008**	-0.502	-0.004	0.000	0.021*
	(0.004)	(0.395)	(0.004)	(0.004)	(0.011)
Distance	-0.000***	-0.000***	-0.000***	-0.000***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Importer's Security Controls					
Regional NCAs	0.279**	0.119	0.326**	0.277**	0.027
	(0.115)	(0.146)	(0.156)	(0.115)	(0.170)
Rivalry Involvement	-0.121	-0.008	-0.182**	-0.246***	-0.021
	(0.075)	(0.135)	(0.087)	(0.080)	(0.141)
Nonproliferation Controls					
Nuclear Weapons	0.468***	0.664***	0.444***	0.414***	0.266
	(0.105)	(0.158)	(0.116)	(0.110)	(0.177)
NPT	-0.081	--	-0.013	-0.157*	-0.360*
	(0.085)	--	(0.106)	(0.090)	(0.191)
NSG	0.473***	--	0.380***	0.503***	1.150***
	(0.096)	--	(0.094)	(0.083)	(0.168)
Constant	-7.791***	-6.656***	-6.845***	-7.688***	-10.116***
	(0.417)	(1.081)	(0.549)	(0.474)	(0.821)
Observations	109655	39573	70082	101311	31229

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parentheses. Results for years passing without signing of nuclear cooperation agreement and 3 cubic splines are not reported in the interest of space.

The results reveal that nuclear supplier states behaved slightly less strategically in the pre-NPT (1950-1969) and post-Cold War periods (1992-2000). In the pre-NPT period, I do not find support for my hypotheses regarding superpower enemies and democracy. This is not particularly surprising given that the proliferation consequences of civilian nuclear trade were less understood prior to the formation of the NPT, and especially before the 1974 Indian nuclear test (e.g. Potter 1990). In the post-Cold War period, the results fail to lend support to my shared enemy and alliance hypotheses. This may be due to system polarity. Gowa (1994) finds that states are more likely to tie trade to the flag when the international system is bipolar because alliances are more stable.[103] With the collapse of the international system's bipolar structure, states' nuclear trade policies are less influenced by international security, perhaps because there is less of a strategic need to link trade and security in a multi-polar world (Skålnes, 2000).

In spite of the differences, I find empirical support for the majority of my hypotheses in both of these time periods. This is noteworthy since we might expect that supplier states' security interests would not dominate civilian nuclear cooperation in the pre-NPT and post-Cold War eras. The saliency of security interests even in these periods lends further support to my argument. Particularly striking is the finding that states use civilian nuclear cooperation as a means to constrain superpowers even after the collapse of the Soviet Union, suggesting that such behavior is not an artifact of the Cold War.

For a further robustness check, I estimate models using an alternate coding of the dependent variable. In the previous analyses presented in this chapter, I considered states to be engaging in cooperation only in the year that they signed a nuclear cooperation agreement. It is possible that assistance takes place as part of the terms of an agreement in years subsequent to its

[103] On the stability of alliances in a bipolar system see Duncan and Siverson (1984).

signing. To account for this possibility, I create a dichotomous variable and code it 1 for every year between the time an agreement was signed until 15 years have passed.[104] Table 4.4 presents the results using this alternate coding of the dependent variable. Column 1 displays a complete model with all explanatory and control variables, while Column 2 excludes variables that were statistically insignificant in Column 1. Columns 3-7 display bivariate models with each of my respective explanatory variables and controls for temporal dependence. As Table 4.4 reveals, the results produced using this alternate measure of nuclear cooperation are virtually identical. There is only one meaningful difference. The militarized conflict variable does not have a statistically significant effect on nuclear assistance when it and controls for temporal dependence are the only variables included in the model (Column 7). In spite of this one difference, this analysis should inspire further confidence that my key findings are robust.

Table 4.4: Logit Analysis of the Effects of Independent Variables on Civilian Nuclear Cooperation (Alternate DV Coding)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Supplier's Security							
Shared Enemy	0.416***	0.395***	1.338***	--	--	--	--
	(0.148)	(0.149)	(0.117)	--	--	--	--
Superpower Rival	0.285***	0.307***	--	0.817***	--	--	--
	(0.104)	(0.103)	--	(0.090)	--	--	--
Alliance	1.293***	1.326***	--	--	1.457***	--	--
	(0.128)	(0.126)	--	--	(0.109)	--	--
Democracy	0.177**	0.194**	--	--	--	1.008***	--
	(0.090)	(0.090)	--	--	--	(0.081)	--

[104] A typical nuclear cooperation agreement stays in force for 15 years.

Conflict	-0.776*	-0.751*	--	--	--	--	-0.170
	(0.397)	(0.395)	--	--	--	--	(0.303)
Supply/Demand Controls							
Supplier GDP	0.000***	0.000***	--	--	--	--	--
	(0.000)	(0.000)	--	--	--	--	--
Importer GDP	0.000***	0.000***	--	--	--	--	--
	(0.000)	(0.000)	--	--	--	--	--
Supplier Nuclear	0.631***	0.623***	--	--	--	--	--
Resources	(0.067)	(0.068)	--	--	--	--	--
Importer Nuclear	0.380***	0.386***	--	--	--	--	--
Resources	(0.029)	(0.029)	--	--	--	--	--
Energy Demand	0.010		--	--	--	--	--
	(0.007)		--	--	--	--	--
Oil Price	0.002*	0.002**	--	--	--	--	--
	(0.001)	(0.001)	--	--	--	--	--
Distance	-0.000***	-0.000***	--	--	--	--	--
	(0.000)	(0.000)	--	--	--	--	--
Importer's Security Controls							
Regional NCAs	0.503***	0.514***	--	--	--	--	--
	(0.113)	(0.112)	--	--	--	--	--
Rivalry Involvement	-0.207**	-0.231***	--	--	--	--	--
	(0.085)	(0.085)	--	--	--	--	--
Nonproliferation Controls							
Nuclear Weapons	0.267***	0.277***	--	--	--	--	--
	(0.099)	(0.097)	--	--	--	--	--
NPT	0.415***	0.433***	--	--	--	--	--

	(0.083)	(0.083)	--	--	--	--	--
NSG	-0.272***	-0.275**	--	--	--	--	--
	(0.089)	(0.089)	--	--	--	--	--
Years without Nuclear Cooperation	-0.010***	-0.003***	-0.012***	-0.012***	-0.011***	-0.013***	-0.012***
	(0.002)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
_spline1	-0.000	--	0.000***	0.000**	0.000***	0.000	0.000***
	(0.000)	--	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
_spline2	0.000	--	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	--	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
_spline3	0.000	--	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	--	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-8.021***	-8.221***	-0.962***	-0.998***	-1.175***	-1.342***	-0.815***
	(0.497)	(0.501)	(0.061)	(0.062)	(0.065)	(0.076)	(0.060)
Observations	134168	134191	148681	148681	148442	134191	148384

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

DISCUSSION AND CONCLUSION

A number of important conclusions flow from this analysis. In a general sense, my findings shed light on the factors motivating states to engage in civilian nuclear cooperation. This is something that was scantily understood prior to this study. The results support my argument that the strategic interests of nuclear suppliers are salient in explaining civilian nuclear commerce. Particularly novel is my finding that supplier states use civilian nuclear cooperation agreements as a means to constrain the power of those that they are threatened by. This lends support to the realist argument that states befriend those they share enemies with in order to constrain the power of their adversaries (e.g. Waltz 1979; Mearsheimer 1994/95). This is an ominous conclusion from the perspective of American foreign policy. It suggests that supplier states' incentives to provide nuclear technology to U.S. enemies—such as Iran and Syria—will ultimately trump Washington's efforts to stop these activities. Finally, this result lends further support to the argument that indirect/triadic relationships are important in international politics and worthy of additional research (Maoz et al 2006, 2007; Crescenzi 2007).

My analysis reveals that supplier state's strategic considerations trump nonproliferation-related factors when it comes to civilian nuclear cooperation. States that are pursuing nuclear weapons are actually *more* likely to receive civilian nuclear assistance. This finding is troubling from a nonproliferation standpoint because it suggests that the states most likely to use civilian nuclear technology for military purposes are most likely to receive it. Since nuclear commodities are dual-use—they can be used to construct nuclear weapons but also have many civilian applications—states can acquire technology for ostensibly peaceful purposes and use it in military applications. What this means is that civilian nuclear trade is likely to contribute to nuclear weapons proliferation. It reveals, perhaps not surprisingly, that states pursuing nuclear weapons have the greatest demand for civilian nuclear technology. What is surprising is that suppliers provide it—especially in light of evidence that they are quite strategic when it comes to channeling nuclear exports. It is unclear at this stage whether suppliers recognize this at the time they export nuclear technology or not. It is certainly possible, and perhaps likely, that states are able to conceal their weapons acquisition efforts from suppliers of nuclear technology. Whether this is the case is another question that future research should try to address.

I find no support for the argument that NPT membership increases the likelihood that states will receive nuclear technology. This raises cause for concern from a policy standpoint because it suggests that the nuclear weapons states (China, France, Russia, the United Kingdom, and the United States) are not living up to their commitment to supply nuclear technology for "peaceful purposes" to states that sign the NPT. This finding also speaks to a general debate in international relations regarding whether treaties and other institutional commitments matter (e.g. Chayes and Chayes 1993; Downs, Rocke, and Barsoom 1996). Although NPT membership may reduce the likelihood that states pursue nuclear weapons (Jo and Gartzke 2007) my results suggest that it does not make states more likely to receive nuclear technology for peaceful use. This casts some doubt on the argument that international commitments change state behavior and/or that states maintain the commitments they make, although we should be cautious about reading too much into this finding.

As I highlighted in the introduction, the United States has been widely criticized for signing a nuclear cooperation agreement with India because New Delhi possess nuclear weapons and refuses to sign the NPT. Many scholars have asserted that U.S. plans to supply technology to India threaten the existence of the nuclear nonproliferation regime (e.g. Percovitch 2005). What my analysis reveals is that U.S. behavior in the India case is actually nothing new. For decades, nuclear suppliers have been willing to export technology to states with poor nonproliferation records if doing so is otherwise in their strategic interests.

CHAPTER 5

TIES TO SECURITY: AN ANALYSIS OF SUCCESSFULLY PREDICTED CASES

The previous chapter presented statistical evidence in favor of my argument that suppler states' strategic interests shape civilian nuclear cooperation and that normative concerns about weapons proliferation are a secondary consideration. The statistical evidence reveals that on average, supplier states are more likely to cooperate with their allies, states they share an enemy with or are enemies of the superpowers, states that they are not fighting, and democracies. The previous chapter does not, however, explore the decision-making context. This is the task of the next two chapters. The idea is to supplement the statistical evidence with qualitative analysis in order to improve the confidence in the main findings of my study (Lieberman, 2005). This chapter uses process tracing (e.g. George, 1979) to analyze cases where my argument successfully predicted outcomes. The subsequent chapter uses the same method to analyze several outlying cases of nuclear cooperation that are not predicted by my argument.

This chapter seeks to accomplish two related goals. First, it tests whether the causal processes specified in my theory operate correctly in cases where my empirical prediction held true. It is possible that the outcomes—while consistent with my predictions—are attributable to other explanations (Bennett and Braumoeller, 2006; George and Bennett, 2005). Thus, this chapter addresses concerns about equifinality—the notion that different processes can lead to the same outcomes (Mahoney and Goertz, 2006). Second, it provides a rich description of how and why states' strategic considerations affect civilian nuclear cooperation.

These considerations motivate the selection of the cases I analyze in this chapter. The cases examined here include civilian nuclear cooperation between: the United States and Iran (1957-1979); the Soviet Union and Libya (1975-1986); and Canada and India (1955-1977). Thus, I examine three very different nuclear suppliers. The United States has commanded a significant share of the nuclear market since 1950, is a great power and a self-proclaimed champion of nonproliferation, and is a democracy. The Soviet Union is also a major nuclear supply, a great power, and in many respects has been a greater champion of nonproliferation than the United States. But unlike the United States, it is an authoritarian state with a closed economic structure. Finally, Canada is a middle power and controls less of the nuclear market than either the Soviet Union or the United States. By examining three suppliers that are different in several respects, I am able to explore whether my argument is generalizable to all types of states or whether considerations such as the supplier's regime type or military power are important.

U.S. NUCLEAR COOPERATION WITH IRAN, 1957-1979

Between 1957 and 1979, the United States engaged in nuclear cooperation with Iran. It supplied Tehran with a research reactor and enriched uranium to fuel it in the early 1960s and worked to supply eight power reactors, but these facilities were never delivered. This relationship is significant because it contributed to Iran's nuclear weapons program once relations between the two countries were severed in 1979. The empirical evidence reveals that U.S. strategic objectives go a long way in explaining nuclear cooperation with Iran. Washington perceived that nuclear assistance to Tehran was an important means to strengthen the alliance the two countries shared. This was crucial to the United States because of Iran's strategic location. Additionally, the U.S. plans to bolster nuclear assistance in the 1970s were driven by a desire to constrain the ability of the Soviet Union to exert aggression against Iran. By this point, both countries were threatened by Moscow and this shared strategic interest motivated Washington to promote nuclear sales to Tehran. Concerns about the spread of nuclear weapons did not affect nuclear cooperation with Iran at the highest levels of government. Further, Iran's signature of the NPT did little to subdue concerns about U.S. exports contributing to proliferation when they arose at the lower levels of government. Economic considerations influenced U.S. interests, although they were not the driving force behind U.S.-Iranian cooperation.

This section proceeds by describing U.S. nuclear cooperation with Iran between 1957 and 1979. It then presents the empirical evidence, which reveals that U.S. behavior is consistent with my argument and that the causal processes I have identified operate correctly in this case. The section concludes by summarizing the results and briefly discussing their implications.

U.S. Nuclear Exports to Iran

Table 5.1 summarizes the key events in civilian nuclear cooperation between the United States and Iran. U.S. civilian nuclear cooperation with Iran began after the two states signed an agreement for cooperation in the peaceful uses of nuclear energy on March 5, 1957. This agreement stated that the United States would supply "information as to the design, construction, and operation of research reactors and their use as research development and engineering tools" as well as "appropriate equipment and services" to Iran (U.S. Department of State, 1957). The agreement, which entered into force on April 27, 1959, was significant because it provided the basis for U.S. nuclear cooperation with Iran to commence. But it took a few years for such cooperation to develop, in part because Iran had an insufficient electrical capacity and no national grid to accommodate even a single power reactor (Poneman, 1982: 84). During the 1960s, the United States built a 5MWt water-moderated research reactor in Tehran and provided

5.5kg of enriched uranium to fuel it (Nuclear Threat Initiative, 2005). In November 1967, the Tehran research reactor went critical—five years behind schedule (Kessler, 1987; Poneman, 1982). During this period, the United States also provided Iran with "hot cells" and training for their use.[105] This hot cell was reportedly "small" and capable of separating only a few grams of plutonium (Albright, 1995).

After these initial transfers, the United States worked to deepen its nuclear cooperation with Iran. In March 1969, U.S. President Richard Nixon amended the 1957 agreement, extending it for an additional period of 10 years. Plans for cooperation really began to accelerate in 1974 when the Shah established the Atomic Energy Organization of Iran (AEOI) and pursued arrangements to generate 23,000 MWe from nuclear power facilities. A State Department telegram on March 11, 1974 stated that Washington had an interest in "mov[ing] quickly" to "broaden ties with Iran," including cooperation in the development of nuclear breeder reactors. Officials in Washington "noted the priority the Shah gives to developing alternative means of energy production through nuclear power and agree this is the area in which we might most usefully begin on a specific program of cooperation and collaboration" (U.S. Department of State, 1974a). According to a declassified study on "Joint U.S.-Iranian Cooperation" (Interdepartmental Working Group, 1974), the United States had an interest in becoming "a major source of the equipment as well as the technology used" in the burgeoning Iranian nuclear industry. In May 1974, Dixie Ray, head of the U.S. Atomic Energy Commission (AEC) visited Tehran and established direct contact between the AEC and the Atomic Energy Organization of

[105] Hot cells are shielded rooms with remote controlled arms that are used to chemically separate material, such as plutonium, that has been irradiated in a reactor. They are significant from a nonproliferation standpoint because they enable the separation of plutonium.

Iran (AEOI). During Ray's visit, the United States agreed to supply enriched uranium for 8 power reactors and considered plans for a "broad range of future cooperative activities" with Iran (U.S. Department of State, 1974b). Iran also expressed interest in participating in a proposed commercial uranium enrichment facility that was planned to be built in the United States.

U.S. Secretary of State Henry Kissinger visited Iran from November 1-3, 1974. During Kissinger's visit, the two countries created a sub-commission on nuclear energy—within a broader bilateral Economic Commission—to facilitate plans for intensified cooperation in this area (U.S. Department of State, 1974c). This commission met in Washington on March 3-4, 1975 and announced Iran's intentions to purchase nuclear power plants from U.S. firms. This announcement was described as the "most dramatic feature of the meeting" (U.S. Department of State, 1975a). Henry Kissinger and Iranian Finance Minister Hushang Ansary signed a $15 billion trade agreement, which called for U.S. firms to supply eight nuclear power reactors in exchange for $6.4 dollars (Nuclear Threat Initiative, 2005). In order for these transfers to take place, the United States needed to sign another nuclear cooperation agreement with Iran. The 1957 agreement, which had been extended until 1979, dealt only with nuclear research and could not be extended to cover nuclear power as well (Poneman, 1982: 87).[106]

The United States and Iran made progress toward signing such an agreement. In March 1975, U.S. President Gerald Ford called for a study looking at the implications that such an agreement might have. The major point of contention stymieing the signing of a nuclear agreement dealt with authority to reprocess plutonium. Due to nonproliferation considerations, the United States wanted to explicitly authorize any Iranian plans to reprocess U.S.-origin fuel.

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[106] Section 123 of the U.S. Atomic Energy Act of 1954 requires that a nuclear cooperation agreement exist before nuclear technology can be supplied.

Washington called for Tehran to establish a multinational reprocessing plant in Iran—that included the United States and possibly others in the region—because U.S. involvement in such a facility would ensure that it was adequately safeguarded. Meanwhile, the Iranians expressed interest in such a multinational facility but sought U.S. approval on reprocessing based only on a "good faith effort" to work towards establishing this facility (Sober, 1975). This was an especially salient issue since Iran was seeking to develop plutonium reprocessing capabilities (Gelb, 1975).

The reprocessing disagreement created tension between the two countries, and in August 1976 negotiations on a nuclear cooperation agreement were suspended. In April 1977, the two countries signed an agreement pledging to cooperate on technical matters related to nuclear safety (Keeley, 2003). And on August 8, 1977 talks between the two states regarding the export of power reactors resumed after Iran renounced its intention to build a reprocessing facility (Washington Post, 1977). On January 1, 1978, U.S. President Jimmy Carter and the Shah reached a tentative agreement on nuclear cooperation that would permit the aforementioned nuclear sales to take place. This agreement represented a compromise on reprocessing; it did not promise reprocessing rights for Iran but neither did it permit a U.S. veto over such rights. This provided Iran with "most favored nation" status as far as reprocessing is concerned (Poneman, 1982: 88).

Just when the prospects for nuclear cooperation looked bright, troubles almost immediately ensued. The United States grew increasingly troubled by the social unrest and political turmoil that existed in Iran. On October 17, 1978, a telegram sent from the U.S. embassy in Tehran to the U.S. Secretary of State stated: "taking into account the setback to [Iran's] nuclear power program, [the] overall political situation, and [the] disorganization of bureaucracy, we do not believe that now is the time to attempt to push [Iran] into quick signature of [the] nuclear agreement…no U.S. nuclear reactor supplier sales will take place in the near future" (U.S. Department of State, 1978). Following the 1979 Islamic Revolution, the United States ended its supply of highly enriched uranium (HEU) and terminated all nuclear cooperation with Iran.

Table 5.1: Key Events in U.S.-Iran Nuclear Cooperation, 1957-1979

Date	Event
December 8, 1953	-U.S. President Dwight Eisenhower launches Atoms for Peace program at the United Nations General Assembly.
March 5, 1957	-United States and Iran sign agreement concerning civil uses of atomic energy as part of the Atoms for Peace program.
1960	-United States agrees to supply a 5MW research reactor at Tehran University.
1960s	-United States supplies "hot cells," which can be used to separate plutonium from spent reactor fuel, and training for their use.
September, 1967	-United States supplies 5.54kg of enriched uranium to fuel the research reactor and 112g of plutonium for use as a start-up source in the reactor.
March 13, 1969	-United States amends 1957 nuclear cooperation agreement, extending it for another 10 years.
June, 1974	-United States tentatively agrees to supply Iran with two nuclear power reactors and enriched uranium fuel.
1975	-U.S. nuclear energy advisors are sent to Iran to provide technical assistance and training.
1975	-U.S. signs agreement calling for export of eight civilian power reactors and fuel for two 1,200mw light water reactors to Iran.
May, 1976	-United States supplies 226kg of depleted uranium to Iran.
April 11, 1977	-United States and Iran sign agreement on "Exchange of Technical Information and Cooperation in Nuclear Safety Matters."
1977-1979	-United States and Iran work to conclude a new nuclear cooperation

	agreement. A tentative agreement is reached and sent to the U.S. Congress for approval, but is never concluded due to the Islamic Revolution in Iran.

The Empirical Evidence

The previous discussion of U.S.-Iran nuclear cooperation highlights a number of important questions. Why did nuclear cooperation between these two countries begin in March 1957? Why did the United States make a push to deepen it beginning in 1974? And why did nuclear cooperation terminate so abruptly in 1978-79? A review of declassified national security documents and other primary sources suggests that the causal mechanisms driving my hypotheses on the effect that alliances, shared enemies, and militarized conflict operate correctly in this case. One factor emerges as important in this case that I did not include in my original statistical model—oil. What follows is a description of these variables and how they affected civilian nuclear cooperation at various stages.

Military Alliance

The United States and Iran did not share a formal defense pact during the period under examination according to the Correlates of War Formal Alliance data (Gibler & Sarkees, forthcoming). Iran was, however, an important part of the American alliance system. In 1955, Great Britain, Iran, Iraq, Pakistan, Turkey, and the United States (as an associate member) formed the Baghdad Pact. This arrangement was renamed the Central Treaty Organization (CENTO) following the 1958 revolution in Iraq that resulted in Baghdad's withdrawal from the alliance (Miglietta, 2002: 44). In 1959, the United States bolstered its relationship with Iran by signing the Bilateral Defense Treaty on March 5, 1959. This treaty stipulated that the United States would come to the aid of Iran in case of aggression against it.

The United States and Iran signed their first nuclear cooperation agreement just as the two states were becoming allies. The nuclear agreement entered into force on April 27, 1959—just one month after the signing of the Bilateral Defense Treaty. The timing of these events seems to suggest a relationship between an alliance and nuclear trade in this case. There is some evidence supporting this assertion. U.S. nuclear cooperation with Iran appears to represent an attempt to strengthen the bilateral alliance, particularly in light of Washington's refusal to formally join the Baghdad Pact (e.g. to become a full, rather than associate, member). A declassified U.S. National Security Council document published on February 3, 1957 stated that technical assistance, including nuclear cooperation for peaceful purposes, is "important as a means of making the presence of the United States felt at all levels of the population throughout [Iran]." This "presence" was perceived to be important in part because of Iran's "strategic location" between the Persian Gulf and the Soviet Union and its vast oil reserves (NSC, 1957).

However, it is important to note that there is very little information in the available historical record that directly relates to this agreement. This is in part because it was perceived to be fairly uncontroversial and was signed in the wake of U.S. President Dwight Eisenhower's famous "Atoms for Peace" speech when the exchange of research reactors was quite routine.[107] In the only Congressional hearing before the Joint Committee on Atomic Energy (1957) on the

[107] On December 8, 1953, U.S. President Dwight Eisenhower delivered his famous "Atoms for Peace" speech before the United Nations General Assembly. In the speech, Eisenhower (1953) said, "The United States pledges before you—and therefore before the world—its determination to help solve the fearful atomic dilemma—to devote its entire heart and mind to find the way by which the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life."

subject of the 1957 agreement, U.S. officials said little to justify the arrangement other than to note that it is “similar to those negotiated with 35 other countries.”[108]

In the late 1960s and early 1970s, following the British withdrawal from the Persian Gulf, the U.S.-Iran alliance took on increased importance (Miglietta, 2002). The United States depended on its alliance with Iran for a number of reasons. First, Washington depended on military intelligence facilities located in Iran that were “essential to the American capacity to monitor and analyze Soviet adherence to arms control agreements” (State Department, 1976). Second, the United States needed over-flight rights allowing American aircraft to have access to the Indian Ocean and South Asia. The only alternatives to Iranian airspace were sensitive routes over Egypt or Israel. Third, the United States required access to Iran’s oil. Finally, it was important for Washington that Iran play a “constructive regional role” to help limit Soviet influence in the region (State Department, 1976).

The strengthened alliance had a salient affect on U.S.-Iran nuclear cooperation. U.S. Secretary of State Henry Kissinger, who was involved in plans to export between 6-8 power reactors to Iran, justified renewed U.S.-Iran nuclear cooperation by stating simply: “They were an allied country” (Linzer, 2005). Similarly, Charles Naas, who served as deputy U.S. ambassador to Iran in the 1970s, noted that nuclear commerce took place in part because “the relationship [with Iran] as a whole was very important” (Linzer, 2005). It is telling that all U.S. nuclear cooperation with Iran ended following the collapse of the alliance in 1978-79. This lends support for my argument that states are willing to trade nuclear technology with their allies and

[108] It is further telling that not a single congressperson asked a question on the merit of the Iran deal. Questions instead focused on the U.S.-Norway agreement, which was controversial because it was the first power agreement signed after the declassification of power reactor data by the United States.

reluctant to exchange such items with their non-allies. In the post-Cold War era—now that Iran is a non-ally—the United States has exerted considerable effort to prevent Tehran from acquiring the same technology it was openly offering to Iran in the 1970s.

The available evidence substantiates these assertions. In particular, it suggests that the alliance influenced the drive for nuclear cooperation in the 1970s in three basic respects. First, the United States felt compelled to export nuclear technology to Iran as a means to demonstrate that it valued their strategic partnership. Second, Washington was less threatened by potential gains from trade by Tehran because it was a military ally. And third, the United States was less concerned that its exports would contribute to nuclear proliferation.

Of these three factors, the first was especially salient. The empirical record offers considerable support for the argument that the United States pursued nuclear cooperation with Iran in the 1970s as a means to strengthen the two states' alliance and demonstrate to Tehran how much it valued their strategic partnership. Indeed, atomic energy development was a "prominent centerpiece" of American relations with Iran (Atherton, 1974). In April 1974, prior to his visit to Tehran, Kissinger called for the United States to cooperate with Iran in the peaceful uses of nuclear energy to provide "concrete evidence of our…interest in developing closer ties through specific concrete programs" and signal that we "attach highest value to a partnership" with Iran (Kissinger, 1974). Similarly, a report produced by the U.S.-Iran joint commission on Economic Cooperation (Sisco, 1974) stated that U.S. nuclear exports to Iran would serve as a means to "engage the Iranians so intimately as to assure an enduring relationship under this or successor regimes." And according to a State Department document (1975), the purpose of intensified nuclear cooperation was to "reinforce our close and harmonious relations with Iran, with a view toward promoting a stable and enduring relationship."

This reveals that nuclear cooperation was perceived to be important because it could strengthen the American alliance with Iran at a time when Washington depended on this strategic partnership. At the same time, the United States was deeply concerned that a failure supply Iran with power reactors could have adverse effects on the alliance. According to a declassified National Security Council (1975) document, an inability to cooperate with Iran in the peaceful uses of nuclear energy could have "serious short, as well as long-term, adverse effects in our relations, given the Shah's sensitivity towards U.S. attitudes and Iran's strong desires to be treated in a nondiscriminatory manner and as a nation that often has supported U.S. interests."

This evidence cited above suggests that U.S. nuclear commerce with Iran took place in part to strengthen the two states' military alliance. It is also clear that the United States felt less threatened by potential Iranian gains from nuclear trade because Tehran was an ally. A National Security Council (1975) document that put forth the U.S. strategy for pursuing a nuclear cooperation agreement with Iran stated that receiving nuclear assistance from the United States will "free remaining oil reserves for export or conversion to petrochemicals." In other words, Washington was aware that nuclear cooperation with Iran would free up resources, indirectly augmenting Iran's national power, and aggressively worked to conclude a reactor deal until it was clear that the alliance was crumbling in October 1978.

Finally, I find some support for the argument that an alliance reduces the perceived likelihood of proliferation, although the other two motivations are more salient in explaining nuclear cooperation. For example, Kissinger later observed that "we didn't address the question of them one day moving toward nuclear weapons," presumably because Iran was an ally (Linzer, 2005). Gary Sick, who dealt with nonproliferation issues under U.S. Presidents Ford, Carter, and Reagan, hinted that because Iran was an ally, the United States trusted that Tehran would use nuclear technology only for peaceful purposes. Sick stated: "The shah made a big convincing case that Iran was going to run out of gas and oil and they had a growing population and a rapidly increasing demand for energy…The mullahs make the same argument today, but we don't trust them" (Linzer, 2005). When it came to nuclear proliferation, there was considerable disagreement among senior policymakers such as Kissinger who were not overly concerned about possibly contributing to an Iranian nuclear program and technical experts and members of Congress who were quite concerned about this possibility. This is a point that I will revisit when I discuss the nonproliferation-related variables below.

Enemy of an Enemy/Enemy of the Soviet Union

Iran was a rival of the Soviet Union for a significant portion of the Cold War period.[109] Tehran's concerns over Soviet domination date back to 1946 when Moscow refused to withdraw its military forces from northwestern Iran following the end of World War II. The Soviet Union eventually withdrew in May 1946, but this crisis raised concerns in Iran and the United States about possible Soviet control of the Persian Gulf (Department of State, 1980; Miglietta, 2002). A February 1957 U.S. Security Council document on "U.S. Policy Toward Iran" noted that "Iran remains concerned by the Soviet penetration of Afghanistan and exploitation of Arab disorder which threaten to outflank Iran, already exposed along a 1200-mile frontier with the USSR." The Shah's "nightmare scenario" was "Soviet envelopment of Iran through client forces in Iraq and Afghanistan" (Kissinger, 1975). Iran's rivalry with the Soviet Union ended following the 1979 Islamic Revolution.

[109] This is according to rivalry data produced by Klein, Goertz, and Diehl (2006), which I use in my quantitative analysis.

Since the United States and Iran both experienced a number of militarized interstate disputes (MIDs) with the Soviet Union between 1959 and 1978, Iran was also an enemy of the United States' enemy at various points. My argument is that nuclear cooperation for peaceful purposes should occur under such circumstances because it produces positive security externalities for the supplier. Indirectly increasing the importing state's power via nuclear trade can benefit the supplier state's security because it makes the importing state less vulnerable to aggression from the common enemy. Additionally, engaging in nuclear cooperation with the enemy of an enemy can create concerns for the shared adversary that the importing state might use technology it acquires for peaceful use to pursue nuclear weapons—regardless of whether this is the intention of nuclear trade or not. The empirical evidence lends strong support for this argument, particularly the notion that civilian nuclear cooperation was a means to enhance Iran's power and decrease the likelihood of Soviet aggression against it.

In the mid-1950s, the United States launched its policy of containment, which resulted in an extensive system of alliances designed to "restrain expansion of Soviet influence" (U.S. State Department, 1980). Building on the notion of containment, the "Eisenhower doctrine" asserted U.S. interest in supporting the independence of countries in the Middle East. In March 1957, President Eisenhower received Congressional approval to provide assistance to non-communist Middle Eastern states threatened by Soviet aggression. During this period, the United States perceived that the best way to prevent Soviet penetration into Iran was to strengthen it economically (Miglietta, 2002: 42-43).[110] This assistance was designed to "underwrite extensive modernization of the Iranian economy" so that it would be in a position to prevent Soviet

[110] A 1957 U.S. National Security Council documented stated, for example: "Iran is a tempting and important target of Soviet expansion because of its vulnerability to overt and covert penetration."

aggression (U.S. State Department, 1980).[111] Assistance of all kinds, including cooperation in the peaceful uses of nuclear energy, was perceived to be an "important [pillar] supporting the Shah in his present paramount position" (U.S. National Security Council, 1957).

In the 1970s, U.S. interests in promoting strength and stability in Iran were especially salient. A declassified national security document from 1974 stated:

> "Our interests in Iran are substantial and are growing steadily…Iran is the most powerful, politically most stable, and economically most developed state on the Persian Gulf. It shares with us an interest in promoting moderate elements in the area and in limiting the influence of the Soviet Union and radical forces…Acting as a responsible regional power, Iran can help stabilize the area politically" (Sisco, 1974).

The sale of nuclear power reactors was part of a broader U.S. strategy to increase Iran's power and promote stability in the Persian Gulf, while mitigating Soviet influence in the region. In the mid-1970s, it was believed that cooperation in the peaceful uses of nuclear energy could create "a framework and atmosphere" to discuss these types of strategic interests (Department of State, April 1974). This sentiment continued through 1978, when Jimmy Carter and the Shah reached an agreement on the sale of nuclear reactors to Iran. Indeed, Carter felt it was important to export nuclear power reactors to Iran to introduce further stability in the Persian Gulf (Sick, 1985: 25).

This evidence lends support for my general argument that states are more likely to export nuclear items to enemies of the most powerful states in the system (e.g. the United States or the Soviet Union) and those that they share an enemy with. In this case, the need to strengthen

[111] From 1953-1957, the United States provided Iran with a total of $250 million in grants and $116 million in loans (Miglietta, 2002: 43).

Iran's power and capabilities to prevent Soviet influence goes a long was in explaining U.S. interests in selling power reactors to Iran.

The NPT and Nonproliferation

The empirical evidence suggests that nonproliferation-related considerations affected the terms of the arrangement negotiated by the United States and Iran, but that they had little bearing on the initial decision to transfer nuclear power reactors. The senior decision-makers, especially those in the Nixon and Ford administrations, appear to have spent little time thinking about the proliferation consequences of U.S. nuclear exports to Iran (Linzer, 2005). The available evidence does reveal, however, that others at lower levels of government wanted to ensure that U.S. nuclear transfers did not contribute to nuclear proliferation. Fred Ikle (1975), the Director of the U.S. Arms Control and Disarmament Agency when the nuclear deal was being negotiated, noted that one of the key objectives of U.S. nuclear cooperation with Iran was to ensure that nuclear exports were used only for peaceful purposes. There was some concern that Iran might use U.S. nuclear technology to pursue nuclear weapons. According to a U.S. Defense Department (1975) document, "the potential for instability and uncertain political situation in the Middle East [means that] the proposed agreement for nuclear cooperation could have serious national security implications in the future." These concerns explain why the United States refused to give in to Iranian demands on reprocessing—at least initially.

That Iran was a member of the nuclear Nonproliferation Treaty (NPT) did little to alleviate fears that U.S. exports might contribute to proliferation. According to a U.S. National Security Council document (Sisco, 1975), "The fact that Iran is a party to the NPT is a very positive element but the concern in our country over the possibility of proliferation is really extraordinary." The United States recognized that refusing to provide Iran the right to reprocess spent nuclear fuel while allowing some non-NPT states to do so could pose political problems. The United States was concerned that "subjecting an NPT party like Iran to more rigorous controls" might be perceived as "undermining the NPT" (National Security Council, 1975). In addition to this concern, many U.S. officials were not convinced that Iran's status in the NPT provided sufficient assurances against future proliferation: "despite Iran's present benign attitude towards the NPT and non-proliferation, some are concerned over her possible longer-term nuclear weapon ambitions should others proliferate" (National Security Council, 1975).

The evidence suggests that concerns over whether Congress would approve the agreement helps explain why the United States wanted to negotiate an agreement with Iran that was strong on nonproliferation (e.g. why they did not want to give in on Iranian demands to reprocess spent fuel). Washington recognized that it had to "weigh any modification of our position [on reprocessing] carefully in the light of general public and Congressional concerns over proliferation" (Sisco, 1975). If the agreement was perceived to be weak on nonproliferation, then the United States recognized that Congress would not approve it (Ikle, 1975; National Security Council, 1975).

Economics

There is some evidence that economic-related considerations were salient in explaining the decision to begin nuclear cooperation with Iran in 1957. For example, one of the goals of enhanced nuclear cooperation with Iran was "to obtain for the United States a major share in the additional business which Iran's oil wealth will generate" (State Department, March 1975). As previously mentioned, the agreement forged in the mid 1970s would have generated $6.4 billion in revenue for U.S. companies. Declassified national security documents (e.g. Sisco, 1974) often mention this as a benefit of nuclear cooperation with Iran. A related consideration involved influencing Iran on oil pricing. Some decision-makers in the United States wanted to move forward with nuclear cooperation because they believed that these types of "credible efforts" could yield new incentives for the Iranians to cooperate more closely with us in the other, more controversial fields [such as] oil pricing" (Sisco, 1974). In short, the United States perceived that by providing Iran with nuclear technology it could convince the Shah to lower the price of oil, which in turn would benefit American economic and security interests.

While these economic-related justifications for nuclear cooperation were often mentioned by key U.S. decision-makers, they were far less salient than the security considerations. Any time economics was mentioned as a justification for cooperation, it was overshadowed by security-related considerations. For example, in a declassified State Department memo, Henry Kissinger argued that U.S. nuclear cooperation with Iran would provide economic benefits but emphasized that it would "underpin the broad political-military collaboration which we see in our interest" (Kissinger, May 1975). Further, it was the change in the security environment that led to the collapse of U.S.-Iranian nuclear cooperation. The United States could have gone through with plans to build nuclear reactors in Iran following the Islamic Revolution, generating large sums of money in the process, but it chose not to because of changes in the security relationship between the two countries.

Conclusion

The empirical results presented above reveal that U.S. security considerations were salient in explaining American-Iranian nuclear cooperation. Washington perceived that nuclear assistance to Iran was a means to strengthen the alliance the two countries shared and make it more difficult for the Soviet Union to exert aggression or influence against Tehran. Economic considerations played a role, but the ending of nuclear cooperation once the political/strategic relationship changed in 1979 suggests that they were less important. Senior U.S. decision-makers including Henry Kissinger did not appear to be influenced by normative considerations relating to nuclear proliferation. Government officials at lower levels of government who were concerned that U.S. exports might contribute to proliferation were not impressed by Iran's membership in the NPT. Collectively, these results lend strong empirical support for my hypotheses and illustrate that the causal mechanisms driving them operate correctly in the U.S.-Iran case. The exception, of course, is the democracy hypothesis. Iran was not a democracy, yet cooperation in the nuclear moved forward regardless.

The Iran case illustrates that nuclear suppliers play a dangerous game. U.S. behavior, while consistent with my argument, ultimately harmed U.S. security in the long term. There is evidence suggesting that the Tehran research reactor, which was provided by the United States, is used today to provide advanced training to Iranian nuclear scientists. Thus, the United States contributed to Iran's nuclear weapons program (Roe, 2006). These contributions became especially problematic after the political relationship between the two countries quickly changed in 1979.

SOVIET NUCLEAR COOPERATION WITH LIBYA, 1975-1986

The Soviet Union served as Libya's principal supplier of nuclear technology during the Cold War period. The most significant exports were a 10MW research reactor, which came on-line at the Tajoura Nuclear Research Center (TNRC) in 1981, and 11.5kg of highly enriched uranium to fuel it. The Soviets signed an agreement with Libya pledging to construct two nuclear power reactors, but they were never built. The empirical evidence reveals that Moscow's security interests were especially salient in explaining Soviet nuclear cooperation with Libya. Nuclear commerce was perceived by the Soviets to be a means to strengthen Moscow's partnership with

Libya and counter the influence of the United States and Israel. The economic-based explanations for this cooperation that have been advanced by scholars are not the driving force behind this trade, although Moscow was interested in exchanging Soviet technology for Libyan oil. Nonproliferation considerations were not salient in explaining Soviet nuclear sales. Although Libya ratified the NPT in 1975, it was widely known to be pursuing nuclear weapons. Moscow knew this, but chose to sell Libya nuclear technology regardless because of the security-related benefits it expected to obtain as a result of the transaction.

The Soviet-Libyan case lends strong support for my overall argument. But this case fails to offer support for my hypothesis that nuclear suppliers are more likely to trade with democracies, however. Libya was not a democracy during the period under investigation and I find no evidence that this made Moscow reluctant to provide it with nuclear technology. What follows is a description of Soviet-Libyan nuclear cooperation between 1975 and 1986 and a discussion of the variables that influenced it.

Soviet Nuclear Cooperation with Libya

The Soviet Union was one of Libya's principal suppliers of nuclear technology.[112] Table 5.2 summarizes the key events in Soviet-Libyan nuclear cooperation. An agreement signed on May 5, 1975 initiated cooperation between these two countries. The terms of this deal authorized the Soviet Union to build a 10MW research reactor in Libya and assist in constructing the TNRC (Martel and Donnelly, 1987). In April 1981 the Soviet Union delivered the first shipment of highly enriched uranium (11.5kg) to fuel the Tajoura reactor and in August it became operational (Bowen, 2006: 29). The TNRC became the focal point of Libya's covert

[112] Libya signed nuclear cooperation agreements with Argentina, India, Belgium, and Pakistan, but the Soviet Union was the only country to provide a nuclear reactor.

nuclear weapons program until Tripoli abandoned these efforts in 2003. Suspicious activities that took place at this facility included undeclared work on uranium conversion, gas-centrifuge enrichment, and plutonium separation (Bowen, 2006: 31-32).

While the TNRC was in the construction phase, the Soviet Union signed an additional nuclear cooperation agreement with Libya in December 1977 pledging to construct a 440MW nuclear power plant along Libya's Mediterranean coast (O'Toole, 1977). Western sources indicate that the plans actually called for the export of two 440MW PWRs, the standard Soviet export reactor (Nucleonics Week, 1981). Libya ran into "major problems" with the Soviets in acquiring these reactors (CIA, 1985) and nuclear trade proceeded slowly following the completion of the Tajoura project (Potter, 1985: 479). Although tangible progress was lacking, Soviet officials continued to indicate an interest in cooperating with Libya in the nuclear arena. During a visit to the Soviet Union in May 1981, Libyan leader Muammar Qaddafi discussed the nuclear reactor issue for the third time and reportedly made some progress towards concluding the deal (Nucleonics Week, 1981). And in May 1986, the Soviet Ambassador to Libya asserted that "we have an idea to cooperate in building a nuclear power station [in Libya]" (Martel and Donnelly, 1987; Bowen, 2006: 33). Despite these sentiments, the Soviet deal expired in late-1986 and the reactors were never delivered to Libya.[113]

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[113] Dissatisfied with the lack of progress, Libya turned to other nuclear suppliers In May 1984, Belgium signed a nuclear cooperation agreement with Libya that authorized Belgian participation in the Soviet-proposed nuclear reactor project. The Belgian firm Belgonucleaire was going to be responsible for the non-nuclear parts of the facility while the Soviet Union was going to build the reactors. Belgium cancelled its participation in the Soviet project in November 1984 (Martel and Donnelly, 1987).

Table 5.2: Key Events in Soviet-Libyan Nuclear Cooperation, 1975-1986

Date	Event
May 5, 1975	-The Soviet Union signs a nuclear cooperation agreement with Libya authorizing the export of a 10MW research reactor and help in constructing a research center at Tajoura.
December 1977	-The Soviet Union signs a second nuclear cooperation agreement with Libya pledging to construct a 440,000KW nuclear power plant in the Surt region.
April 1981	-The first fuel shipment (11.5kg of highly enriched uranium) for the Tajoura research reactor arrives in Libya.
August 1981	-The Tajoura reactor becomes operational.
1986	-The agreement to supply power reactors expires. The reactors are never delivered to Libya.

The Empirical Evidence

Why did Soviet nuclear cooperation with Libya begin in 1975 and end in 1986? The empirical evidence presented below reveals that the alliance between the two countries and the shared rivalries with the United States and Israel had a strong effect on nuclear cooperation. Further, statements from Soviet leaders and other supplementary evidence suggest that these considerations influence nuclear trade for reasons that are consistent with my theory. The Soviet Union's security considerations were more important in explaining nuclear cooperation with Libya than considerations related to economics or nonproliferation. The following section describes the relevant variables and the effect they had on nuclear commerce.

Military Alliance

The Soviet Union did not share a formal defense pact with Libya during the period that civilian nuclear cooperation occurred (Gibler and Sarkees, forthcoming), but Moscow formed a strategic partnership with Tripoli beginning in the early 1970s. Prior to the 1970s, the two countries did not share warm relations. Libyan monarch Idris I, whose reign began in 1951, adopted a pro-Western posture. And Colonel Muammar Qaddafi, who rose to power following a bloodless coup against Idris in 1969, initially kept his distance from the Soviet Union (Phillips, 1984). During the early years of Qaddafi's tenure, Moscow allied closely with Egypt and did not look to improve its relations with Tripoli. However, in 1972, Egyptian President Anwar Sadat expelled the Soviet Union from Egypt and Moscow looked to improve relations with Libya (Laipson, 1983: 138). During a Libyan delegation's visit to Moscow in May 1974, Alexey Kosygin, Premier of the Soviet Union, declared: "we hope to examine various aspects of the cooperation between our countries [and] exchange opinions relating to the prospects for expanding Soviet-Libyan ties. In our opinion, there are considerable opportunities for this" (Current Digest of the Soviet Press, 1974).[114] Further, a joint communiqué issued following bilateral discussions in Tripoli stated that "the Soviet Union and the Libyan Arab Republic regard the development and deepening of friendship and cooperation between them as a highly important task of their foreign-policy activity" (Current Digest of the Soviet Press, 1975: 20).

There are a number of reasons why Moscow wanted to strengthen its alliance with Libya beginning in the early 1970s. One of the most salient was Libya's strategic location. Its position on the Mediterranean coast offered convenient ports of call for the Soviet navy (Whelan and Dixon, 1986: 189) and Libyan airfields could provide valuable support for Soviet actions in sub-Saharan states (Laipson, 1983: 138). Additionally, Moscow was in need of a partner in North Africa after the expulsion from Egypt.[115]

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[114] The Soviet Union and Libya also cooperated in the area of arms. In 1974 the two states concluded the first major arms deal and in the 1970s Moscow exported between $10 billion and $16 billion worth of arms to Libya (Phillips, 1984).

[115] Before expulsion in 1972, the Soviet Union had nearly 20,000 troops and advisers in Egypt (Whelan and Dixon, 1986: 189).

The Soviet-Libyan alliance became strained at several points during the 1980s. In 1983 the Soviets refused Qaddafi's request for a formal treaty to strengthen relations between the two countries and attempted to keep the erratic Libyan leader "at arms length" (Freedman, 1986). And Moscow failed to come to Libya's direct aid during two military confrontations with the United States in March and April 1986. These actions demonstrated that "the USSR was not willing to back up Qaddafi with more than words" (Freedman, 1986). The cooling of Soviet-Libyan relations occurred because Moscow became increasingly worried about Qaddafi's unpredictable behavior and his frequent conflicts with Arab neighbors. Further, Mikhail Gorbachev, who rose to power in 1985, did not want to risk other priorities by engaging Libya too closely (Freedman, 1986,1987).[116]

The empirical evidence suggests that civilian nuclear cooperation was perceived as a means to strengthen the Soviet-Libyan partnership. In one of the most comprehensive analyses of Soviet nuclear exports to date, Potter (1985: 478) argues that "political opportunism and influence" is "the most obvious" explanation for the Soviet decision to provide nuclear technology to Libya. In other words, nuclear cooperation provided a means for the Soviet Union to increase its influence in the region by drawing Tripoli closer. The timing of the nuclear cooperation lends support to this argument. The first nuclear cooperation agreement was signed (in May 1975) just as Moscow expressed a newfound desire to improve its relations with Libya. Additionally, nuclear cooperation ended when Soviet-Libyan relations deteriorated in the mid-1980s.

[116] Gorbachev was particularly interested in rebuilding the Soviet economy, maintaining his domestic support, and reaching arms control agreements with the United States (Freedman, 1986). Soviet-Libyan relations continued to oscillate throughout the late-1980s. After a period of poor relations, Moscow looked to improve them in 1989 when it agreed to sell high-performance bombers to Libya (Engleberg, 1989).

Statements from Soviet leaders substantiate this assertion. For example, during bilateral discussions in Moscow during May 1974, Kosygin stated that "we hope to examine various aspects of the cooperation between our countries…we are prepared to come to an agreement that would make our cooperation more stable and long-term in nature. Coordinated actions in this area would undoubtedly facilitate the strengthening of mutual understanding and trust between our countries" (Current Digest of the Soviet Press, 1974: 18). The cooperation that Kosygin referred to included cooperation in the nuclear area. Just months after making this statement, the Soviet Union signed its first nuclear cooperation agreement with Libya.

Part of my argument regarding alliances is that close political relations decrease the proliferation risks of nuclear cooperation, making it more likely to occur. The evidence lends some support to this notion. As I will highlight below, there were significant proliferation risks stemming from nuclear cooperation with Libya given that Tripoli was pursuing nuclear weapons. The Soviet Union perceived that its political relationship with Libya would minimize the likelihood that Tripoli would use Soviet technology to acquire nuclear weapons.[117] As Duffy (1979: 85) notes, "the Soviets…seem confident enough in their ability to influence this avowedly aspiring nuclear power not to…make weapons."

[117] In the 1950s, the Soviets adopted a similar outlook when providing nuclear technology to China. Unfortunately for the Soviets, Beijing used this cooperation to acquire nuclear weapons. Consequently, for many years Moscow did not have confidence in its ability to dissuade even its closest allies from pursuing nuclear weapons. The Libya deal signals a shift back to the pre-1960 philosophy (Duffy, 1979: 84).

Enemy of an Enemy/Superpower Enemy

The Soviet Union and Libya were enemies of the United States and Israel during the period that nuclear cooperation took place.[118] Leaders of both countries routinely condemned the "expansionist" policy of Israel and American "imperialism" (Current Digest of the Soviet Press, 1972, 1974). The Soviet Union was engaged in a superpower rivalry with the United States while Libya and the United States terminated diplomatic relations and faced military confrontation in the 1980s. In May 1974, Qaddafi noted that Libya's friendship with the Soviet Union was based on a shared interest in opposing the United States. Libya desired to defend itself from the "U.S. diplomatic offensive beginning in the Middle East" while the Soviets wanted to gain a "strategic advantage" over its principal rival (Cooley, 1981). Following Gorbachev's rise to power in 1985, the Soviet Union toned down its anti-Imperialist rhetoric and identified less with Libya on the basis of a shared rivalry with the United States. Gorbachev's "new thinking" in foreign policy called for a reduction of Cold War tensions and improved relations with Washington and the West. The Soviet leader met with U.S. President Ronald Reagan for the first time in November 1985 and opened a dialogue aimed at warming U.S.-Soviet relations. The two leaders met again in Iceland in January 1986, were they famously called for the elimination of all nuclear weapons, and soon developed a close personal relationship (Gorbachev, 1996).

The timing of nuclear cooperation suggests a correlation with having these shared enemies; the Soviet Union and Libya did not share an enemy (the United States) until 1973, which is just prior to the unset of nuclear cooperation in 1975. Further, nuclear cooperation

[118] Both countries also grew to be enemies of Egypt in the early 1970s when Cairo adopted an independent foreign policy and cultivated close relations with Washington (Phillips, 1984).

between the two states ended once the Soviet Union looked to improve its relations with the United States. The empirical evidence reveals a strong causal link between these two factors. The shared strategic interests of Libya and the Soviet Union motivated the previously described partnership between the two countries. It also had a significant effect on nuclear cooperation between the two countries.

The two analyses of Soviet-Libyan nuclear cooperation to date both identify a desire to constrain Israel's nuclear potential as a motivating factor (Duffy, 1978; Potter, 1985).[119] Although Moscow did not want Libya to acquire nuclear weapons in the late 1970s as the Tajoura reactor was under construction, the Soviets may have been enabling Libya to prepare for "a future in which they may find themselves faced with local nuclear enemies" (Duffy, 1978: 95). This logic suggests that Moscow wanted to constrain the power of Israel and the United States by forcing them to consider the possibility that one of its enemies, Libya, might acquire nuclear weapons. Primary documents substantiate this argument as well as the more general notion that Soviet-Libyan nuclear cooperation was a means to counter the influence of the United States and Israel.

During the March 1972 bilateral discussions—which laid the groundwork for the 1975 nuclear agreement—the Soviet Union and Libya noted "the great importance of the friendship [between the two countries] for the success of the struggle…against imperialism…and Zionist-Israeli aggression" (Current Digest of the Soviet Press, 1972: 9). Just prior to signing the 1975 agreement during a trip to Tripoli in May 1975, Kosygin stated that enhanced cooperation is necessary to succeed in the "struggle against the common enemy—[the United States]" (Current Digest of the Soviet Press, 1975: 11). These sentiments were continually reinforced as the

[119] Potter (1985: 478) is slightly skeptical of this argument but does not provide much evidence to explain why.

Soviet Union negotiated a second nuclear cooperation agreement with Libya and built the Tajoura reactor. In April 1981, Soviet leader Lenoid Brezhnev stated that nuclear cooperation, and relations with Libya more generally, were vital in countering the influence of the United States. Brezhnev stated:

> "[We are] good comrades and brothers-in-arms in the struggle for the rights and freedom of peoples, against imperialist oppression and aggression…Our cooperation is of special significance in conditions of the current complication of the international situation. The reason for this complication is well known. It is the policy of the aggressive circles of imperialism…We in the Soviet Union appreciate the principled position that Libya takes on questions [of American imperialism]…you consistently oppose imperialist intrigues and encroachments on the rights of peoples" (Current Digest of the Soviet Press, 1981: 10)."

Additionally, during discussions with the Libyans on cooperation in nuclear power in May 1982, Nikolai Tikhonov, Chairman of the Soviet Council of Ministers, stated:

> "We see the unity of our two countries' goals in the anti-imperialist struggle…as the firm basis of our relations. It is [this] lofty goal that our cooperation ultimately serves, and we will keep on doing everything necessary to see to it that this cooperation continues to develop along an ascending line" (Current Digest of the Soviet Press, 1982: 18)

The "new thinking" in Soviet foreign policy following Gorbachev's rise to power meant that Moscow was less threatened by the United States and less interested in constraining U.S. capabilities. Consequently, one of the major incentives for Soviet-Libyan nuclear cooperation was removed. This goes a long way in explaining why the agreement to supply two power reactors to Libya fell through in 1986 (Bowen, 2006).

NPT and Nonproliferation

Libya ratified the NPT on May 26, 1975 but is widely known to have pursued nuclear weapons from the time Qaddafi rose to power in 1969 until 2003. Qaddafi attempted to purchase nuclear weapons from China and India in the 1970s and reportedly was willing to pay $1 million in gold to anyone who could produce a complete warhead (Micallef, 1981). Despite this, the Soviet Union moved forward with plans to provide nuclear technology to Libya between 1975 and 1986.

The Soviet Union developed a reputation as a "responsible" nuclear supplier that held high nonproliferation standards (Potter, 1985; Duffy, 1979). Troubled by its inadvertent contribution to the Chinese nuclear weapons program in the 1950s, the Soviet Union scaled back its nuclear exports in the 1960s and demanded that recipients of nuclear technology provide certain assurances. Moscow instituted a system of safeguards, insisted that all recipients of reactors obtain fuel from the Soviet Union and return spent fuel rods, and prohibited its Eastern European allies from obtaining uranium enrichment or plutonium reprocessing facilities (Potter, 1985: 470). It also generally demanded that recipients of nuclear technology sign the NPT.

The nuclear transfers to Libya are at odds with these priorities.[120] The Soviet Union's cooperation with Libya demonstrates its willingness to supply nuclear technology to a state with a weak nonproliferation record if doing so achieves important strategic objectives. The Soviet

[120] In the 1970s and 1980s, the Soviet Union engaged in nuclear commerce with other states that had weak nonproliferation records including India, Argentina, and Cuba (Potter, 1986).

Union needed to forge a partnership with Libya—especially following the expulsion from Egypt in 1972—in part to constrain U.S. and Israeli power and selling nuclear technology helped achieve this objective. This objective was perceived to be more important than Libya's weak nonproliferation commitments.

It is important to note that the Soviet Union was well aware of the proliferation risks that came with this nuclear cooperation and underwent some efforts to minimize them. Libya's ratification of the NPT occurred just four days before it signed the first agreement with the Soviet Union, which led some observers to speculate that Moscow pressured Tripoli to ratify the treaty in exchange for nuclear assistance (Potter, 1985: 477). The Soviets also applied "stringent" safeguards to Libya to provide additional assurances that nuclear cooperation would not contribute to proliferation (Duffy, 1979: 84). Given Libya's pursuit of nuclear weapons, however, the Soviet Union likely viewed its NPT commitment as a "hollow pledge." It is probable that Moscow believed it contained sufficient political control over Tripoli that exports would not be used to build nuclear weapons (Duffy, 1979: 85; Potter, 1985: 481).

It is also noteworthy that there was a limit to Moscow willingness to cooperate with a state determined to acquire nuclear weapons. The Soviet Union built the Tajoura reactor knowing that it could produce plutonium.[121] But it proved to be reluctant to supply power reactors that were capable of producing around 10 to 20 nuclear weapons per year (Micallef, 1981). Ultimately, the arrangement to sell two power reactors fell through in part because of fears that Libya "might seek to adapt any nuclear programme (sic) for military purposes" (PPNN, 1987).

[121] The reactor was capable of producing 1.2 kg of weapon grade plutonium per year, which means that it would take ten years to accumulate enough material for a nuclear bomb.

A final possible explanation for Soviet-Libyan nuclear cooperation related to nonproliferation is that Moscow wanted to "preempt the sale of nuclear technology…by less cautious suppliers" (Potter, 1985: 478). The Soviet Union had previously suffered when other suppliers provided technology after it refused to. For example, in the early 1970s the Soviet Union refrained from supplying a plutonium producing reactor to Iraq only to see France, Italy, West Germany, and Canada compete for the contract.[122] Not wanting this to happen again, Moscow may have supplied a reactor to Libya to prevent it from receiving proliferation-prone nuclear technology from Western European nuclear suppliers. In other words, the nuclear deal was conceived to make it more difficult for Libya to acquire nuclear weapons.

The empirical evidence does not lend support for this argument. Qaddafi was determined to acquire nuclear technology and there is no indication that he stopped approaching other suppliers after the Tajoura facility was built (Micallef, 1981; Bowen, 2006). If this logic is correct, we would have expected the Soviet Union to follow through with plans to supply power reactors, which of course is not what happened.

Economics

A number of economic-based explanations have been offered, although the evidence reveals that they are less salient in explaining nuclear cooperation with Libya than the Soviet Union's strategic interests. One argument is that the Soviet Union wanted to sell nuclear technology to Libya to illustrate that it was a viable supplier to developing nations (Potter, 1985). The Soviet VVER-440 reactor was one of only two small reactors on the market at the time (the

[122] Ultimately, France and Italy supplied technology that would have enabled Iraq to produce plutonium for nuclear weapons had Israel not bombed the facility in 1981.

other being the Canadian CANDU) and Moscow may have been attempting to command a portion of the market where there was relatively little competition (Duffy, 1978). The problem with this explanation is that there were several developing countries that had a demand for nuclear power—including Iran, the Philippines, Cuba, and Egypt—that the Soviet Union could have sold nuclear technology. This argument cannot explain why the Soviets sold to Libya when there were other ways they could have demonstrated their ability to be a viable supplier to developing nations. A related economic rationale for the nuclear sales is a desire to maximize profits and gain access to Libya's hard-currency reserves (Potter, 1985). This may have been a benefit of nuclear cooperation with Libya but it could not have been a primary motivating factor. There were many countries with better proliferation records than Libya that could have paid for Soviet nuclear technology. The final argument in this vein is that the Soviets hoped to exchange nuclear technology for Libyan oil. There is little evidence from key Soviet decision-makers to support this contention, but some scholars have suggested that Soviet trade with Libya was likely part of a strategy to obtain oil to meet growing domestic needs (Freedman, 1982: 165).

Conclusion

The results reveal that the Soviet Union's security considerations explain nuclear cooperation with Libya more comprehensively than factors related to economics or nonproliferation. The evidence from this case lends support to my overall argument, especially my hypotheses that states use nuclear cooperation as a means to strengthen alliances (H1) and constrain the power of their enemies (H2 and H3). The Soviet Union generally had a strong nonproliferation record and refrained from exporting nuclear items to proliferation-prone countries on several occasions after transactions with China in the 1950s helped Beijing produce the bomb. The Libyan case reveals, however, that the Soviet Union was willing to overlook proliferation concerns in exchange for security-related benefits.

CANADIAN NUCLEAR COOPERATION WITH INDIA, 1955-1976

Canada was India's most significant nuclear supplier during the period 1955-1976. It agreed to provide India with an un-safeguarded research reactor in 1955 and two power reactors in the 1960s. Ultimately Canada's nuclear assistance enabled India to test a nuclear device in May 1974 using plutonium extracted from the Canadian-supplied research reactor. The empirical evidence reveals that Indo-Canadian nuclear cooperation can be explained in large part by Canada's strategic considerations. Specifically, Ottawa began nuclear cooperation with India as a means to strengthen the Indo-Canadian partnership and make it more difficult for the Soviet Union to exert influence or aggression against New Delhi. Economic considerations, especially a desire to break into the nuclear market, influenced this cooperation but the evidence reveals that these considerations were less salient that the security motivations described above. Notably, concerns about nuclear weapons proliferation offer little explanatory power in this case. Canada knew that India was pursuing nuclear weapons and that New Delhi was the staunchest critic of the NPT but it engaged in nuclear cooperation with it right up until the nuclear test in 1974. The Canada-India case is significant for a number of reasons, including that it illustrates my argument is applicable to middle powers as well as major/great powers.

This section proceeds by describing Indo-Canadian nuclear cooperation during the period 1955-1976. Then it presents the results of the empirical investigation and concludes by discussing the implications of my findings.

Canadian-Indian Nuclear Cooperation

Canadian-Indian nuclear cooperation began on April 28, 1956 when the two countries signed a nuclear cooperation agreement authorizing Canada to build a 40MW research reactor in India. This Canada-India-United States research reactor (CIRUS) was built as part of the Colombo Plan, a developmental aid program for countries of South Asia modeled after the Marshall Plan (Bhatia, 1979). The CIRUS reactor was intended to be a "teaching tool" to allow the Indians to build up their knowledge in nuclear engineering (Bratt, 2006: 89). The Canadians placed very limited safeguards on the CIRUS transaction, stating only that "the Government of India will ensure that the reactor and any products resulting from its use will be employed for peaceful purposes only" (Bratt, 2006: 95). This vague provision meant that Ottawa had little means to ensure that its exports did not ultimately contribute to an Indian nuclear weapons program. As I will highlight below, this is something that Canada would later deeply regret. The CIRUS reactor went critical on July 10, 1960.

The construction of a research reactor paved the way for Canada to assist India in the construction of power reactors. On December 16, 1963, Canada and India signed a second nuclear cooperation agreement. This agreement led to the construction of a 100MW Rajasthan Atomic Power Plant (RAPP-1). The terms of this deal called for the "free exchange of scientific and technical information…for the development of heavy water moderated reactor systems." It also enabled India to obtain "detailed design data, including plans and working drawings regarding the design and construction of nuclear power stations of the heavy water type" (India Nuclear Chronology, 2003). Canada additionally agreed to provide one-half of the initial uranium fuel charge for the Rajasthan reactor.[123] Unlike the CIRUS arrangement, Canada was able to include fairly stringent safeguard provisions in the RAPP-1 deal. Most notably, the

[123] The other half was going to be fabricated in India.

agreement allowed for Canadian inspections of the RAPP-1 reactor to ensure that it is being used only for peaceful purposes (Bratt, 2006: 100). RAPP-1 was built by Indian scientists using designs obtained from Canada under the terms of this NCA, not on a turnkey basis as many other reactors were.[124] This reactor went critical on August 11, 1972 (Pathak, 1980).

On December 16, 1966, Canada agreed to offer assistance in the design and construction of a second nuclear power reactor at Rajasthan (RAPP-2). The capacity of RAPP-2, 200MW, was twice as much as RAPP-1 (Bratt, 2006). The safeguards requirements attached to this agreement were more stringent than the other two deals because they allowed inspectors from the International Atomic Energy Agency (IAEA) to verify that the reactor is not used for weapons-related purposes (Perkovich, 1999: 131; India Nuclear Chronology, 2003).

On May 18, 1974 India conducted a "peaceful" nuclear test at Pokhran in the Rajasthan desert. Just four days after the explosion, Canada suspended all nuclear assistance to India (Bratt, 2006). This included suspension of the RAPP-2 reactor construction. On January 25, 1974 Canada canceled an export license covering $1.5 million in nuclear-related equipment and materials destined for the RAPP-2 facility (India Nuclear Chronology, 2003). After two years of strenuous negotiations, Canada permanently suspended all nuclear assistance to India on May 18, 1976.[125] Allan MacEachen, Canada's Secretary of State for External Affairs, explained the permanent suspension of nuclear relations with India in the following terms:

> "Canada has insisted that any cooperation in the nuclear field be fully covered by safeguards which satisfy the Canadian people that Canadian assistance will not be

[124] The term turnkey refers to facilities that are completed by the supplier so that the only thing left for the customer to do is to "turn the key."

[125] For more on these negotiations see Kapur (1978).

diverted to nuclear explosive purposes. This Canadian objective could not be achieved in these negotiations [with India]…The Canadian Government…could agree to make new nuclear shipments only on an understanding by India that Canadian supplies…whether past or future, shall not be used for the manufacture of any nuclear explosive device…We have concluded that the Indian Government would not be prepared to accept [these additional] safeguards" (Kapur, 1978: 315-316).

Canada's nuclear cooperation with India is significant because it enabled New Delhi to acquire nuclear weapons. Canadian assistance was critical in two respects. First, the CIRUS reactor provided a means to produce the plutonium necessary for use in a nuclear weapon. In 1964, India had produced its first weapon-grade plutonium by reprocessing spent fuel from the Canadian-supplied CIRUS reactor (Perkovich, 1999: 28). The principal reason that New Delhi used the CIRUS reactor to produce plutonium was because it was not governed by any nuclear safeguards (Bratt, 2006: 118-119). Second, Ottawa's transfers of knowledge and technical expertise related to nuclear engineering in the 1950s and 1960s helped establish India's "self-sufficiency in reactor technology" (Bratt, 2006: 119). Once Canada terminated its nuclear relations with New Delhi in 1976, India's nuclear program suffered considerably (Perkovich, 1999; Halloran, 2007).

Table 5.3: Key Events in Canadian-Indian Nuclear Cooperation, 1955-1974

Date	Event
April 28, 1956	-Canada signs a nuclear cooperation agreement with India authorizing the export of a 40MW CIRUS research reactor and uranium fuel.
July 10, 1960	The CIRUS reactor goes critical.

December 16, 1963	-Canada signs a second nuclear cooperation agreement with India authorizing the export of a 100MW Rajasthan Atomic Power Plant (RAPP I) to India.
December 16, 1966	-Canada agrees to build a second nuclear power reactor at Rajasthan (RAPP II).
May 18, 1974	-India conducts a peaceful nuclear test.
May 18, 1976	-Canada permanently suspends all nuclear cooperation with India.

The Empirical Evidence

This section presents the empirical results. It identifies the role that key variables had in shaping Indo-Canadian nuclear cooperation based on Canadian primary documents and an array of secondary sources. The results reveal that Canada's strategic considerations, especially a desire to strengthen its partnership with India and minimize the influence of the Soviet Union in the region, are very salient in explaining this cooperation. Economic considerations also played a role, although their effect was less significant than these security-related considerations. Nonproliferation-related concerns, including India's pursuit of nuclear weapons and disdain for the NPT, did not stop Canada from selling India a significant amount of nuclear technology.

Military Alliance/Militarized Conflict

Canada did not share a formal defense pact with India (Gibler and Sarkees, forthcoming), but the two countries forged a close partnership beginning in the 1950s that some scholars have dubbed the "Indo-Canadian Entente" (e.g. Rajan, 1961-62). The partnership between India and Canada resulted in cooperation during a number of international crises during the 1950s including the Korean War, the International Commission for Supervision and Control in Indochina, and the Suez crisis (Rajan, 1961-62; Bratt, 2006). Canadian leadership recognized the value of the entente as it was forged in the 1950s. Prime Minister Louis St. Laurent and External Affairs Minister Lester Pearson "attached the highest importance to Canadian-Indian relations" (Bratt, 2006: 91-92). As the 1960s progressed, relations between Canada and India soured a bit. After 1966, in large part because of disagreements about the war in Vietnam, India began to move away from Canada and the West and closer towards the Soviet Union (Bothwell, 1988: 370-371).

Nuclear cooperation went a long way in shaping the relationship between Ottawa and New Delhi (Kapur, 2007). Indeed, a principal justification for the onset of Indo-Canadian nuclear cooperation in the 1950s was a desire to strengthen the alliance shared by the two countries. Canada wanted to provide India with the CIRUS reactor in March 1955 because it "believed that such a move was of considerable international political importance for the West in its attempts to secure the loyalty of the developing world as the Cold War heated up" (Touhey, 2007:12). Canadian leaders recognized the need for a strengthened partnership with India and further acknowledged that nuclear cooperation was the best way to accomplish this. Jules Leger, the Undersecretary of State for External Affairs argued just as nuclear relations with India commenced that: "politically, it would do more to strengthen our relations with India than anything I could think of" (Donaghy, 2007). Canadian Minister of External Affairs Lester Person echoed these sentiments when he noted on November 7, 1955 that nuclear cooperation with India had "a real political value in bringing us closer together" (Rajan, 1961-62: 379; Bothwell, 1988: 353). Pearson also recognized that "India is a great power and is subject to the temptations of a great power." He felt that nuclear commerce could help Canada "direct Indian energies into friendly channels—friendly, that is, to Canada and the West" (Bothwell, 1988).

Ottawa recognized that it was well positioned to accomplish important strategic objectives for the West through nuclear cooperation with India. U.S. intentions were viewed skeptically in India and Washington's attempts to entice India with nuclear technology would likely be less successful—or at least this was the perception in Ottawa. Ultimately, Canada hoped that it could "assist the United States in parts of the world where American views by themselves were considered too extreme" (Bothwell, 1988). It was a middle power that had the "ability to moderate the harsh aspects in the policies of the two superpowers" (Kapur, 2007). Escott Reid, Deputy Undersecretary for External Affairs, hoped to—and ultimately did—engage India in ways that were "more acceptable" (Mackenzie, 1995).

The Indo-Canadian entente remained strong in the early 1960s, as India was still "a key nation in Canada's contacts with the non-aligned world" (Bothwell, 1988: 357-358). Thus, Ottawa moved forward with plans to sell nuclear power reactors to India in December 1963. But when Indo-Canadian relations began to weaken after 1966, nuclear cooperation between the two countries lost some momentum. As Bothwell (1988: 368) notes, "the political rationale [for nuclear cooperation] was beginning to wear thin, as Indo-Canadian relations frayed in a number of areas, and the vision of the 1960s that an intercontinental bridge of friendship could be constructed…was becoming blurred."[126] But this "bridge" lasted long enough for RAPP II to travel over it (Bothwell, 1988: 368). Canada moved forward with the RAPP I and RAPP II projects because it was committed to see them through (AECL, 1966). But it did so reluctantly, which explains in part why both reactors were completed far behind schedule. RAPP I was not completed until 1973 (four years behind schedule) and RAPP II was not finished until 1981 (nearly eight years behind schedule). India's peaceful nuclear explosion in May 1974 had catastrophic consequences for Indo-Canadian relations. Escott Reid (1981: 261), a former High

[126] By the early 1970s, the Department of External Affairs did not attach strong importance to the Indo-Canadian partnership. Prime Minister Pierre Trudeau's foreign policy review largely ignored India, instead focusing on China, Japan, and the Pacific. Trudeau was increasingly alarmed by India's relationship with the Communist bloc (English and Touhey, 2007: 231-232).

Commissioner noted that India's nuclear test "had a catalytic effect on Indo-Canadian relations. It demonstrated that so far as Canada was concerned the special relationship had ceased to exist." Not surprisingly, all bilateral nuclear cooperation came to a screeching halt. Although the 1974 nuclear test did not result in a militarized dispute between Canada and India (Ghosn, Palmer, and Bremer, 2004), the cessation of nuclear relations at this time lends support to my argument that states are unlikely to sell technology to their adversaries.

The empirical evidence also reveals that Ottawa perceived that the presence of the Indo-Canadian entente would minimize the proliferation risks of nuclear cooperation. As Bratt (2006) observes, "it was felt that India could be trusted due to the special relationship that existed between the two British Commonwealth countries during the 1950s and 1960s." This is one of the reasons why Canada did not fret about the lack of safeguards on the CIRUS reactor and the fairly week safeguards associated with the RAPP reactors.

Shared Enemy/Superpower Enemy

Part of my argument is that states exchange nuclear technology with those that they share enemies with. The logic driving this expectation is that trading with enemies of enemies makes it more difficult for threatening states to exert influence or aggression against recipient states. Canada and India did not share a rival according to the Klein, Goertz, and Diehl (2006) dataset but one of the primary motivations for the initiation of civilian nuclear cooperation in 1955 was the perceived need to limit the Soviet Union's ability to exert influence against India. And while India ultimately became an ally of the Soviet Union, relations between the two countries were far from friendly prior to the mid-1950s (Appadorai and Rajan, 1985; Perkovich, 1999: 41).

One of the factors motivating Canada's nuclear exports during the Cold War was a desire to limit the spread of communism and Soviet influence. As Bratt (1998, 2006) argues, Canada recognized that nuclear transactions resulted in long-term partnerships between the supplier and recipient states and it did not want to see the Soviet Union develop stronger relations with other countries, especially developing countries. This was particularly true of nuclear cooperation with India. The sale of the CIRUS revealed that Ottawa was "acutely conscious of its membership in the American-led Western alliance against the Soviet Union and its allies" (Donaghy, 2007: 269). Canada feared that the Soviet Union might seize the opportunity to supply nuclear technology and replace Western exporters as the principal provider of assistance (Heat and Trudeau, 1995: 122-123; Donaghy, 2007). Ultimately, Ottawa demonstrated that it preferred to weaken nuclear safeguards demands than "allow the Soviets to use a nuclear reactor to establish closer ties with a developing country" (Bratt, 2006: 40). By beginning nuclear cooperation in 1955 Ottawa anticipated that it—not Moscow—would develop a closer relationship with India. Further, the Canadians hoped that the CIRUS transaction would limit Moscow's influence in Asia by counteracting the "positive impression" that the Soviet Union was helping China develop a "peaceful" nuclear program (Donaghy, 2007: 269).

Following Soviet Premier Nikita Khrushchev's historic visit to India in 1955, New Delhi drifted further away from the West towards the Soviet Union (English and Touhey, 2007).[127] Slowly, beginning in 1955, the "geopolitical interest" that originally motivated Canada to export nuclear technology to India began to fade because of New Delhi's closer alignment with the Soviet Union (Delvoie, 2007: 241). But Canada moved forward with nuclear cooperation in the 1960s and 1970s in part because it recognized that India remained strategically important and

[127] In November 1956, Prime Minister Nehru condemned the Anglo-French-Israeli attack against Egypt during the Suez crisis but refrained from criticizing the Soviet Union following its invasion of Hungary. This provided a clear illustration that a gulf had emerged between India and the United States (English and Touhey, 2007).

that a termination of nuclear trade at that point would put a serious strain on Indo-Canadian relations (Touhey, 2007: 20).[128]

Democracy

India is a democracy (Beardsley and Gleditch, 2003) and—according to my argument—democracies should be more likely to receive nuclear technology. The logic here is that because democratic institutions are comparatively transparent (e.g. Gaubatz, 1996) and democracies tend to make more reliable commitments (e.g. Fearon, 1994), nuclear suppliers can provide technology to democratic states with a greater degree of confidence. In short, democracy reduces the proliferation risks associated with civilian nuclear cooperation. The empirical evidence supports this causal logic. Inside Canada, there was "considerable trust in the political reliability of the Indian government" because it was democratic (Bothwell, 1988; Bratt, 2006). Ottawa perceived that the "domestic constraints of the Indian political system" would help ensure that Canadian nuclear exports were used only for peaceful purposes (Bothwell, 1988: 370). These domestic constraints—India being a democracy—may have been the most effective

[128] Further, just as the Indians began to ally with the Soviet Union, another common enemy emerged—China. In the fall of 1962 China launched a surprise invasion of northern India and easily captured territory that was disputed between the two countries. Canada and China have been labeled "reluctant adversaries" in part because Ottawa was part of Western efforts to constrain Beijing. Rubinoff (2002) notes that these strategic interests affected Canadian assistance to India. There is little evidence from Canadian officials to indicate that exports to India were an attempt to constrain China by making it more difficult for the latter country to exert influence or aggression against the former country. Nor is there evidence that reactor sales to India were intended to force China to cope with the possibility that New Delhi might acquire nuclear weapons. But all of this is certainly plausible, especially given the timing of events. Plans to sell power reactors to India were concluded just after New Delhi's humiliating defeat to China when incentives to acquire nuclear weapons were especially strong.

protection against military uses of Canadian technology. This goes a long way in explaining why Canada did not pursue a stringent safeguards agreement (Bratt, 2006: 94)

NPT and Nonproliferation

India has historically been one of the most ardent critics of the NPT and other nonproliferation arrangements on the grounds that they are discriminatory (Perkovich, 1999).[129] New Delhi began exploring nuclear weapons in 1954 (Singh and Way, 2004) and embarked on a concerted effort to acquire them following the Sino-Indian border war in 1962 and Beijing's nuclear test in 1964 (Touhey, 2007; Perkovich, 1999). India conducted a peaceful nuclear explosion in May 1974, using plutonium extracted from the Canadian-supplied CIRUS reactor.

When engaging in nuclear cooperation with India, Canada was well aware of the proliferation risks. Chester Ronning, the Canadian high commissioner to New Delhi worried about India's nuclear ambitions and was "disturbed" by his conversations with Indian leaders (Touhey, 2007: 15). As Canada was negotiating with India over the sale of the RAPP-1 and RAPP-2 reactors in the mid-1960s, a briefing book prepared for Prime Minister Lester Pearson stated:

> "the present and future development of India's civilian nuclear research and power programme (sic) will continue to ensure that a militarily significant scale in four to five years from now, could be initiated very quickly and without a prohibitive diversion of manpower resources…It is known…that the operation of the Canada-India Reactor (CIR) at Trombay has been oriented towards optimizing

[129] India is one of four states to remaining outside the NPT today. The others are Pakistan, Israel, and North Korea, which withdrew from the treaty in 2003.

the production of weapons-grade plutonium since the summer of 1963" (Canada, 1965).

Further, Paul Martin, the Secretary of State for External Affairs, claims to have realized as early as the 1950s that Homi Bhabha, who established the Atomic Energy Commission of India, "intended India to produce its own atomic bomb" (Touhey, 2007: 19).[130] Intelligence reports received by Canadian officials substantiated these assertions. In 1965, the Canadian Defense Minister Paul Hellyer received intelligence from his British counterpart suggesting that India was "making all necessary preparations for a test explosion sometime before the end of the year" (Canada, 1965).[131]

Canadian officials warned India that the development of nuclear weapons could lead to a termination of atomic cooperation. In 1971, Prime Minister Pierre Trudeau sent a letter asserting to Indian Prime Minister Indira Gandhi that the use of Canadian supplied technology or materials in the development of nuclear weapons would "inevitably call on our part for a reassessment of our nuclear cooperation arrangement with India" (Bratt, 2006: 125-126). But Ottawa continued to engage in civilian nuclear cooperation with India in spite of the overwhelming evidence that New Delhi was pursuing nuclear weapons. India's harsh rhetoric against the NPT, which was being negotiated in the mid-1960s, also did not dissuade Canada from moving forward with the plans to supply additional power reactors. It quickly became clear that India would not accept a treaty that treated the nuclear "haves" and the "have-nots" differently. Only a treaty that obligated *all states* to stop production of nuclear weapons would be acceptable to New Delhi (Perkovich, 1999).

[130] Martin also acknowledged that this sentiment likely wasn't shared by Prime Ministers Nehru or Shastri.

[131] This intelligence proved to be inaccurate but Canada had no way of knowing this at the time (Touhey, 2007).

There as “nothing native” about Canada’s nuclear cooperation with India (Finch, 1986).[132] Ottawa knew that the CIRUS reactor was an efficient plutonium producer and that India’s commitment to nonproliferation was weak, but went through with nuclear sales anyways. Security considerations, particularly a desire to strengthen the Indo-Canadian partnership and prevent Soviet penetration of India, outweighed concerns about the spread of nuclear weapons. Proliferation concerns, incidentally, were also outweighed by economic considerations.

Economics

The empirical evidence reveals that a few economic factors influenced Indo-Canadian nuclear cooperation. The initial CIRUS transaction was motivated by a desire to enter the nuclear market and compete with the United States and the United Kingdom for reactor exports. Canadian officials perceived that by entering the nuclear market early, in 1955, they could “showcase Canadian nuclear technology and engineering talent abroad” which could “encourage the export of additional reactors” (Donaghy, 2007). Indeed, a cabinet memorandum concluded that Canadian business and the atomic industry could “gain competitive advantage in an emerging field and Ottawa could actively assist their position for constructing various types of atomic units in Canada or abroad in later years” (Touhey, 2007: 12). This was an especially salient consideration because the Canadian reactor used plutonium-heavy water-based technology, which was unique from the U.S.-made light water-enriched uranium technology (Kapur, 2007). Canadian officials recognized that it would be “most undesirable, especially from the longer-term commercial point of view, for us to lag behind” the Americans and the

[132] Some scholars have claimed that “sheer naiveté” explains Canada’s nuclear cooperation with India (Morrison and Wonder, 1978). This explanation was propagated in large part to absolve Canadian decision-makers for their eventual contribution to nuclear proliferation (Finch, 1986: 78-79).

British (Lester, 1955). These economic considerations—in conjunction with the security motivations described above—help explain why Canada was willing to export the CIRUS reactor virtually un-safeguarded (Finch, 1986: 79).

Economic considerations also influenced Canadian thinking about continued nuclear cooperation with India in the 1960s and 1970s. Ottawa recognized that a failure to provide nuclear power reactors to India (e.g. the RAPP-1 and RAPP-2) jeopardized an important market for the Canadian nuclear industry and that other suppliers such as France would gladly replace Canada should it decide not to go through with the cooperation (Touhey, 2007). Further, it cemented Ottawa position as a key player in the nuclear market. The Canadian Minister of Trade and Commerce stated following the conclusion of the RAPP-2 agreement that "the sale confirmed Canada's position as one of the leading international suppliers of nuclear power stations" (Touhey, 2007: 27). Although these factors were important, they were less significant than Ottawa's security considerations in driving nuclear cooperation. This is a point that I will revisit below.

Conclusion

The empirical evidence presented above reveals that Canadian security considerations were especially salient in explaining nuclear cooperation with India. In particular, Ottawa felt that nuclear assistance was a means to strengthen the Indo-Canadian entente and constrain the Soviet Union's ability to exert influence or aggression against New Delhi. Economics clearly had an effect on the onset of Indo-Canadian nuclear cooperation and its continuation throughout the 1960s and 1970s. But economic-considerations were less salient than Canada's security interests in motivating the nuclear cooperation. That Canada permanently terminated nuclear cooperation with India in 1974, once it was clear that its strategic value was extremely limited, lends support to this argument. Ottawa could have continued to make money and confirm its position as a leading nuclear supplier by engaging in additional cooperation with India post-1974. Indeed, Canada suffered immediate and future economic losses once it ended nuclear assistance to India. It lost $12 million worth of heavy-water sales and $1 million in spare parts for the RAPP program. But more importantly it gave up the possibility of future sales to India and harmed the Canadian nuclear industry by raising questions about its reliability as a supplier (Morrison and Wonder, 1978; Bratt, 2006). If economics were the driving force behind civilian nuclear cooperation, we would have expected Canada to resume sales after 1974 in pursuit of these financial gains. That it did not lends further support to the argument that security considerations heavily influenced Indo-Canadian nuclear cooperation. Bothwell (1988:369) summarizes this well: "it is clear that in its origins Canada's atomic connection to India was political; that it was aimed at influencing India's attitudes to and relations with the Western alliance, of which Canada was a self-conscious and active part."

The Indo-Canadian case is significant for several reasons. First, this is a case of great historical significance. Canada's nuclear cooperation with India did as much to undermine nonproliferation (albeit inadvertently) than any other case of assistance (Perkovich, 1999). While other states contributed to India's nuclear program, it was Canadian assistance that made the 1974 test possible because plutonium could be extracted from the un-safeguarded CIRUS reactor. Given the consequences of this cooperation, there is significant value in understanding why it took place. Second, this case illustrates that nonproliferation considerations can be trumped by *both* security and economics. This indicates that concerns about the spread of nuclear weapons are very low on supplier states' hierarchy of interests. Third, Canada is a middle power—not a great power like the United States and the Soviet Union. This case demonstrates that my argument is applicable to more than the great powers. Finally, the Indo-Canada case provides empirical support for my hypothesis that democracies are more likely to receive nuclear assistance. The other two cases I examine in this chapter do not lend support for this argument; both Iran and Libya were non-democratic states but still received nuclear technology. The causal logic driving my democracy hypothesis operates correctly in this particular case, suggesting that it is valid even though there are certainly cases when non-democratic states receive nuclear assistance.

CONCLUSION

The cases examined in this chapter clearly demonstrate the effect that supplier states' strategic interests have on civilian nuclear cooperation. Further, they reveal that the causal processes I identified in the theory section operate correctly in actual cases of nuclear assistance. In all three cases, a desire to strengthen an alliance with the importing state and constrain the power of a common adversary was paramount in explaining why the supplier offered civilian nuclear technology. Nuclear cooperation ended in each case once political relations between the two states became strained, suggesting that the logic driving my militarized conflict hypothesis is correct. The empirical evidence for the Canada-India case reveals that India's regime type convinced Ottawa that it could trust New Delhi not to use Canadian technology to develop nuclear weapons, which supports the logic driving my democracy hypothesis. But I do not find support for this hypothesis in the other two cases since neither recipient was a democracy but nuclear cooperation occurred regardless.

In all three cases, the supplier's strategic considerations were more salient than explanations rooted in nonproliferation or economics. In all three cases, supplier states had suspicions that the recipient state was pursuing nuclear weapons but this did not prevent nuclear cooperation from taking place. In two of the cases (Soviet Union-Libya and Canada-India), the recipient state had an openly disdainful attitude towards the NPT and in the third (United States-Iran) the recipient state's status inside the NPT proved to be largely irrelevant. Economics mattered more than nonproliferation, but it was not the driving force in any case.

As I highlighted in the introduction to this chapter, three very different nuclear suppliers were examined here. That my argument applies equally well to all three cases suggests that it is generalizable. Great powers and non-great powers appear to engage in civilian nuclear cooperation for similar reasons, as do democracies and non-democracies. Collectively, the evidence presented in this chapter lends further empirical support to my central argument: civilian nuclear cooperation is a mechanism for supplier states to enhance their strategic interests.

CHAPTER 6

CASES NOT PREDICTED: AN ANALYSIS OF OUTLIERS

The results presented in Chapter 4 reveal that, on average, suppliers provide nuclear aid to meet strategic objectives. There are cases of nuclear cooperation, however, that are not successfully predicted by my theory. Out of 2,791 agreements signed between 1950 and 2000, 295 (roughly 11 percent) do not appear to be influenced by the supplier state's strategic interests.[133] Table 6.1 lists the unsuccessfully predicted agreements. This chapter examines 10 of these outlying cases to uncover the reasons for the onset of nuclear assistance. The purpose of this chapter is to introduce short descriptions of the outlying cases and summarize the most salient factors that explain why cooperation occurred based on the available evidence. The objective here is to determine why these cases were not predicted by my theory and whether a variable originally omitted from my statistical analysis is important in explaining civilian nuclear cooperation.

Table 6.1: Unsuccessfully Predicted Cases of Nuclear Cooperation

Supplier State	Recipient State (Year)
Argentina	Spain (1966, 1978); Yugoslavia (1982); Romania (1972, 1978, 1990); Armenia (1997, 1998); Nigeria (1988); Morocco (1996); Libya (1971); Egypt (1988, 1996); South Korea (1995, 1996); Pakistan (1983); Indonesia (1990)
Belgium	Argentina (1962); Poland (1965, 1973); Romania (1974); Egypt (1983); Pakistan (1963)
Brazil	France (1967); Spain (1968); Portugal (1965); Iraq (1979, 1981)

[133] Cases not predicted by my theory are those where hypotheses 1-4 all fail to predict the onset of cooperation. In only one case (India-Sri Lanka) do all five hypotheses collectively fail to predict cases of nuclear assistance.

Canada	Spain (1975); Hungary (1987); Romania (1976, 1980, 1992); Ukraine (1994, 1995); Egypt (1980); South Korea (1991, 1998); Pakistan (1959, 1964); Philippines (1980)
China	Peru (1995); Brazil (1984, 1985); Chile (1989); Yugoslavia (1980, 1984); Romania (1984); Morocco (1998); Algeria (1996, 1997); Indonesia (1985)
France	Mexico (1979, 1980, 1981); Brazil (1975); Argentina (1962, 1963); Spain (1956, 1964); Poland (1975); Hungary (1983, 1984); Czechoslovakia (1964, 1967, 1986, 1990); Yugoslavia (1955, 1957, 1962, 1966, 1967); Bulgaria (1966, 1967, 1986); Morocco (1988, 2000); Algeria (1963, 1982); Tunisia (1996); Iraq (1975); Saudi Arabia (1975); Qatar (1974); UAE (1980); Kazakhstan (1992); South Korea (1990, 1991, 1997); Pakistan (1962, 1964); Bangladesh (1980); Sri Lanka (1980); Vietnam (1996); Indonesia (1969, 1970, 1979; 1980)
Germany	Brazil (1971, 1972, 1974, 1978, 1979); Chile (1970); Argentina (1962, 1980, 1981); Spain (1969; 1970; 1973; 1978); East Germany (1973, 1987); Poland (1989); Hungary (1990); Czechoslovakia (1990); Yugoslavia (1975); Romania (1969); Egypt (1981); South Korea (1986); Pakistan (1969, 1972, 1986); Indonesia (1977)
India	Brazil (1984); Argentina (1983); France (1965); Spain (1965); East Germany (1974, 1982); Poland (1962, 1977); Hungary (1961, 1962); Czechoslovakia (1966); Yugoslavia (1965, 1979); Bulgaria (1965); Romania (1971); Algeria (1980); Iraq (1974); Egypt (1970, 1981, 1990); Sri Lanka (1986); Vietnam (2000); Indonesia (1981)
Israel	Mexico (1966); Bolivia (1972); Chile (1966); Egypt (1994); Philippines (1963, 1966)
Italy	Brazil (1971, 1981); Argentina (1962, 1965); Spain (1965); Poland (1963, 1964, 1965); Romania (1964, 1969); South Africa (1965); Iraq (1976); Egypt (1973, 1984); Pakistan (1966); Indonesia, 1976)
Japan	Mexico (1990); Brazil (1985); France (1965, 1966, 1968); Niger (1981); Zambia (1980); Kazakhstan (1994); Thailand (1991); Indonesia (1988, 1998)
Netherlands	Brazil (1978); Argentina (1962)
North Korea	Czechoslovakia (1988)
Pakistan	Argentina (1983); Spain (1965); Poland (1970); Malaysia (1984); Philippines (1981); Indonesia (1980)
Russia/Soviet	France (1965, 1966, 1967, 1968); East Germany (1955); Yugoslavia (1956, 1963, 1964, 1975); Ghana (1962); Libya (1972, 1998);

Union	Afghanistan (1963); Kazakhstan (1994, 1995, 1996); Pakistan (1968, 1970)
South Africa	France (1963)
South Korea	Argentina (1980); Czechoslovakia (1990); Romania (1993, 1996)
Spain	Mexico (1978, 1979, 1980); Brazil (1983); Chile (1972); Argentina (1966); Uruguay (1979); France (1964); Portugal (1964, 1971); South Korea (1996); Pakistan (1966)
Sweden	East Germany (1989, 1990); Poland (1964); Yugoslavia (1965); Estonia (2001)
Switzerland	France (1964)
United Kingdom	Brazil (1974, 1978, 1981); Yugoslavia (1964); Romania (1975, 1976); Ukraine (1993); Swaziland (2000); Egypt (1981); South Korea (1991); Pakistan (1960)
United States	Spain (1955, 1957); Poland (1962, 1991); Hungary (1990); Czechoslovakia (1989); Yugoslavia (1985); Romania (1967); Ukraine (1993); Armenia (1996, 1997); Ghana (1995); Swaziland (2000); Morocco (1980, 1955); Lebanon (1955); Kazakhstan (1994; 1997); Pakistan (1957, 1967); Bangladesh (1981); Vietnam (1959); Indonesia (1960, 1980, 1992)
Yugoslavia	Argentina (1982); France (1966, 1967); Germany (1991); Poland (1972); Hungary (1965); Czechoslovakia (1964, 1966); Bulgaria (1967); Romania (1967, 1980); Indonesia (1960, 1962)

The cases analyzed in this chapter are nuclear cooperation agreements between: (1) the United States and Indonesia between 1960 and 1965; (2) Brazil and Iraq in 1980; (3) the United Kingdom and South Korea in 1991; (4) Canada and Romania in 1977; (5) China and Algeria between 1983 and 1993; (6) France and Iraq in 1974; (7) Germany and Iraq in 1975; (8) India and Vietnam in 1999; (9) Italy and Iraq in 1975; and (10) the Soviet Union and Yugoslavia between 1956 and 1967. My principal objective in selecting these cases among the 295 that were not successfully predicted was to analyze a representative sample of outliers. Thus, I chose cases involving 10 different suppliers over various time periods. Additionally, since there is value in explaining historically significant cases, I chose the most important cases that were not successfully predicted by my theory. These cases are French and Italian cooperation with Iraq during the 1970s and they are significant because they nearly enabled Baghdad to acquire nuclear weapons.

After reviewing these 10 cases of nuclear cooperation, I discuss two possible alternative explanations that emerge from this analysis. The first is that suppliers are more likely to offer assistance to oil producing states in order to ensure a stable supply of petrol. In other words, suppliers engage in oil-for-nuclear technology swaps. The second is that states offer nuclear aid in circumstances they otherwise would not because of pressures to become a key player in the nuclear marketplace. This logic suggests that emerging suppliers should behave differently from established suppliers. At the end of this chapter I use statistical analysis to test each of these alternative hypotheses and do not find significant support for either of them. Ultimately, this offers further evidence in favor of my strategic theory of nuclear cooperation.

AMERICAN NUCLEAR COOPERATION WITH INDONESIA, 1960-1965

U.S. nuclear cooperation with Indonesia began in June 1960 when the two countries signed a nuclear cooperation agreement. This deal, which was part of the U.S. initiated Atoms for Peace program, authorized the United States to provide a $350,000 grant towards the cost of a research reactor and $141,000 towards the development of a nuclear research program (Poneman, 1982; Cornejo, 2000). The agreement also permitted the United States to provide enriched uranium to fuel the research reactor.[134] This assistance resulted in the construction of a

[134] The agreement stipulated that Indonesia could possess no more than 6kg of uranium enriched to 20 percent at any one time. At least 25kg of uranium enriched to 90 percent is necessary to trigger an effective nuclear explosion (Cornejo, 2000).

small 250KW TRIGA-Mark II research reactor, which became the centerpiece of the Indonesian nuclear program during the 1960s (Poneman, 1982). In October 1964, the U.S.–supplied reactor conducted Indonesia's first successful nuclear reaction (Cornejo, 2000). Shortly after this event, in July 1965, Indonesian leader Sukarno proclaimed that his country would acquire nuclear weapons. He boasted: "God willing, Indonesia will shortly produce its own atom bomb" (Cornejo, 2000: 35). Despite these nuclear aspirations, the United States continued its assistance to Indonesia's nuclear program. Washington renewed the 1960 agreement in September 1965, just as is was set to expire.[135]

The 1960 agreement with Indonesia was one of about 40 bilateral agreements that were signed as part of the Atoms for Peace program (Finney, 1965). Like other cooperation initiated through this program, nuclear aid to Indonesia emerged in part because the United States wanted to "discourage the proliferation of nuclear weapons by shifting international attention from the development of weapons and toward the peaceful uses of nuclear energy" (Bundy, 1988; Cornejo, 2000). Thus, one objective of U.S.-Indonesian cooperation was to decrease the likelihood that Jakarta would desire nuclear weapons by offering a "peaceful" alternative.

While this motivation influenced U.S. decision-makers there was also a strategic consideration on their minds. The empirical evidence reveals that Washington perceived that nuclear cooperation with Indonesia was an important means to limit the influence of the Soviet Union in South East Asia. This became especially salient after Moscow signed a nuclear cooperation agreement with Indonesia in 1960 (Poneman, 1962).[136] A declassified memo

[135] On March 11, 1966, Sukarno was overthrown by General Suharto and Indonesian nuclear weapons aspirations officially ended (Cornejo, 2000.

[136] The Soviet Union offered $5 million worth of equipment, materials, and isotopes for a 1-2MW research reactor to be used for training. Ultimately, the Soviet research reactor project was unsuccessful (Poneman, 1982: 100).

written by Richard Bissell, the Central Intelligence Agency's Deputy Director of Plans, noted that "the new policy of the Soviet Union vis-à-vis Indonesia leaves us with only one practicable alternative," which is "to continue a moderate program of economic and military assistance sufficient to bolster the political position of our friends within Indonesia and to enable those who are willing to stand on principle to do so without being submerged by the overwhelming temptation of and pressures engendered by Soviet officers" (Bunnell, 1976). A National Security Council (1959) document published just prior to the signing of the first nuclear agreement echoed this sentiment: "the size and importance of Indonesia, together with its strategic position in relation to Australia and Free Asia, and the probable serious consequences of its loss to Communist control, dictate a vigorous U.S. effort to prevent these contingencies." To counter the Soviet threat, Washington hoped to bring "new urgency and empathy to U.S. relations with the Third World" and felt that nuclear cooperation with Indonesia would be one policy that could help achieve this goal (Bunnell, 1976: 133).

U.S. enthusiasm about using nuclear cooperation with Indonesia as an instrument to constrain Soviet capabilities faded when President Sukarno adopted an increasingly anti-American posture in the early 1960s. Relations between the two countries began to sour beginning in the summer of 1963 when Sukarno proclaimed that he was going to destroy neighboring Malaysia and began do develop a closer relationship with communist China (Sheehan, 1965). Additionally, the United States began to worry about Sukarno's intent to acquire nuclear weapons, although Washington was skeptical of Jakarta's ability to actually acquire the bomb. According to a U.S. intelligence estimate written in 1964, "Indonesia will be unable to produce nuclear weapons from its own resources in the foreseeable future" (U.S. Department of State, 1964).

Despite these concerns, Washington reluctantly pledged to continue nuclear cooperation with Indonesia in 1965. When renewing the 1960 agreement, the United States added the condition that Indonesia must allow the International Atomic Energy Agency (IAEA) to inspect the American-supplied research reactor. Ultimately, cooperation continued because the United States did not want to lose complete control of the technology and materials it had supplied. If the agreement were terminated, Washington feared that Sukarno might refuse to return the low enriched uranium it had supplied to fuel the research reactor. Were this to happen, the credibility of the Atoms for Peace program would have been questioned (Poneman, 1982). In short, the United States was "persuaded to continue the cooperation basically by the argument that there was no way to end the program without the Indonesians taking full control of it" (Finney, 1965).

BRAZILIAN NUCLEAR COOPERATION WITH IRAQ, 1980

In January 1980, Brazil and Iraq signed a nuclear cooperation agreement. This deal authorized Brazil to provide technology in uranium exploration and train Iraqi scientists (McCrary, 1979). It also specified that Brazil would eventually supply unprocessed and enriched uranium and offer assistance in the construction of nuclear reactors (Eisner, 1980). An official statement issued by the Brazilian foreign ministry asserted that:

> "the bilateral cooperation will be effected in accord with the capacities and priorities of each side, in complete conformity with the agreements and international obligations of the respective countries…The two parties reaffirm their support of the principle of the nonproliferation of nuclear arms and reaffirm their right to develop and use nuclear energy for peaceful purposes" (Eisner, 1980).

Brazil initiated this nuclear cooperation with some reluctance. According to press reports, the Brazilian government feared that it could suffer diplomatically if it was too enthusiastic about nuclear aid to Iraq (Chemical Week, 1979).[137] This initial reluctance did not prevent Brazil from exporting nuclear materials to Iraq beginning in 1980. Shortly after signing the nuclear cooperation agreement, two Iraqi plans traveled to Brazil and loaded eight tons of uranium oxide for Baghdad. Israeli agents reportedly forced the aircraft to the grown over Africa and unloaded the uranium, preventing it from reaching Iraq (Hoge, 1981; Weisman and Krosny, 1981). This incident created a fair amount of embarrassment for Brazil, which sought to keep its cooperation with Iraq quiet. It did not, however, deter Brasilia from offering additional aid to Baghdad. In September 1990, Brazilian President Fernando Collor de Mello admitted to U.S. President George H.W. Bush that Brazil had transferred "significant nuclear technologies" to Iraq but that he intended to immediately terminate this assistance (Middle East Defense News, 1990).

The empirical record indicates that Brazil aided the Iraqi nuclear program because it wanted to secure a stable oil supply. At the time the agreement was signed, Brazil depended on outside sources for 80% of its energy supply and Iraq provided 40% of this (Chemical Week, 1979). Brasilia believed that nuclear aid would induce Baghdad to keep a steady flow of oil to Brazil. This was an especially important consideration because Brazil was desperate to "negotiate payment in counter-trade to avoid exacerbating its grievous foreign debt load" that resulted in part from its dependence on Iraqi oil (Middle East Defense News, 1990). As Brazil's minister of mines and energy, Cesar Cals, stated, nuclear cooperation with Iraq emerged due to "pressure from a crushing oil bill" (Latin America Economic Report, 1979). While Brazil

[137] In particular, Brazil worried that cooperation with Iraq would jeopardize the continuation of West German nuclear aid (McCrary, 1979).

recognized the political risks of cooperating with Baghdad, it could not afford to "ignore Iraq's control of a crucial part of Brazil's hydrocarbon energy supply" (Chemical Week, 1979). Just two days after the signing of the nuclear agreement, Iraq agreed to supply Brazil with an additional 20.7 million (42 gallon) barrels of oil at current prices and to increase Brazil's daily allotment of oil by at least 160,000 barrels a day for the next 13 years (Easner, 1980). In the long-run, however, the nuclear technology-for-oil swap did not pay off for Brazil. After the onset of the Iran-Iraq war in September 1980, Iraqi oil exports to Brazil were drastically reduced to 100,000 barrels a day (Hoge, 1981).

Some observes have suggested that Brazilian-Iraqi nuclear cooperation was part of a "mutual help scheme" designed to aid the nuclear weapons programs of both countries (Latin America Weekly Report, 1981). Proponents of this argument maintain that Brazil initiated a "short-cut" to nuclear weapons and that it needed Iraqi help to make this plan work.[138] The empirical evidence does not lend significant support to this argument, beyond unsubstantiated references to mutual cooperation on weapons efforts in a few media outlets. A desire to protect the country's oil supplies is clearly the most important factor motivating Brazil's nuclear cooperation with Iraq.

BRITISH NUCLEAR COOPERATION WITH SOUTH KOREA, 1991

On November 27, 1991 the United Kingdom signed an agreement with South Korea authorizing cooperation in areas related to the nuclear fuel cycle. The deal called for the "transfer of nuclear material, equipment, and technology between the two countries" in the areas

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[138] As part of this alleged plan, Brazil would provide Iraq with uranium to be irradiated in Iraqi reactors. Some of the irradiated uranium would stay in Iraq for use in Baghdad's nuclear program while some would be returned to Brazil (Latin America Weekly Report, 1981). At the time, Brazil had only a small 2MW research reactor while Iraq possessed a 70MW reactor.

of “management, storage, and final disposal of irradiated fuel and radioactive waste, and transport of radioactive material (Hibbs, 1991). In short, the arrangement authorized the United Kingdom to reprocess South Korean spent fuel in Britain and return separated plutonium and reprocessing wastes to South Korea. This agreement was signed at a time when there was considerable concern about potential nuclear weapons ambitions of both countries on the Korean peninsula. South Korea appeared on the British governments “danger list” for exports causing “strategic and proliferation concerns” (Lean, 1993). Media reports criticized British attempts to sell reprocessed fuel to South Korea, noting that such efforts increased the risk of nuclear proliferation in “one of the world’s hottest troublespots” (Lean, 1993). North Korea—a country pursuing nuclear weapons at the time—chastised Britain for “criminal acts of encouraging” South Korean nuclear proliferation (BBC, 1993). Further, the United States, which needed to approve this arrangement as the original supplier of the South Korean uranium, voiced concern about the proliferation significance of the deal (Hibbs, 1991, 2000). These concerns and reorganization of the South Korean nuclear industry delayed the implementation of the 1991 agreement, but Britain remained interested in offering reprocessing services to for Seoul throughout the 1990s (Hibbs, 2000).

The empirical record reveals that commercial incentives explain British attempts to initiate nuclear cooperation with South Korea in 1991. The British government recognized that South Korea was a “potential major customer” for reprocessing services due to its rapidly expanding nuclear industry (Hibbs, 2001). Beginning in the early 1990s, South Korea increased civilian nuclear energy development; it planned to construct nine new nuclear power reactors in the 1990s and have a total of 25 n in operation by 2015 (Kang and Feiveson, 2001). Britain perceived that this surge in nuclear power capacity would result in a large stockpile of spent-fuel, creating opportunities for British industry. According to a statement issued by the British Department of Energy, "The [1991 nuclear cooperation] agreement is intended as a framework for the U.K. nuclear industry to pursue the commercial opportunities presented by South Korea's large and expanding civil nuclear power program" (Hibbs, 1991). John Wakeham, the British secretary of state of energy, further highlighted the commercial value of the agreement: "my hoe is that companies…who have teamed up to develop business opportunities in Korea…will secure contracts on a commercial basis with their South Korean counterparts" (Hibbs, 1991). Ultimately, generating revenue and providing additional opportunities for the British nuclear industry were sufficiently powerful motivations to trump concerns about nuclear proliferation in East Asia. These commercial considerations were especially powerful because the nuclear agreement came at a time when some in the British government were questioning the future of British reactor sales and related fuel services (Marshall, 1994).

CANADIAN NUCLEAR COOPERATION WITH ROMANIA, 1977

Canada signed a nuclear cooperation agreement with Romania in 1977 after several years of negotiations. The terms of this deal authorized Ottawa to provide one 600MW Canada Deuterium Uranium (CANDU) nuclear power reactors to Romania.[139] This arrangement would turn out to be "nothing less than a fiasco" for Ottawa as financial delays, safety concerns, and financial difficulties plagued the project (Bratt, 2006: 179). Over a decade after construction began, the Canadian reactor was only 45 percent complete. In the early 1990s, Canada supplied Romania with $315 million in additional loans so that the project could be complete (Bratt, 2006).

[139] The Romanians claimed that the project initiated by the Canadians would result in the construction of *five* power reactors, but only one reactor was actually being built (Wells, 1995).

Romania was a close ally of the Soviet Union, a country that Canada sought to contain as part of its commitment to the North Atlantic Treaty Organization (NATO). This meant that Canada would have less political leverage to ensure that its exports would not contribute to nuclear proliferation, which was a concern for Ottawa in the Romania case. Canadian officials worried that it might be aiding Soviet bloc attempts at nuclear espionage by supplying a power reactor to Romania (Globe and Mail, 1987).[140] Additionally, Canada and Romania did not share any rivals so there was little opportunity to use nuclear cooperation as a means to constrain the power of states Ottawa was threatened by. Since Romania was well entrenched in the Soviet camp, nuclear technology certainly would not have been perceived as a means to constrain Moscow's capabilities.

A desire to reduce East-West tensions was the most salient factor motivating Canadian nuclear aid to Romania. Beginning in 1972 the United States took a series of steps towards détente and sought to minimize tension with the Soviet Union.[141] Ottawa felt compelled to assist in this effort. Prime Minister Pierre Trudeau, who was elected in 1968, felt that communist bloc countries should be "encouraged, enticed or cajoled into becoming full participants in the community of nations. The way to reduce their revolutionary zeal was to bind them to the world, not to cast them beyond the pale. Trade, scientific exchanges, tourism and culture were all threads to be spun into a web" (Axworthy, 1990: 44). In short, Canada perceived that it could contribute to détente by engaging in nuclear cooperation with Romania (Bratt, 2006). There is

[140] These fears were legitimate. It was later revealed by a former Romanian spy that Romania had stolen Canadian nuclear technology in the 1970s (Bratt, 2006: 272).

[141] For example, U.S. President Richard Nixon and Soviet Premier Leonid Brezhnev participated in three major summits and engaged in cultural exchanges, technical cooperation, and promoted bilateral trade.

no evidence that economic considerations were a driving force behind this arrangement (Bratt, 2006; Bothwell, 1988).

While not successfully predicted by my theory, Canadian-Romanian nuclear cooperation provides another illustration of how concerns about nuclear proliferation are often overlooked. Although Romania had signed the NPT prior to the onset of nuclear cooperation, Ottawa knew that it might re-transfer Canadian-supplied technology to states like Pakistan or the Soviet Union (Bratt, 2006). But this did not stop Canada from ultimately supplying nuclear technology. This is particularly noteworthy because this transaction occurred just three years after India used Canadian technology to test a nuclear device, suggesting that Ottawa should have been especially cognizant of proliferation risks. Thus, this case lends support to my argument that concerns about proliferation—particularly whether the importing state is pursuing nuclear weapons or has signed the NPT—offer little explanatory power once the supplier state's strategic interests are controlled for.

CHINESE NUCLEAR COOPERATION WITH ALGERIA, 1983-1993

China's nuclear cooperation with Algeria began when the two countries signed a secret nuclear cooperation agreement in February 1983. This agreement led to the construction of a research reactor located in an isolated area near Ain Oussero, roughly 130 kilometers south of Algiers. The Ain Oussero facility was a 15MW heavy water moderated research reactor fueled with low enriched uranium (Department of State, 1991). Construction for the reactor began in 1986 and began operating in late 1993 (Albright and Hindersetin, 2001). The 1983 agreement included no safeguards assurances other than an Algerian promise that they would only use Chinese-supplied nuclear technology and materials for peaceful purposes. However, in response to U.S. pressure, Algeria signed a safeguards agreement with the IAEA in February 1992 and agreed to inspections at the Ain Oussero reactor (Nuclear News, 1992).[142]

Sino-Algerian cooperation was (and remains) controversial for a number of reasons. First, it was conducted under a shroud of secrecy. The 1983 agreement was signed covertly and remained the world was unaware of Chinese nuclear sales to Algeria until U.S. satellites discovered suspicious activities on the ground in 1991 (Gertz, 1991). Second, it raised suspicions that China was helping Algeria acquire nuclear weapons. U.S. officials claimed that Chinese assistance could be intended to aid an Algerian weapons program because the size of the reactor was larger than the size required for nuclear research and surface-to-air missiles were located nearby to protect the facility (Shuey and Kan, 1994).[143] Finally, it perpetuated concerns that China was an "irresponsible" nuclear supplier. During the 1980s, China engaged in a number of transfers that raised concern among those countries seeking to limit the spread of nuclear weapons. Among these sales were: weapon-grade uranium and a number of other sensitive transfers to Pakistan; heavy water to India; enriched uranium and heavy water to South Africa and Argentina; and enriched uranium to Brazil (Milhollin and White, 1991). The discovery of the Algerian transaction in 1991 cast further doubt on China's commitment to nuclear nonproliferation. Indeed, China's exports to Algeria represented a "major challenge to recent initiatives to shut down exports of unsafeguarded nuclear technology" (Hibbs, 1991).

[142] China's nuclear cooperation with Algeria continued throughout the 1990s. In mid-1996, China completed construction of a hot cell laboratory near the Ain Oussero site and in May 1997 agreed to provide a radioactive isotope and radioactive pharmaceuticals production facility (Albright and Hinderstein, 2001).

[143] This point was hotly debated, even within the U.S. government. Some State Department officials did not believe that Chinese assistance (as of 1991) would make a sufficient contribution to a weapons program (Albright and Hinderstein, 2001).

In 1984, China implemented a new policy on nuclear exports that pledged not to support "threshold" weapons states. Beijing also joined the International Atomic Energy Agency (IAEA) and accepted international rules dealing with nuclear exports (Brenner, 1990). Vice Premier Li Peng stated official Chinese policy on January 18, 1985: "I wish to reiterate that China has no intention, either at the present or in the future, to help non-nuclear countries develop nuclear weapons…China's nuclear cooperation with other countries, either at present or in the future, is confined to peaceful purposes alone" (Brenner, 1990). Further, as the Algerian transaction was exposed in 1991, a spokesman from the Chinese foreign ministry reaffirmed China's commitment to nuclear nonproliferation:

> "China's nuclear export [policy] is strictly guided by its policy of nuclear nonproliferation. China does not stand for, or encourage, or itself engage in nuclear proliferation, nor does it help other countries to develop nuclear weapons. There are three principles guiding China's nuclear export [policy], namely: guarantee for peaceful use, submission to IAEA safeguards and supervision and non-transfer to third [countries" (Department of State, 1991).

Despite these sentiments, nonproliferation was not a salient factor influencing Sino-Algerian cooperation. Beijing transferred technology to Algeria with weak safeguards requirements and with disregard for that country's alleged nuclear weapons aspirations and its status outside the NPT.[144]

The empirical evidence suggests that a desire to make money and catalyze China's domestic nuclear industry were the most important factors motivating Sino-Algerian nuclear cooperation. In the 1980s, China experienced a severe energy crisis and turned to nuclear power

[144] Algeria signed the NPT in 1995.

to meet rapidly growing energy demands. Foreign exchange shortages hampered efforts to expand the domestic nuclear power program. This "created incentives to earn hard currency via export sales" (Brenner, 1990). Thus, the Algerian transaction provided China a means to finance efforts to expand nuclear power domestically.

Algeria also presented a unique opportunity for China because other suppliers—especially the United States—were reluctant to sell technology to a country with a weak commitment to nonproliferation. The Algerian sales were part of an "aggressive and secret Chinese campaign to export technology and weapons that takes advantage of uneven Western efforts to stem the spread of weapons of mass destruction" (Sciolino and Schmitt, 1991). During the 1980s, China was less threatened by nuclear proliferation than many of the other nuclear suppliers, which created an opportunity to generate revenue by adopting an unrestrained nuclear export policy. As U.S. Department of Defense officials observed, China's cooperation with Algeria was an attempt at "testing the waters for a future wide-open nuclear supply policy" (Hibbs, 1991). Beijing welcomed lucrative opportunity to sell nuclear technology to the "radical or potentially radical states" in the Middle East and North Africa (Tyson, 1992). Ultimately, the "money making potential of nuclear-technology exports" encouraged China to overlook proliferation concerns in order to secure the Algerian order (Cheung, 1991).

The economic incentives to trade with Algeria extended to Chinese leaders and their families, who personally profited from the sales to Algeria. Secret nuclear trade with Algeria and other countries became "quasi-official Chinese policy" in part because the Chinese firms that export nuclear technology are staffed by sons and daughters of Chinese leaders. Thus, some of the profits from these transactions went to the Chinese military, but leaders' families made money as well (Hibbs, 1991).

FRENCH NUCLEAR COOPERATION WITH IRAQ, 1974

France signed a nuclear cooperation agreement with Iraq on November 18, 1975 during a visit to Baghdad by the newly named Prime Minister of France, Jacques Chirac (Keeley, 2003). This deal authorized France to supply Baghdad with a 40 MW research reactor, a zero-power reactor, and a radioactive waste treatment station (NTI, 2003). The research reactor, which came to be known as Osiraq, was significant in part because it operated with 93 percent enriched uranium, which is suitable for use in a nuclear bomb.[145] The nature of Franco-Iraqi nuclear cooperation raised concerns around the globe that Baghdad might acquire nuclear weapons. These fears were perpetuated by provocative rhetoric from Iraqi leaders. In 1975, just days after the signing of the NCA with France, Saddam Hussein declared that the agreement "is the first concrete step towards the production of an Arab atomic weapon" (Styan, 2006). These statements did not prevent France from continuing nuclear cooperation. In July, 1980, France shipped 13kg of highly enriched uranium to Iraq for use in the Osiraq reactor (Marshall, 1981). According to those who were involved in nuclear transactions with Iraq, "the question of nuclear proliferation really was not that important. The French concerns were far more prosaic, and reflected the kind of practical economic considerations that so often lie behind great political decisions" (Weisman and Krosney, 1981: 92). Many countries, most notably Israel, grew increasingly intolerant of Franco-Iraqi cooperation as it became clear that Paris had no intention of ending its assistance to Baghdad. On June 7, 1981 eight Israeli bombers entered Iraqi airspace and destroyed the Osiraq reactor.[146] The Israeli government proclaimed the attack a success and

[145] The name "Osiraq" emerged because the reactor was similar to Osiris, a French reactor that operated south-west of Paris, and it was supplied to Iraq. Osiraq is also known as Tammuz I.

[146] For more on this attack see Feldman (1982).

argued that it was necessary because "Iraq was preparing to produce atomic bombs" and "the target of those bombs was Israel" (Styan, 2006). The attack against Osiraq brought an end to French nuclear cooperation with Iraq.[147]

Why did France overlook the clear proliferation risks associated with selling Iraq nuclear technology? The empirical evidence reveals that the French nuclear sales were part of a broader strategy to secure a reliable supply of oil from Iraq (Lieber, 1980; Marshall, 1981; Lellouche, 1981; Weissman and Krosney, 1981; Levy, 1982; Barnaby, 1987; Styan, 2006). The nuclear cooperation agreement explicitly linked "permanent and reliable" oil supplies to the nuclear transactions (Weisman and Krosney, 1981).[148] In 1970s, France was highly dependent on imports to meet its energy needs. Following the Yom Kippur War and the subsequent Arab oil embargo, maintaining a secure oil supply became a priority for Paris (Lieber, 1980). As one scholar observed, "the real danger for France [in the late 1970s was] the oil crisis, not the SS-20" (Lieber, 1980).[149] Thus, France was "madly scrambling to secure oil supplies" and engaging in nuclear cooperation was one way to accomplish this (Wiesman and Krosney, 1981: 90). This strategy proved to be successful. French nuclear sales produced an increase in Iraqi oil shipments from 20 million tons per year in 1978 to 25 million in 1979 and 30 million in 1980

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[147] In July 1981, French Foreign Minister Claude Cheysson stated: "If Iraq wants to conclude a new accord to obtain a nuclear reactor, France will be ready to supply her under the same conditions as those applied to other customers." Despite this sentiment, President Mitterrand officially ended nuclear cooperation with Iraq in 1983 (Styan, 2006: 138-139).

[148] This is one reason why the agreement was kept secret (Weisman and Krosney, 1981).

[149] The SS-20 was a Soviet missile that was deployed in the western part of the Soviet Union in the late 1970s. The deployment of these missiles became a concern for France because their precision and multiple-warhead capacity meant that a number of French targets were vulnerable.

(Lieber, 1980). Further, Iraqi Vice-President Saddam Hussein assured French Prime Minister Barre that Paris could count on "the continuity and security" of oil supplies from Iraq (Lieber, 1980: 150).

GERMAN NUCLEAR COOPERATION WITH BRAZIL, 1975

On June 27, 1975, West Germany and Brazil signed one of the most controversial nuclear cooperation agreements to date. The German-Brazilian deal was monumental because it was the first to include a self-sufficient "fuel cycle package sale," meaning that it offered Brazil the capability to sustain its nuclear program indigenously (Lowrance, 1976). The arrangement included five elements: (1) uranium exploration and mining; (2) uranium enrichment; (3) fuel fabrication; (4) reprocessing of spent fuel; and (5) nuclear power plants (Gall, 1976). The most alarming components of this agreement from a nonproliferation perspective were the construction of facilities capable of enriching uranium and reprocessing spent fuel because they could be used to produce fissile material for a nuclear bomb. From a financial perspective, the "centerpiece of the deal" is the sale of between two to eight nuclear reactors. This transaction was valued at between $2 billion and $8 billion (Gall, 1976). The United States strenuously objected to this arrangement because:

> "the political context for the trade is not at all reassuring. Although relatively stable at the moment, Brazil has suffered recurring upheavals of government, internal repression, terrorism, and saber-rattling toward neighbors. Brazil has steadfastly refused to subscribe to the Nonproliferation Treaty, and it has never been more than a reluctant participant in the discussion of nuclear restraint" (Lowrance, 1976: 153).

The deal was further criticized in the U.S. press as "a reckless move that could set off a nuclear arms race in Latin America, trigger the nuclear arming of a half-dozen nations elsewhere and endanger the security of the United States and the world as a whole" (New York Times, 1975).

The German-Brazilian pact, once dubbed the "deal of the century," bore little fruit.[150] The project "ran into trouble from the very start" (Hibbs and dos Reis, 2000). This was in part because of technical problems, economic hardship, and a lack of funding from the Brazilian government. In the end, Germany only constructed one 1,300MW power reactor at Angra dos Reis (this reactor is known as Angra II) and transferred a limited amount of fuel-cycle knowledge. A second German reactor, Angra III, is partially complete and it is unclear whether Brazil plans on finishing it (Hibbs, 2004).[151]

Although the German-Brazilian agreement yielded little concrete cooperation, it is worthy understanding what compelled Bonn to sign "the most controversial foreign deal ever struck by West German Industry" (Lowrance, 1976: 147). The empirical evidence reveals that Germany wanted to export nuclear technology to Brazil in large part to receive assurances of uranium supplies (Gall, 1976; Lowrance, 1976; Chemical Week, 1975). In the 1970s, West

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[150] Thus, fears that West German exports would aid a Brazilian nuclear weapons program proved to be unfounded. But the United States was correct in suspecting the presence of a weapons program. The military government of Ernesto Geisel established a secret military nuclear program, although Brazil terminated it in 1990 and joined the NPT regime several years later (Kraus, 2005).

[151] Days before the 1975 agreement was set to expire, on November 18, 2004, the two countries renewed it for another five years. This could allow for the completion of the Angra III reactor, although the extension may have been intended to produce cooperation in alternative energy sources (Hibbs, 2004). Some sources claim that Germany wanted to scrap the 1975 nuclear agreement entirely and replace it with a deal on cooperation in renewable energy sources (Agence France Presse, 2004).

Germany decided to increase its investment in nuclear power and construct 40 power reactors to meet growing energy needs. Bonn had planned on obtaining enriched uranium from the United States in order to fuel these reactors. However, following India's test of a nuclear device in 1974, the United States imposed strict limits on exports of highly enriched uranium. The United States informed Germany that it would not supply nuclear fuel for 10 reactors scheduled to come online in the early 1980s, as originally planned. Washington's cutoff of future enrichment commitments "created both a reason and an opportunity for Brazil and West Germany to act together to implement separate strategic aims" (Gall, 1976: 164). Bonn hoped to secure uranium from Brazil in exchange for enrichment technology and other nuclear items. One of the "main hopes" was that West German cooperation with Brazil would lead to the discovery of uranium reserves, offering Bonn an alternate source of nuclear fuel (Gall, 1976). This was especially important in light of the 1973 oil crisis and West Germany's growing dependence on imports to meet its energy needs.

Although the acquisition of uranium was the most salient factor motivating the 1975 agreement, other economic considerations also affected the deal. In the 1970s, Germany's nuclear energy program experienced financial difficulties because of the lack of domestic demand for nuclear power. Bonn may have sought to export nuclear reactors to Brazil as a means to revive the nuclear industry (Hofhansel, 1996). Additionally, Germany may have perceived cooperation with Brazil as a means to develop future ties with the developing world. After signing the pact with Brazil, Bonn proclaimed that "the day of the industrial nations' hegemony is over—perhaps particularly that of the United States. The developing countries cannot and should not be denied; they will no longer tolerate, no do they have to tolerate, the kind of discrimination they have had to suffer in the past" (Lowrance, 1976: 154). Klaus

Scharmer, head of the international section of the Julich nuclear research center, echoed these sentiments: "We must combat the 'development gap' that tends to grow between countries that are more and less developed. We must try to hasten the advance of the underdeveloped" (Gall, 1976: 166).

Concerns about proliferation were not salient in explaining the signing of the German-Brazilian agreement. Despite U.S. warnings, West Germany was undeterred by Brazil's hostile attitude towards the NPT or its nuclear weapons program. Bonn even went so far as to claim that: "Germany is simply following the provisions of the Nonproliferation Treaty's Article 4, which binds subscribers to facilitate 'the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy" (Lowrance, 1976: 154). This statement fails to mention, however, that Brazil was not entitled to the Article IV privilege because it had not ratified the NPT.

INDIAN NUCLEAR COOPERATION WITH VIETNAM, 1999

On January 19, 1999, India and Vietnam initiated nuclear cooperation by signing an agreement on cooperation in the peaceful uses of nuclear energy.[152] This deal authorized India to construct a "Nuclear Training Center" in Dalat and provide training to Vietnamese scientists at Indian nuclear facilities (Suryanarayana, 1999). After the conclusion of this agreement, Indian Prime Minister Vajpayee asserted that "science and technology…are the backbone of a modernizing society and India is pleased to assist Vietnam in this direction. I am glad cooperation in the area of peaceful uses of nuclear energy is progressing well" (Baruah, 2001). Nuclear cooperation became a subject of interest during bilateral meeting subsequent to 1999.

[152] The 1999 agreement was signed under the framework of the 1986 Indo-Vietnamese agreement for nuclear cooperation.

For example, a joint statement issued on May 2, 2003 called for additional cooperation in the area of nuclear power (Voice of Vietnam, 2003). To date, however, these sentiments have yet to yield further tangible nuclear cooperation.

The historical record indicates that India initiated nuclear cooperation as a means to foster stronger relations with Vietnam to counter the influence of China in Southeast Asia. In the early 1990s, Indian Prime Minister Narasimha Rao initiated a "Look East" policy to develop stronger economic and political ties to the countries in Southeast Asia. The purpose of this policy was to: (1) institutionalize linkages between India and the Association of Southeast Asian Nations (ASEAN); (2) improve bilateral relations with each of the ASEAN countries; and (3) prevent China from exerting too much influence in the region (Naidu, 2004). India's Look East policy generated a lot of hype but progress was stymied until Prime Minister Vajpayee revived the policy following the 1997-98 Asian economic crisis and began to closely engage several Southeast Asian countries.

Engagement of Vietnam was a component of the Look East strategy. Indeed, Prime Minister Vajpayee stated that Vietnam is a "critical element" of this policy (Yahya, 2003). Vietnam's "geostrategic location" meant that an Indo-Vietnamese partnership would be crucial for a strategy aimed at containing "the hegemonic rise of China" (Singh, 2007). Further, Vietnam and India fought wars with China in 1979 and 1962, respectively, and both countries were threatened by Beijing's growing capabilities. They were especially threatened by China's emerging presence in the Indian Ocean beginning in the late 1990s (Cherian, 2007).

This shared strategic interest (e.g. a desire to counter China's influence) had a salient effect on nuclear cooperation between the two countries (Cherian, 2007). The 1999 nuclear agreement was signed just as both countries' concerns about China's growing presence in the region were escalating.[153] By engaging in nuclear cooperation with Vietnam, New Delhi perceived that it would strengthen its partnership with Hanoi, which in turn would help balance China's growing influence in the region (Batabyal, 2006). India offered nuclear and other forms of assistance to Vietnam beginning in 1999 because it needed Vietnam to serve "as a spear in the Chinese underbelly to counter the threatening Beijing-Islamabad-Rangoon entente now taking shape against New Delhi" (Brooke, 2000). In short, the nuclear deal helped "counterbalance Beijing's fledging military prowess in the region (Kumar, 2007)."[154] At the same time, an Indo-Vietnamese partnership made it harder for Beijing to cultivate a strategic relationship with Hanoi. There is no evidence that Indian leaders wanted to provide Vietnam with nuclear weapons in order to constrain China's power. Leading Indian strategic thinkers, however, have argued that India should provide additional nuclear technology to Vietnam to impose constraints on Beijing (Karnad, 2002). This is, after all, precisely the strategy that China adopted when it provided nuclear technology to Pakistan as a means to limit India's capabilities (Paul, 2003).

This case is illustrative because even though it was not successfully predicted by my theory, the causal logic underpinning my argument was clearly a motivating factor. This means that support for my theory can be found even in cases where the statistical analysis generates an inaccurate prediction. It also reveals that my measurement of concepts such as "rivalry" and "enemy" is not perfect, although on the whole it is valid.

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[153] Interestingly, both India and Vietnam publicly claim to be developing more friendly relations with China but the actions of both countries are clearly motivated to balance against its growing influence in the region (Cherian, 2007).

[154] India and Vietnam signed several agreements beginning in 1999, including a "15 point" Defense Assistance Agreement (Yahya, 2003).

ITALIAN NUCLEAR COOPERATION WITH IRAQ, 1975

Italy signed a nuclear cooperation agreement with Iraq on January 15, 1976 (Keeley, 2003). The terms of this deal enabled Italy to supply Iraq with a "radiochemistry lab" that would include lead-shielded hot cells and glove-boxes for the remote manipulation of radioactive material (Weisman and Krosney, 1981). This lab's "peaceful" use was the safe handling of highly radioactive substances; but it could also be used to extract plutonium from spent nuclear fuel. In other words, it would provide Iraq with a reprocessing capability, which is one of the keys to building nuclear weapons. Italy provided this facility for a mere $1.67 million—$600,000 less than Italy's initial offer (Weisman and Krosney, 1981: 98). The 1976 agreement also provided the basis for Italy to build four additional laboratories in Iraq, train Iraqi nuclear scientists, and supply 1,767kg of uranium enriched to 2.6%. These additional transactions generated slightly more than $50 million for the Italian firm *SNIA Technit* (Marshall, 1981). Italy completed construction on the radiochemistry lab in 1978 and ended its other nuclear assistance to Iraq following the Israeli raid of Osiraq. Collectively, Italian nuclear assistance to Iraq between 1976 and 1981 was very sensitive in nature. As one U.S. State Department official frighteningly observed, it was "of sufficient magnitude to permit Baghdad to obtain enough plutonium to produce a nuclear weapon in about a year's time" (Weisman and Krosney, 1981: 265). Understanding Italian motivations in selling nuclear technology to Iraq is particularly important given the historical significance of this case.

The empirical evidence reveals that Italy's nuclear cooperation with Iraq was an attempt to secure a stable oil supply (Nye, 1980; Lellouche, 1981; Spector, 1985; Facts on File, 1989). The Italians were "hit hard by the energy crisis, and were even hungrier than the French to export high technology, especially to the Arab oil producers on whom they depended for a large part of their oil supply" (Weissman and Krosney, 1981: 97). Like France, Italy depended on Iraq for about 20 percent of its oil supplies (Weissman and Krosney, 1981:97). Key Italian decision-makers like Umberto Columbo, president of the Italian Nuclear Agency (CNEN), saw Iraq as a "great commercial opportunity" (Gardner, 2005: 255) because it provided Italy with a means to trade nuclear technology for oil. In short, Italian officials concluded that "oil is persuasive" (Wiesman and Krosney, 1981).

A desire to secure a stable oil supply is clearly the most salient factor in explaining Italian-Iraqi nuclear cooperation. A second economic consideration may have also influenced the transactions. The Italian nuclear industry was in its infancy and it was struggling due in part to the lack of demand domestically. Colombo noted that by engaging in nuclear cooperation with Iraq "we are also trying to give our nuclear industry work, and it needs to work if we are to develop it for the future" (Weissman and Krosney, 1981: 97-98). Italy may have perceived that nuclear cooperation with Iraq could kick-start its nuclear industry, but this motivation was not the driving force behind the sales. The nuclear transactions were clearly about oil and not about making money. Italy had to work at near cost and just barely broke even, having agreed to build the nuclear labs for a very modest sum (Weissman and Krosney, 1981).

Unlike France, Italy was a NPT member and it insisted that its nuclear customers accept international safeguards. Iraq ratified the NPT in October 1969 and it was willing to accept safeguards. But it was widely know at the time that Iraq began efforts to acquire nuclear weapons in the early 1970s. Iraqi leader Saddam Hussein routinely proclaimed that "any country in the world that seeks peace and security…should assist the Arabs in one way or another to obtain the nuclear bomb in order to confront Israel's existing bombs...No power can stop Iraq from acquiring technological and scientific know-how to serve its national objectives" (New

York Times, 1981). In response to statements such as this, Colombo stated that Italy would "disassociate itself entirely" from nuclear cooperation if it were found that Iraq was pursuing nuclear weapons (Nucleonics Week, 1981). This was, of course, nothing more than hollow rhetoric. Italy began nuclear cooperation with Iraq in 1976 and continued it until the early 1980s despite being well aware of the proliferation risks. In the end, nonproliferation considerations were largely irrelevant when it came to nuclear cooperation with Baghdad. As Weissman and Krosney (1981: 977) note, because of the oil considerations "the Italians were in even less of a position than the French to turn down a deal that could possibly lead to a bomb for Iraq."

SOVIET NUCLEAR COOPERATION WITH YUGOSLAVIA, 1956-1967

The Soviet Union initiated assistance to Yugoslavia in January 1956, when the two countries signed their first nuclear cooperation agreement. This arrangement permitted Moscow to construct a 6.5MW heavy water moderated reactor at Vinča. As part of the terms of this agreement, the Soviet Union also supplied heavy water and uranium fuel for the reactor (Canada, 1956; Potter, 1985; Potter, Miljanic, and Slaus, 2000). The fuel was not subjected to International Atomic Energy Agency (IAEA) safeguards and Yugoslavia assumed ownership of it upon delivery (Koch, 1997). The Soviets eventually supplied 48.2kg of weapons-grade uranium—nearly enough to manufacture two nuclear weapons—to Yugoslavia (Potter, Miljanic, and Slaus, 2000). Using this Soviet-supplied fuel, the Vinča reactor began operation in December 1959. Following this initial transfer, the Soviet Union and Yugoslavia went on to sign additional nuclear agreements in 1963 and 1975 but Belgrade began to rely increasingly on other suppliers including France and the United States.

During Soviet-Yugoslav cooperation in the 1950s, the government of Josip Broz Tito was pursuing nuclear weapons. The Tito regime proclaimed in January 1950: "we must have the atomic bomb. We must build it even if it costs us one-half of our income for years" (Potter, Miljanic and Slaus, 2000). These ambitions were well known by intelligence agencies around the world by January 1954, before the onset of Soviet assistance (Koch, 1997). Yugoslavia suspended its nuclear weapons program in the early 1960s, but Soviet-Yugoslav nuclear cooperation provides another illustration of how concerns about proliferation can be subordinated to other political objectives.[155] Consistent with Soviet policy at the time, Moscow perceived that it could maintain political control over Yugoslavia's nuclear weapons ambitions to minimize the risk of proliferation (Duffy, 1979).[156]

The evidence reveals that Moscow initiated nuclear cooperation with Yugoslavia as part of its policy of *rapproachement* to improve relations with Belgrade, which had deteriorated during the tenure of Josef Stalin (Ginsburgs, 1960). After World War II, Tito launched an ambitious industrialization plan and worked towards a Balkan alliance to balance against Soviet dominance. These actions alienated Moscow and led to the Soviet Union's disassociation from Yugoslavia in 1948 (Zinner, 1956). Desperate for assistance from other countries, Yugoslavia forged closer relations with the West. Beginning in 1950, it "slowly but steadily built up its economic, military, and diplomatic ties with the Western Powers, capitalizing skillfully on Western interest in keeping it free of Soviet domination" (Central Intelligence Agency, 1955).

After Stalin's death in March 1953, Moscow sought to normalize relations with Yugoslavia. In May 1955, Soviet leader Nikita Khrushchev traveled to Belgrade to improve relations and consolidate peace with Yugoslavia (Zinner, 1956). A joint declaration issued

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[155] Yugoslavia resumed the nuclear weapons program in 1974, following the Indian nuclear test, only to suspend it again in 1987 (Potter, Miljanic, and Slaus, 2000).

[156] This policy was altered in the late 1950s when China used Soviet nuclear aid to acquire nuclear weapons.

during Khrushchev's trip stated that: "the two Governments have agreed to assist and facilitate cooperation among the social organizations of the two countries through the establishing of contacts, the exchange of Socialist experiences and a free exchange of opinions" (Zinner, 1956). Shortly thereafter, Moscow ceased issuing propaganda critical of Tito's regime, reopened communications from Eastern Europe to Yugoslavia, and lifted a blockade on Yugoslav-Soviet Bloc trade (Canada, 1956). An important part of normalizing relations was the assistance offered by Moscow in the development of nuclear energy in Yugoslavia (Ziner, 1956; Ginsburgs, 1960).

By using nuclear aid as an instrument to improve relations with Yugoslavia, Moscow hoped to reintegrate Belgrade into the Soviet Bloc (Central Intelligence Agency, 1956). Short of reintegration, Moscow hoped to weaken Yugoslavia's developing relationship with the West. Soviet nuclear assistance—and foreign aid more generally—to Yugoslavia was "aimed at the destruction or weakening of the existing defense agreements or military alliances which [recipient] countries may have with Western powers" (Peselj, 1964). This strategy proved to be at least partially successful. As a result of "wooing" Belgrade, the Soviet Union "arrested" Yugoslavia's ties with the Western Powers and enhanced opportunities for influence over the Tito regime (Central Intelligence Agency, 1956).

DISCUSSION

The analysis of outliers brings to light some interesting results. As Table 6.2 reveals, four considerations are especially salient in explaining nuclear cooperation in outlying cases. These factors include: (1) a desire to jump-start the domestic nuclear industry; (2) the perceived need to strengthen bilateral relations; (3) an attempt to constrain the capabilities of a threatening state; and (4) securing a stable petrol supply from oil producing states. Other motivations influence nuclear aid in only one case. In one instance (U.S.-Indonesia) nuclear cooperation was aimed at convincing the recipient country to abandon nuclear weapons and in another (Germany-Brazil) it was intended to secure a continuous flow of uranium. These results are significant for a number of reasons.

Table 6.2: The Determinants of Nuclear Cooperation in Outlying Cases

Motivation for Nuclear Cooperation	Cases
Jump-Start Domestic Nuclear Industry	-China-Algeria -Germany-Brazil -Italy-Iraq -U.K.-South Korea
Strengthen Bilateral Relations	-Canada-Romania -India-Vietnam -U.S.-Indonesia -U.S.S.R.-Yugoslavia
Constrain the Capabilities of a Threatening State	-India-Vietnam -U.S.-Indonesia -U.S.S.R.-Yugoslavia
Secure a Stable Oil Supply	-Brazil-Iraq -France-Iraq -Italy-Iraq
Discourage Proliferation	-U.S.-Indonesia
Reserve Assurances of Nuclear Fuel Supply	-Germany-Brazil

First, they reveal that support for my argument can be found even in cases that are not successfully predicted by my statistical model. Two of the four significant motivations to emerge from the analysis of outliers—strengthening bilateral relations and constraining the power of threatening states—are part of my strategic theory of nuclear cooperation. Particularly strong support for my theory comes from the India-Vietnam case. India initiated nuclear cooperation with Vietnam in the late 1990s to develop closer relations with Hanoi in order to constrain the growing influence of China in the region. This cooperation may have also been intended to force Beijing to cope with the possibility that Vietnam, one of its adversaries, might acquire nuclear weapons. Such behavior would be analogous to what China did to India when it provided Pakistan with nuclear assistance, enabling Islamabad to acquire nuclear weapons (Paul, 2003). The outlying cases of nuclear cooperation are those that I least expected to offer support for my theory. That I find evidence in favor of my argument in three outliers suggests that my theory applies to more cases than the statistical analysis leads one to believe. This should inspire further confidence in the robustness of my findings. It also suggests that my key concepts are not precisely measured, which is a common problem in quantitative analysis (Moore, 2006). For example, based on my coding, at the time nuclear cooperation occurred between India and Vietnam they were not military allies, they did not share an enemy, and Vietnam was not a superpower enemy. But an examination of this case reveals Vietnam and India were both threatened by the same state—China—and the presence of a common enemy motivated New Delhi's nuclear aid to Hanoi.

The analysis of outliers further sheds light on the limits of nonproliferation-related explanations of civilian nuclear trade. In 8 of the 10 cases, serious concerns existed regarding the recipient state's commitment to norms of nonproliferation. Iraq, Algeria, Brazil, and Yugoslavia all had active nuclear weapons programs at the time they received civilian nuclear assistance. South Korea and Indonesia did not have active weapons programs at the time nuclear cooperation occurred, but there were concerns that both of these countries would use civilian technology for military purposes. In each case, the supplier was well aware that their assistance might be used to acquire nuclear weapons. In some instances—especially the U.S.-Indonesia case—suppliers voiced reservations about these proliferation risks. But ultimately suppliers went through with nuclear cooperation despite these qualms because the perceived economic and/or strategic gains of assistance outweighed fears of contributing to proliferation. This provides further evidence in favor of my argument that nuclear suppliers will provide nuclear aid to countries that are pursuing nuclear weapons or that have not signed the NPT if doing so is otherwise in its strategic or economic interests.

While the cases analyzed in this chapter offer some support for my strategic theory of nuclear cooperation, they also illuminate its limitations. The U.S.-Indonesia and U.S.S.R.-Yugoslavia cases are illustrative of this. U.S. nuclear aid to Indonesia in the 1960s was intended in part to prevent the Soviet Union from developing close ties with the country. Similarly, Soviet assistance to Yugoslavia was intended to transform its relationship with Belgrade after diplomatic contact was severed in 1948. Moscow was growing worried about increased Yugoslav ties to the West and it used nuclear assistance as a means to improve its relationship with Belgrade while preventing the West from exerting further influence against it. These motivations are consistent with my argument that states use nuclear cooperation as a means to improve bilateral relations, with the overall objective of constraining the power of a third party. However, part of my argument is that supplier states constrain the power of an enemy by providing nuclear technology to states that share the same adversary. This was not the case in either of these instances. U.S. aid to Indonesia was intended to constrain the power of the Soviet Union (a U.S. enemy), but Indonesia was not threatened by Moscow. Similarly, Soviet assistance to Yugoslavia was intended to prevent the United States (a Soviet enemy) from influencing that country, but Belgrade was not an enemy of Washington. This suggests that suppliers can use nuclear assistance as a means to constrain the power of a state they are threatened by even if the recipient state does not share its threat perception. Supplier states may do so if they believe that a state they are threatened by is also seeking to influence the recipient state. In other words, if an exporting state and one of its enemies are competing for influence against the same state, it may offer nuclear assistance as a means to stymie the enemy's efforts. While partially consistent with my argument, this logic is fully not captured by it.

One of the primary purposes of this chapter is to determine whether there is a variable that is important in explaining nuclear cooperation that I omitted from my statistical analysis. The examination of outliers reveals two new variables that could be salient in explaining nuclear cooperation. The first is whether the importing state is an oil producer. Previous research finds that states export strategic commodities such as arms to states that are oil producers in order to receive oil imports on favorable terms (e.g. Chan, 1980; Snider, 1984). The analysis of outliers suggests that this logic might translate to civilian nuclear cooperation. In three of the cases analyzed in this chapter—Brazil-Iraq, France-Iraq, and Italy-Iraq—the supplier provided nuclear assistance to secure a stable supply of oil from the recipient country. When Brazil, France, and Italy assisted the Iraqi nuclear program in the 1970s they were heavily dependent on imports to meet their energy needs and they were "madly scrambling to secure oil supplies" (Weisman and Krosney, 1981: 90). The 1973 Yom Kippur War and the subsequent Arab oil embargo provided uncertainty about the future sources of petrol. All three suppliers provided nuclear aid to Iraq with the explicit expectation that doing so would increase its oil imports from Baghdad at a time when energy imports were hard to come by. In these three cases, this motivation was more salient in motivating nuclear cooperation than any other political or economic consideration. These examples suggest that an alternative hypothesis for nuclear cooperation:

Alternative Hypothesis 1: *Suppliers are more likely to export nuclear technology to states that are oil producers.*

The analysis of outliers also reveals that states sometimes engage in nuclear cooperation due to a perceived need to break into the market. For example, part of the reason Italy provided aid to Iraq was because its nuclear industry was relatively small and it felt a need to compete with more established suppliers such as the United States. Similarly, China exported nuclear technology to Algeria because it was a relatively new supplier and needed to jump-start its domestic industry. Interestingly, a desire to break into the nuclear market also influenced Indo-Canadian nuclear cooperation in the 1950s—a case that was successfully predicted by my theory—although this was by far not the most influential consideration. These examples indicate that relatively new suppliers are heavily influenced by economic considerations and look for opportunities to establish themselves as a legitimate and reliable provider of nuclear technology. These considerations force them to export technology to states that they otherwise would not due to proliferation risks or other political concerns. If this logic is correct, emerging suppliers should behave differently than well-established suppliers:

Alternative Hypothesis 2: *Emerging suppliers are less likely than established suppliers to export nuclear technology in pursuit of strategic objectives.*

STASTICAL ANALYSIS OF ALTERNATIVE HYPOTHESES

In this section, I use statistical analysis to test the two alternative hypotheses articulated above. I begin by replicating the analysis I conducted in Chapter 4 with a variable operationalizing Alternative Hypotheses 1 included in the statistical model. To determine whether a state is an oil producer, I consult data compiled by Fearon and Laitin (2003).[157] I create a dichotomous variable that is coded 1 if the importing state is an oil producer and 0 otherwise. Then I estimate the model from Chapter 4 separately for established and emerging suppliers based on categorizations of exporters provided by Potter (1990).[158]

Table 6.3 displays the results of the analysis testing whether oil supply has a significant effect on nuclear cooperation. Column 1 displays the complete model presented in Chapter 4. Column 2 displays the complete model with the oil variable added. Column 3 displays a trimmed model including the variables operationalizing the supplier's security interests and the oil variable. Column 4 displays a model including only the oil variable and the controls for temporal dependence. Finally, Column 5 displays a model identical to the one presented in Column 2 but that only includes observations between 1973 and 1979.

Some interesting results emerge from this analysis. In Columns 2 and 3, whether the importing state is an oil exporter has no statistically significant effect on the probability of nuclear cooperation. Equally noteworthy, including the oil variable in these two models does not change the results of the other variables. This suggests that oil-for-nuclear technology swaps do occur but that on average they are not a compelling determinant of nuclear cooperation. Further evidence against Alternative Hypothesis 1 is presented in Column 4. In a bivariate model including only the oil variable and the controls for temporal dependence, oil exporters are statistically *less* likely to be on the receiving end of nuclear cooperation agreements. This

[157] Fearon and Laitin (2003) define a country as an oil exporter if its oil exports exceed one-third of its total export revenues in a particular year. They rely on data from the World Bank to construct this measure.

[158] According to Potter's (1990) list, emerging suppliers include: Argentina, Brazil, India, Israel, Japan, Pakistan, China, South Africa, South Korea, and Spain.

suggests that oil producers have less of a demand for nuclear technology since they can meet their energy needs through alternate sources.

As Column 5 reveals, however, during the period 1973-1979 oil exporters were statistically more likely to be on the receiving end of nuclear cooperation agreements. Although all of my explanatory variables retain their statistical and substantive significance—except for the superpower rival variable—this suggests that oil-for-nuclear technology swaps were prominent features of the mid to late 1970s. This was the period when many countries were worried about securing a stable oil supply following the Yom Kippur War and the Arab embargo. This result suggests that when nuclear suppliers are desperate, they will provide nuclear technology to oil exporters. But on the whole, the evidence presented in Table 6.3 fails to offer significant support for Alternate Hypothesis 1. The lack of sizable support for another possible competing explanation inspires greater confidence in my strategic theory of nuclear cooperation.

Table 6.3: Effects of Oil on Nuclear Cooperation Agreements

	(1) Full Model	(2) Full Model & Oil	(3) Oil & Supplier's Security	(4) Oil Bivariate	(5) Full Model & Oil, 1973-1979
Oil		0.072	0.128	-0.345**	0.485**
		(0.107)	(0.132)	(0.143)	(0.228)
Supplier's Security					
Shared Enemy	0.192**	0.214**	0.705***		0.333*
	(0.094)	(0.095)	(0.104)		(0.185)
Superpower Rival	0.504***	0.497***	0.834***		0.637***
	(0.081)	(0.081)	(0.092)		(0.223)
Alliance	0.801***	0.839***	1.429***		0.561***

	(0.086)	(0.087)	(0.096)		(0.168)
Democracy	0.256***	0.248***	1.073***		0.326**
	(0.072)	(0.072)	(0.084)		(0.156)
Conflict	-1.190***	-1.114***	-1.129***		--
	(0.400)	(0.406)	(0.405)		--
Supply/Demand Controls					
Supplier GDP	0.000***	0.000***			0.000***
	(0.000)	(0.000)			(0.000)
Importer GDP	0.000***	0.000***			0.000***
	(0.000)	(0.000)			(0.000)
Supplier Nuclear	0.474***	0.462***			0.381***
Resources	(0.056)	(0.056)			(0.115)
Importer Nuclear	0.407***	0.409***			0.334***
Resources	(0.026)	(0.026)			(0.051)
Energy Demand	0.009*	0.007			-0.002
	(0.005)	(0.005)			(0.009)
Oil Price	0.003**	0.003**			0.002
	(0.001)	(0.001)			(0.004)
Distance	-0.000***	-0.000***			-0.000**
	(0.000)	(0.000)			(0.000)
Importer's Security Controls					
Regional NCAs	0.296***	0.292***			0.341*
	(0.098)	(0.098)			(0.195)
Rivalry Involvement	-0.342***	-0.358***			-0.044
	(0.067)	(0.068)			(0.147)
Nonproliferation Controls					

Nuclear Weapons	0.422***	0.433***			-0.469**
	(0.085)	(0.087)			(0.219)
NPT	0.399***	0.407***			0.542**
	(0.092)	(0.093)			(0.244)
NSG	-0.190***	-0.192***			-0.294
	(0.068)	(0.069)			(0.187)
Constant	-8.545***	-8.497***	-3.502***	-2.054***	-7.831***
	(0.370)	(0.367)	(0.094)	(0.114)	(0.846)
Observations	138056	134377	135121	135666	20489

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parentheses. Results for years passing without signing of nuclear cooperation agreement and 3 cubic splines are not reported in the interest of space.

Table 6.4 presents the results of the analysis testing whether emerging and established nuclear suppliers behave differently. Column 1 and Column 2 displays models that only include emerging suppliers in the sample. Column 1 includes all variables in the model while Column 2 includes only variables related to the supplier's security interests. Columns 3 and 4 display these same full and trimmed models, respectively, but only include established suppliers in the sample.

The results presented in Table 6.4 reveal many similarities between the results displayed in Columns 1-4. The Shared Enemy, Superpower Enemy, and Military Alliance variables have statistically significant effects on the probability of nuclear cooperation in all four models. There are two minor differences across the four models. In Column 1, the variable measuring whether the importing state is a democracy is statistically insignificant, suggesting that emerging suppliers are not more likely to provide nuclear assistance to democratic states. Also, in Column 2, the variable measuring whether the exporting and importing states are involved in a militarized dispute is statistically insignificant, suggesting that this has no effect on the probability of nuclear cooperation. Despite these slight differences, the results reveal that emerging and developed suppliers behave roughly the same. In other words, security considerations do not appear to influence one type of supplier more than the other. Thus, this analysis fails to support Alternate Hypothesis 2, which is that emerging suppliers will behave differently than established suppliers due to pressures to become a player in the nuclear marketplace. Instead, it further supports my argument that suppliers' strategic interests drive civilian nuclear cooperation.

Table 6.4: Effects of Independent Variables on Nuclear Cooperation for Emerging and Developed Suppliers

	(1) Full Model, Emerging Suppliers	(2) Trimmed Model, Emerging Suppliers	(3) Full Model, Developed Suppliers	(4) Trimmed Model, Developed Suppliers
Supplier's Security				
Shared Enemy	0.292*	0.974***	0.267**	0.593***
	(0.166)	(0.207)	(0.105)	(0.113)
Superpower Rival	0.329**	0.894***	0.575***	0.800***
	(0.160)	(0.154)	(0.088)	(0.113)
Alliance	1.279***	1.718***	0.544***	1.101***
	(0.167)	(0.178)	(0.090)	(0.113)
Democracy	0.124	1.111***	0.337***	1.134***
	(0.105)	(0.121)	(0.090)	(0.113)
Conflict	-0.857*	-0.852	-1.353**	-1.436**
	(0.489)	(0.549)	(0.623)	(0.585)
Supply/Demand Controls				
Supplier GDP	0.000***		0.000***	
	(0.000)		(0.000)	
Importer GDP	0.000**		0.000***	
	(0.000)		(0.000)	
Supplier Nuclear	0.780***		0.341***	

Resources	(0.106)		(0.056)	
Importer Nuclear	0.445***		0.402***	
Resources	(0.047)		(0.029)	
Energy Demand	-0.002		0.014***	
	(0.010)		(0.005)	
Oil Price	0.005**		0.002	
	(0.002)		(0.002)	
Distance	-0.000		-0.000	
	(0.000)		(0.000)	
Importer's Security Controls				
Regional NCAs	0.475**		0.210*	
	(0.188)		(0.107)	
Rivalry Involvement	-0.267**		-0.367***	
	(0.115)		(0.082)	
Nonproliferation Controls				
Nuclear Weapons	0.236		0.532***	
	(0.146)		(0.106)	
NPT	0.437***		0.490***	
	(0.154)		(0.107)	
NSG	0.092		-0.350***	
	(0.112)		(0.082)	
Constant	-11.601***	-4.126***	-7.528***	-3.131***
	(0.715)	(0.174)	(0.369)	(0.115)
Observations	72416	72672	65640	66139

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parentheses. Results for years passing without signing of nuclear cooperation agreement and 3 cubic splines are not reported in the interest of space.

CHAPTER 7

CONCLUSION

I set to accomplish three tasks in this dissertation. The first was to advance an argument regarding the relationship between nuclear energy and nuclear weapons. The second was to put forth the first comprehensive, generalizable theory of why states engage in civilian nuclear cooperation. And the third was to test both of these arguments using a new dataset I compiled on civilian nuclear cooperation agreements. The preceding chapters offer robust empirical support for the arguments I advance in this dissertation. In this chapter, I summarize my principal findings and discuss how my argument is relevant to a recent high-profile case of nuclear cooperation between the United States and India. I conclude by offering directions for future research.

FINDINGS

The statistical results presented in Chapter 2 reveal that states receiving civilian nuclear assistance are more likely to begin nuclear weapons programs. More specifically, receiving just *one* additional nuclear cooperation agreement in an average year increases the hazard rate that a state will commence a weapons program by 11%. This is a substantial effect given that it is not uncommon for countries to receive numerous nuclear cooperation agreements in a given year. This suggests that future work on nuclear weapons proliferation should pay greater attention to the role played by civilian nuclear cooperation. Nevertheless, a state's security environment is the most salient factor in explaining states' decisions to begin a nuclear weapons campaign. This finding is consistent with prevailing wisdom of the literature on nuclear proliferation (Sagan, 1996/97; Singh and Way, 2004; Jo and Gartzke, 2007). The evidence presented in Chapter 2 also reveals that countries receiving civilian nuclear assistance are more likely to acquire nuclear weapons because peaceful cooperation lowers important technical barriers. These findings suggest that even seemingly "innocuous" nuclear cooperation such as providing training to nuclear scientists or supplying power/research reactors could produce deleterious effects. This has implications for the literature on nuclear proliferation (e.g. Sagan 1996/97; Paul, 2000; Singh and Way, 2004; Jo and Gartzke, 2007; Solingen, 2007; Kroenig, 2008) because it suggests that the links between the peaceful and military uses of the atom are much broader than was previously believed.

The results presented in Chapter 2 underscore that if we want to understand how nuclear weapons spread, we need to understand civilian nuclear cooperation. In Chapter 3, I argue that nuclear cooperation is a means for supplier states to strengthen alliance ties and forge partnerships with states that can help it balance the power of its adversaries. In this sense, it serves as an instrument of states' grand strategies. The statistical results presented in Chapter 4 lend robust support for this argument. They also fail to offer support for alternative explanations rooted in nuclear nonproliferation. States that sign the nuclear Nonproliferation Treaty (NPT) are actually less likely to receive civilian nuclear assistance and states pursuing nuclear weapons are more likely to receive such aid.

In Chapter 5, I analyze three cases that were successfully predicted by my argument. These include Canadian nuclear cooperation with India between 1958 and 1976, Soviet nuclear cooperation with Libya between 1975 and 1986, and U.S. nuclear cooperation with Iran between 1957 and 1979. I analyzed these cases in order to determine whether the causal mechanisms I specified operated correctly in particular cases. This is important because multiple causes can often lead to the same outcome (e.g. King, Keohane and Verba, 1994). My analysis of these cases confirms that the logic I advanced is quite powerful in explaining civilian nuclear cooperation. U.S. nuclear cooperation with Iran was intended to strengthen Washington's partnership with Iran, which was important because of the country's strategic location and because the United States operated key intelligence facilities in the country. Further, the United States and Iran were both threatened by the Soviet Union and Washington perceived that nuclear assistance was an important component of a broader strategy to make it more difficult for Moscow to exert influence or aggression against Tehran. Concerns about weapons proliferation did not have a salient effect on American-Iranian cooperation, especially at the highest levels of government. Economic motivations were in play—the proposed deal to export between 6-8 reactors in the 1970s would have generated $6.4 billion for U.S. companies—but they were not the dominant force driving nuclear assistance. Similarly, my analysis of Soviet cooperation with Libya suggests that the logic I advance is powerful in explaining nuclear assistance. The evidence reveals that this cooperation was perceived to be an important means to strengthen Moscow's partnership with Tripoli to counter the influence of the United States and Israel. Nonproliferation considerations were not salient, since Libya's pursuit of nuclear weapons as early as the 1970s did not derail Soviet assistance. Finally, the driving force behind Canada's cooperation with India was a desire to strengthen the Indo-Canadian partnership and make it more difficult for the Soviet Union to influence New Delhi. Economic motivations were more salient in this case than they were in the other two. Specifically, the Indian sales were perceived by many in Ottawa as an attempt to break into the nuclear market, which was dominated by the United States at the time. Also unlike the other two cases, the Canadian case lends support for my democracy hypothesis. That India was a democracy created considerable trust in Ottawa and inspired confidence that Canadian assistance would not be used to develop nuclear weapons, which is consistent with my argument.[159] Like the other two cases, however, nonproliferation concerns were not particularly relevant. Canada knew that India was pursuing nuclear weapons and that it was one of the staunchest critics of the nonproliferation regime, but cooperation moved forward regardless.

In Chapter 6, I analyze 10 cases that were not successfully predicted by my argument. These cases were nuclear cooperation agreements between: (1) the United States and Indonesia between 1960 and 1965; (2) Brazil and Iraq in 1980; (3) the United Kingdom and South Korea in 1991; (4) Canada and Romania in 1977; (5) China and Algeria between 1983 and 1993; (6) France and Iraq in 1974; (7) Germany and Iraq in 1975; (8) India and Vietnam in 1999; (9) Italy and Iraq in 1975; and (10) the Soviet Union and Yugoslavia between 1956 and 1967. My objective in analyzing outlying cases is to determine whether there is an important variable in explaining nuclear cooperation that I had initially omitted from my analysis. I find that four explanations are salient in explaining nuclear assistance among these cases. Two of these—strengthening bilateral relations and constraining the capabilities of a threatening state—are largely consistent with my theory. This is noteworthy because it suggests that support for my theory can be found even in cases that are not successfully explained by my statistical model. I also uncover two potential alternative explanations as a result of studying outlying cases. The first is that new suppliers behave differently than established suppliers because they face pressures to break into the nuclear market and establish themselves as legitimate exporters. Interestingly, this was also a factor that contributed to Indo-Canadian nuclear cooperation. The

[159] Of course, this faith proved to be misguided since India did use Canadian assistance to conduct in nuclear test in May 1974.

second alternative hypothesis is that oil producing countries are more likely to receive nuclear assistance because suppliers have incentives to engage in oil-for-nuclear technology swamps. I use statistical analysis to test both of these hypotheses and I fail to find strong empirical support for either of them. Ultimately, this should inspire greater confidence that my theory offers the most compelling explanation of civilian nuclear cooperation.

CIVILIAN NUCLEAR COOPERATION TODAY: THE U.S.-INDIA CASE

My project analyzes civilian nuclear cooperation during the period 1950-2000. How relevant is my argument to nuclear assistance taking place today? In this section, I briefly examine the much-publicized nuclear cooperation agreement between the United States and India. A brief review of the available evidence demonstrates that my argument is quite salient in explaining the onset of this cooperation in 2005. The United States viewed nuclear assistance as a crucial component of its strategy to transform its relations with India with an eye towards balancing the capabilities of China in the region. The strategic benefits of nuclear cooperation trumped nonproliferation risks, including the possibility that the arrangement would lead to the collapse of the nuclear nonproliferation regime (e.g. Perkovich, 2005).

The groundwork for the U.S.-India nuclear deal was laid in November 2001 when U.S. President Bush and Indian Prime Minister Singh committed their countries to a strategic partnership. Further momentum towards the deal came in January 2004 when the two leaders established the Next Steps in Strategic Partnership (NSSP) initiative. A major component of this initiative was cooperation in civil nuclear activities, which according to Bush (2004) would "deepen the ties of commerce and friendship between our two nations and…increase stability in Asia and beyond." Then, during Prime Minister Singh's visit to Washington, D.C. in July 2005, President Bush pledged to "achieve full civil nuclear energy cooperation with India" (Squassoni, 2006).

Much has been written about U.S. nuclear cooperation with India in large part because this policy is highly contentious (Perkovich, 2005; Huntley and Sasikumar, 2006; Squassoni, 2006; Tellis, 2006; Blank, 2007; Weiss, 2007). The controversy surrounding Indo-American nuclear cooperation dates back to the 1970s when an international norm emerged that states must make a legal commitment forswearing nuclear weapons by singing the nuclear Nonproliferation Treaty (NPT) in order to receive nuclear technology for peaceful purposes. This norm was bolstered domestically in 1978—in the wake of India's May 1974 "peaceful" nuclear test—when the U.S. Congress passed the Nuclear Non-Proliferation Act (NNPA), which imposed severe restrictions on U.S. nuclear exports and effectively embargoed the sale of nuclear technology, materials, or knowledge to India.[160] The 2005 India deal reverses these policies and permits the sale of nuclear technology to New Delhi for the first time in decades.

The policy reversals required to implement the arrangement created uphill battles for the United States. After announcing its intention to cooperate with India in July 2005, the Bush administration needed to convince Congress to waive certain restrictions contained in the NNPA. After fairly heated deliberations, Congress passed legislation authorizing the necessary revisions, which President Bush signed into law in December 2006. The next hurdle was for Washington and New Delhi to agree to a formal nuclear cooperation agreement, which is required pursuant to the Atomic Energy Act. After months of negotiations, in July 2007, the United States and India finalized the terms of the agreement. The finalized deal enabled "full civil nuclear energy

[160] Specifically, the NNPA required full-scope safeguards as a necessary condition for the supply of nuclear technology.

cooperation" between the two countries (United States, 2007). This includes, but is not limited to, cooperation in: (1) advanced nuclear energy research and development; (2) nuclear safety matters; (3) technical exchanges of nuclear scientists; (4) technical transfer on industrial or commercial scale involving nuclear reactors and aspects of the nuclear fuel cycle; (5) developing a strategic reserve of nuclear fuel for India's reactors; (6) supplying fuel for nuclear reactors; and (7) research on controlled thermonuclear fusion (United States, 2007). As this list of activities reveals, the agreement permits comprehensive cooperation in the area of nuclear energy. In exchange for this cooperation, India agreed to a number of measures which the United States claims will bolster nonproliferation efforts (e.g. Bush, 2006). Specifically, New Delhi agreed to identify and separate its civilian and military nuclear facilities, declare its civilian facilities to the International Atomic Energy Agency (IAEA), voluntarily place its civilian facilities under IAEA safeguards, and sign an Additional Protocol for civilian facilities. It further agreed to continue a unilateral moratorium on nuclear testing, work with the United States to conclude a Fissile Material Cutoff Treaty (FMCT), refrain from spreading uranium enrichment and plutonium reprocessing facilities, and implementing comprehensive export control legislation in accordance with the guidelines of the Missile Technology Control Regime (MTCR) and the Nuclear Suppliers Group (NSG) (Bush and Singh, 2005).

Significant hurdles still remain. Most notably, India must negotiate a safeguards agreement with the IAEA, the Nuclear Suppliers Group must agree to make an exception to its guidelines to allow cooperation with India, and the U.S. Congress must formally approve the text of the July 2007 agreement. At the time of this writing, these remaining obstacles had not been overcome.

What explains U.S. interest in cooperating with India? A review of statements made by key U.S. officials offers a clear sense of why Washington is willing to sell nuclear technology to India—even though doing so requires the reversal of decades-old policies. In short, the United States wants to transform its relationship with India and it believes that nuclear cooperation will help make this happen. The principal reason why Washington wants to strengthen its partnership with New Delhi is to balance the rising influence of China in Asia. This is a view shared by nonproliferation experts (e.g. Perkovich, 2005; Weiss, 2007) and supported by commentary from Bush administration officials.[161] In testimony before Congress in April 2006, U.S. Secretary of State Condoleeza Rice stated that nuclear cooperation with India was an attempt to "seize this tremendous opportunity to solidify a key partnership that will advance American interests." According to Rice (2006), India was a strategically important country because it is "a rising global power that can be a pillar of stability in a rapidly changing Asia." Nicholas Burns, the U.S. Undersecretary of State for Political Affairs and the key negotiator of the 2007 agreement, echoed these sentiments. Burns (2007) stated: "there is a tremendous strategic upside to our growing engagement with India. That is why building a close U.S.-India partnership should be one of the United States' highest priorities for the future. It is a unique opportunity with real promise for the global balance of power." He went on to emphasize that the nuclear cooperation agreement is a crucial means to "deepen the strategic partnership" (Burns, 2007). Burns further emphasized this when he argued that "the real importance of [nuclear cooperation with India] is not just the nuclear aspect; it's the wider implications for the benefit to the United States

[161] Some scholars have speculated that the India nuclear deal is intended to bolster New Delhi's nuclear weapons program by allowing it to reserve indigenous uranium resources for weapons production (Weiss, 2007). Statements from administration officials fail to substantiate this claim, although the agreement is clearly intended to court an ally and counter China's rising influence.

strategically of having this huge democratic power now very close to the United States and us close to them" (Dinan, 2006). Robert Joseph (2005), the Undersecretary of State for Arms Control and International Security, made points similar to those raised by Rice and Burns in testimony before Congress in November 2005:

> "We believe it is in our national security interest to establish a broad strategic partnership with India that encourages India's emergence as a positive force on the world scene. Our desire to transform relations with India is founded upon a contemporary and forward-looking strategic vision. India is a rising global power and an important democratic partner for the United States."

Bush administration officials cited other justifications for nuclear cooperation with India. For example, Secretary Rice (2005) suggested that nuclear assistance to India would "enhance energy security…further environmental protection, and increase business opportunities for both of our countries." These motivations were of secondary importance compared to the strategic objectives described above. This is evident from Rice's (2005) statement that these aforementioned objectives "must be viewed in the still larger, greater context of how this initiative elevates the U.S.-India relationship to a new strategic level." Thus, transforming the Indo-American relationship was not the only motivation for nuclear cooperation, but it was the most important.

Although the U.S.-India nuclear deal falls outside the scope of my study, the preceding evidence reveals that my argument is quite powerful in explaining it. This is noteworthy because it indicates that my theory remains relevant to nuclear cooperation in the present era. It is also significant because it reveals that my argument can explain one of the most high-profile, controversial nuclear agreements that has been signed in recent memory.

DIRECTIONS FOR FUTURE RESEARCH

In this dissertation I shed light on important questions related to civilian nuclear cooperation and its relationship to nuclear weapons. But my analysis also raises a number of interesting questions that future research should address. First, my study of nuclear suppliers' behavior brings to light an interesting paradox. In general, supplier states want to minimize the likelihood that their transfers will contribute to proliferation, yet their behavior often *maximizes* this risk. What accounts for this apparent contradiction in policy? The answer may have to do with the time horizons that states and national leaders adopt when making decisions on nuclear cooperation. More specifically, decision-makers appear to base their choices on short term interests and ignore long term consequences of their actions. A growing body of literature in the field suggests that leaders consider the effects that various decisions will have on their ability to stay in power, which may or may not be consistent with the state's security-maximizing objectives (e.g. Reiter and Stam, 2002; Bueno de Mesquita et al, 2003). If leaders are concerned primarily with staying in power, this could encourage them to pursue short term gains despite potential long term risks. Whether not this explains state behavior in the area of civilian nuclear cooperation is something that future work should consider.

A related question is how often short term gains and long term consequences, respectively, arise from peaceful nuclear aid. My research shows that states play a dangerous game, but it does not shed light on whether this is an effective strategy. It would be interesting to examine the number of cases where civilian nuclear cooperation results in strategic benefits vis-à-vis the number of cases where it leads to long-term security losses. My analysis of nuclear cooperation between Canada and India, the United States and Iran, France and Iraq, among others reveals that peaceful atomic aid often backfires as a strategy aimed at achieving strategic objectives. Future work should conduct research on the cases of nuclear cooperation I have identified to determine what whether they can be identified as "successful" or "not successful" when it comes to strengthening alliance ties and fostering strategic partnerships. This judgment should also be weighed against the proliferation-related consequences of the cooperation. If it turns out that this strategy fails in the majority of the cases, the previously described paradox becomes even more interesting.

In this study, I have demonstrated that one consequence of civilian nuclear cooperation is that it encourages countries to begin nuclear weapons programs. There are other potential consequences of nuclear assistance that are worthy of examination. Most notably, does it make radiological or nuclear terrorism more likely be making materials more available and introducing targets of opportunity?[162] Since nuclear terrorism poses a greater risk to national and international security than any other threat (e.g. Bush and Putin, 2003) it is worth considering whether civilian nuclear cooperation makes this type of event more likely. Evidence that this was the case would provide an additional reason to be cautious about promoting civil nuclear programs around the globe. Despite the risks of nuclear assistance, it offers a number of potential benefits that future research should explore. For example, does civilian nuclear assistance reduce carbon emissions in the importing state, making it productive from an environmental standpoint? This is a worthwhile question given current concerns about global warming and developing recognition of the links between environmental degradation and international security (e.g. Soroos, 1994; Homer-Dixon, 1994). Civilian nuclear cooperation might also affect bilateral relations in a productive way. Previous research has suggested that international trade can foster interdependence and promote peace (e.g. Russett and Oneal, 2001).

[162] See Bryan Early, Matthew Fuhrmann and Quan Li (2008).

This might be especially true of nuclear cooperation because it is such a high-profile area of cooperation and creates many linkages among constituencies in the cooperating countries.[163]

My study demonstrates that civilian nuclear cooperation is an instrument states use to strengthen their alliances and form partnerships to balance the capabilities of threatening states. I argue that peaceful atomic aid is well suited to achieve these objectives because it is a highly salient issue that is capable of transforming relations, as the U.S.-India arrangement illustrates. But there are other tools countries have in their toolbox that can also be used in pursuit of these goals. Different policies can be directed towards these same objectives because they act as substitutes for one another (e.g. Most and Starr, 1989). Arms transfers, military assistance, aid for economic development, and humanitarian support are all potential instruments of "soft balancing" (e.g. Paul, 2005) because they are tool short of alliances that could constrain the capabilities of a potentially threatening state. Indeed, previous research has suggested that foreign aid is a means to entice allies to remain in alliances and achieve strategic goals such as containing the influence of an adversary (e.g. Wittkopf, 1972; Meernick, Krueger, and Poe, 1998). This raises a number of additional questions that future research should consider. Is civilian nuclear cooperation a *compliment* to other policies or is it a *substitute*? In other words, do states use nuclear aid in conjunction with other strategies or instead of them? If it compliments other approaches, how does it do so? If it is a substitute for other tools, why would a country choose it to meet strategic objectives rather than arms transfers or other types of foreign aid? What is the relationship between "soft" and "hard" balancing strategies? In particular, do states view nuclear cooperation as a substitute for military alliances? Answers to these types of questions could contribute to efforts aimed at better understanding how countries

[163] For more on this point see Bratt (2006).

choose among various policies that could produce a similar result (e.g. Palmer, Wohlander and Morgan, 2002).

Finally, this project highlights the importance of the dual-use dilemma. In short, technology, materials, and knowledge intended for peaceful purposes can ultimately contribute to military programs. The evidence presented here reveals that civilian assistance encourages states to pursue nuclear weapons and proliferators are able to manipulate peaceful cooperation to aid their bomb programs, once they have begun. Future research should explore whether there areas other than nuclear technology where we see countries using commercial or "peaceful" activities to contribute to military ends. Much of what is needed to build sophisticated military technology is dual-use in nature (Brooks, 2005). Does the same type of relationship I found in the nuclear arena translate to conventional military weaponry? For example, do countries attempt to develop competence in industries that are particularly relevant for the production of military equipment? It would also be interesting to explore cross-national variation in awareness of the dual-use dilemma. Do some countries care about this dilemma more than others? If so, what accounts for this variation? This is an especially relevant question in light of United Nations Security Council Resolution 1540, which was passed in March 2005 and requires all states to place restrictions on dual-use items that could be used to manufacture nuclear, chemical, radiological, or nuclear (CBRN) weapons.[164]

[164] For more on Resolution 1540 see Fuhrmann (2006).

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