Codebook and Data Notes for "Determinants of Nuclear Weapons Proliferation: A Quantitative Model"

Dong-Joon Jo[†]
University of Seoul

Erik Gartzke[‡]
Columbia University

September 2006

The following are data notes for the article titled "Determinants of Nuclear Proliferation: A Quantitative Model" (*Journal of Conflict Resolution*, February 2006, Forthcoming).

A. Nuclear Weapons Status and Nuclear Weapons Programs

Nuclear proliferation can be seen as occurring in two stages, the development of a nuclear weapons production program and the actual possession of weapons. The first stage, the presence of nuclear weapon programs, is (or at least has been) a *de facto* precondition for the manufacture and possession of nuclear weapons. States intending to join the nuclear club must develop and maintain their own nuclear weapons programs as long as they are intent on ascending to nuclear status. The second stage involves actual nuclear weapons possession. The five major powers proceeded to develop nuclear devices almost as soon as each possessed sufficient nuclear weapons technology. Other states have maintained nuclear opacity for a certain period time or refrained from manufacturing nuclear weapons, even after they possessed a set of weapons materials and the capability to make nuclear weapons. For instance, India refrained from making nuclear weapons until the late 1980's, in spite of the fact that it had demonstrated a mature capability to build a nuclear device in 1974. We therefore treat possession as a distinct phase from the intention to seek nuclear weapons development through nuclear weapons programs (Levite 2002, 69-73).

Secret nuclear activities make it controversial to discern whether states have nuclear weapons programs and whether these states have nuclear weapons. To attempt to reduce the subjectivity of our coding effort, we adopt the following rules. We regard the year in which the highest decision maker in a given state authorized a nuclear weapons program as the year in which the state first possesses a nuclear weapons program. Similarly, we assume that the year in which the highest decision maker terminated an existing nuclear weapons program is effectively the final year of the program. Reasonably reliable dates are available for declared nuclear states' nuclear weapons programs. Little if any clear information can be obtained for non-declared states, however, since such programs are often of necessity clandestine.[1] For unofficial nuclear weapons states (nuclear weapons programs that are not

† Assistant Professor. Department of International Relations. Email: dxj124@uos.ac.kr
‡ Associate Professor. Department of Political Science. Email: gartzek@columbia.edu

[1] Australia and Egypt are coded as not having a nuclear weapons program. Australia's participation in the British nuclear weapons program in the 1950's is not its own independent project, but a joint project led by the United Kingdom (Reynolds 2000). Egypt's nuclear ambitions in the late 1950's and 1960's never materialized in the form of an actual nuclear program, as Egypt failed to acquire large nuclear reactors needed to produce plutonium (Einhorn 2004, 45-48).

recognized in the NPT), we adopt the year in which a suspect state's nuclear activities[2] are seen to increase noticeably as the beginning year of their weapons program.

We code the following countries as possessing nuclear weapons programs (for the periods listed):

United States (1942 -)[3]
President Roosevelt authorized a National Defense Research Committee plan to develop nuclear weapons on January 19, 1942. The Committee made its proposal to the President on November 27, 1941 (Nichols 1987, 34).

USSR/Russia (1943 -)[4]
The State Defense Committee resolved to begin a nuclear weapons program in February 1943. The Academy of Science was then instructed to prepare Laboratory No.2 at Kurchatov (Holloway 1994, 88-96).

United Kingdom (1941 -)[5]
The United Kingdom's nuclear weapons program began with the "Directorate of Tube Alloys" project in October 1941. On September 3, 1941, Prime Minister Winston Churchill and the military chiefs of staff decided to give priority to nuclear weapons and launched the project in October 1941. The United Kingdom maintained an independent program but later joined the Manhattan project (Goldschmidt 1990, 124-135).

France (1954 -)[6]
Prime Minister Pierre Mendes-France authorized a nuclear weapons program on December 26, 1954. The Bureau of General Studies was established for weapons development on December 28, 1954 (Sublette 1999).

China (1956 -)
Chairman Mao Zedong presided over a Central Secretariat meeting on January 15, 1956 in

---

[2] Nuclear activities include nuclear reactor construction or purchase, uranium milling or enrichment plant construction, and plutonium reprocessing facility construction, but exclude small nuclear research reactor construction or purchase intended (and used) for basic nuclear research.

[3] Nuclear weapon activities of the United States can be traded back to the Uranium Committee set up by President Roosevelt in response to Dr. Einstein's letter. However, there was no concrete nuclear activity prior to the establishment of the Office of Scientific Research and Development (OSRD) on June 28, 1941 (Nichols 1987).

[4] The USSR established a Commission on the Uranium Problem on July 30, 1940, following a memorandum from Vladimir I. Vernadskii and Vitalii G. Khlopin to Nikolai Bulganin, deputy premier and chairman of the Council on the Chemical and Metallurgical Industries on July 12, 1940 (Holloway 1994, 61-62).

[5] The United Kingdom established the Thomson Committee in April 1940 with government funds. The Committee was to conduct a pilot study of nuclear weapons and was later upgraded to the MAUD committee (Clark 1961, 74-94).

[6] French nuclear weapon activities may go back even before World War 2. Frederic Joliot-Curie and his colleagues in the College de France obtained a patent on a, "Method for Perfecting Explosive Charges" from the National Center of Scientific Research in May 1939. Though the patent was to build nuclear explosives, French decision-makers were not aware of the potential for nuclear devices at that time (Clark 1961, 28; Goldschmidt 1990, 50-51).

which it was decided to start the "02" project, the first Chinese nuclear weapons program (Lewis and Litai 1988, 38-39).

Israel (1955 -)
Israeli defense minister Ben Gurion began a nuclear weapons program in 1955. The Research and Planning Division (EMET) recruited nuclear scientists for a "most secret national project" (Cohen 1998, 43). We code 1955 as the start date for Israeli weapons programs based on circumstantial evidence. We code Israel as a *de facto* nuclear state in 1966, when Israel was ready to assemble all necessary weapon components (Ibid., 232).[7]

India (1964 - 1965, 1972 -)
Prime Minister Shastri authorized the Subterranean Nuclear Explosive Project in late 1964 and tried to keep it as "peaceful" prior to his death on January 10 1966 (Perkovich 1999, 82-112). Prime Minister Indira Gandhi revoked the project in 1966 and kept Indian nuclear program for peaceful purposes. Later she changed her nuclear policy and authorized another nuclear explosive project in 1972 (Ibid., 166-170).[8] After exploding a nuclear device in 1974, India refrained from possessing nuclear weapons, while slowly increasing its nuclear weapon capabilities. Finally, India came to possess nuclear weapon components, which were ready for "quick assembly and potential dispersal to air base" in 1988 (Ibid., 293). So, we code India as a *de facto* nuclear state beginning 1988.

South Africa (1971 - 1990)
The Minister of Mines permitted the Atomic Energy Board (AEB) to investigate nuclear weapon devices in 1971 and the agency tested a nuclear device at Somchem in May 1974. In the same year, Prime Minister John Vorster instructed the AEB to develop a nuclear explosive capability and search for nuclear test sites. South Africa finally got its first nuclear weapon in 1979 and manufactured advanced nuclear weapons in the 1980's. President de Klerk decided to stop producing additional nuclear weapons in November 1989 and instructed officials to terminate the nuclear weapons program and dismantle existing nuclear devices on February 26, 1990. When it signed the NPT on July 10, 1991, South Africa had no more nuclear weapons (Albright 1994).

Pakistan (1972 -)
Pakistan began a nuclear weapons program in 1972, when Prime Minister Bhutto revealed his intention to develop nuclear weapons to a group of nuclear scientists and key aides at Multan and started recruiting nuclear scientists for nuclear weapons program (Wiessman and Krosney 1981, 43-46). Regarding Pakistan's possession of nuclear weapons, we code Pakistan as a *de facto* nuclear state beginning 1987, when Dr. Abdul Qadir Kahn strongly hinted at Pakistan's nuclear weapons capability.

---

[7] Pinpointing the date of *de facto* nuclear status remains controversial. We use the criteria of whether a state has necessary nuclear weapon components ready to be assembled. Cohen (1998) argues that Israel got its first nuclear device in 1967 and deployed nuclear weapons in 1969 (based on his interviews with key individuals in the Israeli weapons program).

[8] A group of nuclear scientists at the Bhabha Atomic Research Center kept developing nuclear explosives from 1967 to 1971, after Prime Minister Indira Gandhi officially cancelled continued work on the first Indian nuclear explosive project in 1966. Thus, the efforts of the scientists were not officially authorized by the Indian government (Perkovich 1999, 139 – 160).

Germany (1941 - 1945)[9]
The German Army Weapons Research Office issued a patent to make "nuclear reactor-bombs" in 1941 (Rose 1998, 146-154).

Japan (1943 - 1945)[10]
There were four incidents in 1943 that suggest that Japan upgraded nuclear weapons research into lat least one nuclear weapons program. First, a nuclear weapons research team in the Japanese Army's Aviation Technology Research Institute, which Dr. Yoshio Nishina led, decided to use the thermal diffusion process to separate Uranium-235 in mid-March. Second, the nuclear weapons research team finally reached a conclusion that Japan could make nuclear bombs in April 1943. Third, the Japanese Navy also upgraded its nuclear research into the "F-go" project to make nuclear weapons in May 1943, which started in 1942. Finally, at the beginning of 1943 War Minister Hideki Tojo ordered General Toranousuke Kawashima to speed up Japan's Army Air Force Technical Research Institute's nuclear weapons program (Wilcox 1995).

Sweden (1946 - 1969)
Sweden undertook a nuclear weapons program in the early post-World War II period. We code 1946 as the beginning of the Swedish nuclear weapons program, when the Swedish National Defense Institute began marshalling resources for the project. We also code 1969 as the year in which Sweden deactivated its nuclear weapons program. Sweden ratified the Non-proliferation Treaty (NPT) in January 9, 1970 (Cole 1996).

Yugoslavia (1948 – 1963, 1982 – 1987)
Though there is an allegation that the President Tito decided to seek nuclear weapons in the late 1940's, we code 1953 as the beginning of the Yugoslavian nuclear weapons program, when an official document entitled "On Two Essential Conditions for the Development of Atomic Energy Here" mentions "the production of atomic weapons" as one of the two goals of Yugoslavia's nuclear program. President Tito held Yugoslavia's nuclear ambition in the early 1960's. Yugoslavia started a dedicated nuclear weapons program called "Program A" in 1982, when Admiral Branko Mamula was appointed as the Secretary of Defense. The program was terminated on 7 July 1987(Potter et al. 2000).

Taiwan (1967 - 1976)
The Taiwanese Defense Ministry presented a proposal for a nuclear weapons program in 1967. Taiwan got a nuclear reactor from Canada and started building nuclear infrastructure in 1969. Faced with non-proliferation pressures, Taiwan promised not to purchase or build nuclear reprocessing facilities on September 14, 1976. In the same year, Taiwan dismantled its nuclear reprocessing facilities (Albright & Gay 1998).

---

[9] The German War Production Office and the Ministry of Education recruited scientists to begin work on atomic bomb projects in 1939. Later, Germany upgraded its activities to a full-scale nuclear weapons program in 1941 (Rose 1998).

[10] Japanese nuclear weapons interest began in the early phase of World War 2. Lieutenant General Takeo Yasuda, head of the Japanese Army Aviation Technology Institute, assigned nuclear weapons research to the Japanese Physical and Chemical Research Institute in October 1940. The institute gave the assignment to Dr. Yoshio Nishina with funding in December. Finally, the Japanese Army authorized nuclear weapons research to begin in April 1941 (Rhodes 1986, 327, 346).

South Korea (1971 - 1975)
President Park ordered the Weapons Exploitation Committee to explore ways to produce nuclear weapons in 1971. An agreement was signed with France in 1972 to construct a nuclear reprocessing facility (Spector 1984, Mazarr 1995, 27; Meyer 1984, 172). After receiving US guarantees of protection, South Korea ratified the NPT on April 23, 1975.

Iran (1974 - 1978, 1984 -)
We code 1974 as the year that Iran started its nuclear weapons program. Iran's nuclear activities increased dramatically in 1974. Iran established the Atomic Energy Organization of Iran and obtained a 10 year nuclear fuel contract with the United States. The Iranian Revolution and the Iran-Iraq war disrupted the Shah's nuclear weapons program. Even if some figures in Iran's revolutionary government had strong interests in a nuclear weapons program, Iran was unable to resume its nuclear weapons program until 1984 because of the war and because of economic and political disruptions. Around 1984 Iran's nuclear activities increased noticeably. It reopened its isotope separation facility in 1983, opened the Isfahan nuclear research center in 1984, and purchased a nuclear reactor from China in 1985. Given the evidence, we code 1984 as the year Iran resumed its nuclear weapons program (Spector 1990, 203-215; Cordesman 1994, 103-111).

Iraq (1973 - 2002)
We code 1973 as the year Iraq decided to develop nuclear weapons. In that year, Iraq started negotiations to buy nuclear reactors from France. Even though Iraqi nuclear weapon interests may go back to 1970, nuclear activities in the early 1970's were still at a stage of nuclear research (Hamza 2000).

Argentina (1976 - 1990)[11]
Argentina's military junta undertook nuclear activities directly related to nuclear weapon production in the mid 1970's. In 1976, the military regime appointed Navy Captain Castro as CNEA president, who then revealed plans for the Atucha II nuclear power plant. In 1978 the military regime decided to build a plant to reprocess spent fuel and secretly began to build a gaseous diffusion uranium enrichment facility at Pilcaniyeu (Reiss 1995, 46-47; Spector 1990, 223-2234). Considering that decisions usually need at least a fiscal year to be implemented, we coded 1976 as the start of Argentina's nuclear weapons program. President Alfonsin curbed Argentina's nuclear weapon activities, though continuing to keep them alive. He appointed Alberto Constantini to head CNEA but cut the CNEA budget by 40% in 1984. Alfonsin also initiated the nuclear rapprochement toward Brazil. Finally, Argentina and Brazil signed the Joint Declaration of Common Nuclear Policy and discontinued their nuclear weapon activities on November 28, 1990 (Reiss 1995, 52-66).

Brazil (1978 - 1990)
Brazil's direct nuclear weapon efforts go back to the "Solimoes" project in 1978. Facing Argentina's nuclear weapon program in the mid 1970's, Brazil tried to expand its own

[11] Argentina's nuclear weapons interest may go back to 1950, when Argentina established the National Atomic Energy Commission (CNEA). There was an episode of nuclear weapon activities from 1951 to 1952, but it is unclear whether Argentina actually initiated a nuclear weapons program or whether Dr. R. Richter simply tried to showcase his abilities. Considering that the incident ended in Richter's arrest and massive dismissals from his research program, we decided not to count this as an active, officially supported nuclear weapons program (Waisman 1975, 282-283).

nuclear infrastructure by signing a nuclear accord with Germany in 1975. Brazilian military branches had secret "parallel programs," which were not under IAEA control from the late 1970's to late 1980's. President Collor ended Brazilian nuclear weapons projects in 1990 and signed the Joint Declaration of Common Nuclear Policy with Argentina (Reiss 1995, 58-60; Spector 1990, 243-249; Sublette 1999).

Romania (1981-1989)
Romania had a nuclear weapons program in the 1980's, including plutonium extraction facilities that were not subject to IAEA monitoring. After the collapse of the Ceausescu regime in 1989, however, the Iliescu regime ended the nation's nascent nuclear weapons program (Jones & McDough 1988, 11).

North Korea (1982 -)
It is not clear when North Korea decided to start its nuclear weapons program. It seems that North Korea probably launched a concerted effort sometime between 1980 and 1982. We code 1982 as the year in which North Korea initiated its nuclear weapons program, when South Korean intelligence first reported construction activities at Yongbyun (Central Intelligence Agency 1982). Though it officially renounced its nuclear weapons program through the "Agreed Framework" with the United States in 1994, North Korea maintaind a substantial nuclear weapon program using enriched uranium instead of plutonium.

<Table 1 about here>

Table 1 summarizes the results of our coding of nuclear weapons and nuclear weapons program status.[12] There are three groups of states that have active or defunct nuclear weapons programs. The first group is composed of the five declared nuclear states. The United Kingdom, the United States, and the Soviet Union each started nuclear weapons programs during World War 2. France and China each launched their nuclear weapons programs in the 1950's. All five countries have detonated nuclear weapons and have publicly declared their possession of nuclear weapons. Another group of nuclear states is composed of four *de facto* nuclear powers. Israel began a nuclear weapons program in 1955 and probably assembled its first nuclear device in 1967. South Africa started its nuclear weapons program in 1971 and succeeded in producing a weapon in 1979. South Africa produced additional bombs in the 1980's but voluntarily dismantled their program and weapons in 1991. India and Pakistan refrained from publicly acknowledging possession of nuclear weapons until recently, but both countries have been strongly suspected of having nuclear weapons since the late 1980's. The last group, "near nuclear states," is composed of ten states with defunct nuclear weapons programs and two countries that maintain active nuclear weapons programs, but which have yet to develop nuclear weapons.

[12] Levite's coding of nuclear status includes more cases, adding Austria, Canada, Egypt, Indonesia, Italy, Netherlands, Norway, Romania, and Switzerland as "tried but gave up," Belarus, Kazakhstan, and Ukraine as "attained but gave up," and Algeria and Libya as "still trying" (Levite 2002, 62).

B. NUCLEAR WEAPONS PRODUCTION CAPABILITY DATA SET (1939 TO 2002)

This dataset provides latent nuclear weapon production capability estimates for 192 countries from 1938 to 2002 (8278 country-years). Following broadly on Stephen Meyer's approach (Meyer 1984), we identify five resources and two production capabilities: domestic nuclear deposits, metallurgists, chemical engineers, nuclear engineers, electronic/explosive specialists, nitric acid production capabilities, and electricity production capabilities.[13] Using these seven components, we construct a composite measure of latent nuclear weapons production capability by summing the number of resource or capacity categories that a given state satisfies (i.e., sum of "1's").[14] We examined other methods variable construction without substantive changes in the results.[15]

<Table 2 Here>

Variables (files jo_gartzke_0207_nuccap_{version}, in Excel and Stata formats)

CCODE: COW Project's country code.

YEAR: YEAR.

URA_I: It provides information of whether a given country has potential nuclear explosive materials for nuclear weapons. Its indicator is whether a given country has known uranium deposits or produced uranium already. We have employed Organization for Economic Co-operation and Development (1968, 1969 – 2004), Helmreich (1985), Modelski (1959) for Eastern European countries, Wilson and Litai (1988) for China, Nuri (1984) for Pakistan, Cordesman and Hashim (1997) for Iran, Cohen (1983) for Israel, and Wilcox (1995) for Japan and North Korea.

METAL_I: It represents metallurgical capability to process excavated uranium ores. Its indicator is whether a given country produces crude steel or aluminum. The data come from UN Statistical Yearbook (various years).

---

[13] Meyer lists "resource demand components for the base case (low-technology) weapons program" including "previous mining activity, indigenous uranium deposits, metallurgists, nuclear graphite (production capacity), chemical engineers, nitric acid (production capacity), nuclear engineers/ physicists/chemists, electronics/explosive specialists, capital costs of various plant facilities, initial operating costs of the process plants, research, development, testing and engineering costs, steel, construction workforce, cement/concrete, and electricity." Meyer assesses national latent nuclear capability by checking whether a given country meets 10 demands (7 resources and 3 production capacities) (Meyer 1984, 173-186). Similarly Stoll (1996) offers a measure of latent nuclear weapons production capability for 68 countries from 1946 to 1992 (2905 country-years). Stoll assumes that uranium has been available to all countries since 1970. Stoll's dataset correlates with ours at 0.910.

[14] There are differences between our index and Meyer (1984). First, we omit "coal coking/distilling petroleum," "workforce in mining/quarrying," and "cement production" as indicators of latent nuclear weapons production capability because these are too easily available to be thresholds. The correlation between Meyer's composite index based on the 10 indices and ours is 0.987. Second, we have updated information, covering the time span from 1939 to 2002 and including all states.

[15] We chose to use dichotomies rather than continuous variables to measure the size of resources or the strength of production capacities, because there is no clear way to identify thresholds, even if the quantity of resources and the degree of production capacities may be important in measuring latent nuclear weapons production capabilities (see Meyer 1984, 31-38 for more discussion).

CHEMI_I: It represents chemical capability to make nuclear munitions. Its indicator is whether a given country produces nitric or sulfuric acid. The data come from UN Statistical Yearbook (various years).

NITRIC_I: It represents a capability to make explosive materials for nuclear munitions. Its indicator is whether a given country produces non-organic fertilizer. The data come from UN Statistical Yearbook (various years).

EXPLO_I: It represents explosive and electronic capability. Its indicator is whether a given country produces or assembles motors and produces television or radios. The data come from UN Statistical Yearbook (various years).

NUKE_I: It represents nuclear engineering capability. Its indicator is whether a given country's nuclear reactor is more than 3 years. The data come from International Atomic Energy Agency (various years).

ELECT_I: It represents a capability to produce electricity enough to run nuclear weapon programs. Its indicator is whether a given country has at least 200 megawatt electricity production capacity or produces at least electricity equivalent to 50 thousand metric tons of oil. The data come from UN Statistical Yearbook (various years).

N_CAP7: It is a composite index of latent nuclear weapons production capability, summing up all the previous seven indicators. It presumes that states have preserved technologies and materials to manufacture nuclear weapons, even though they do not produce the items in the seven indices any longer.

N-CAP7t: It is another composite index of latent nuclear weapons production capability, summing up all the previous seven indicators. It presumes that states have technologies and materials to manufacture nuclear weapons, only when they produce the items in the seven indices.

C. REPLICATION DATASET

Additional variables necessary to replicate the findings of the study are summarized below.

Variables (files jo_gartzke_0207_replicate_{version}, in Stata data and log formats)

CCODE: The Correlates of War (COW) Project's country code.

YEAR: YEAR.

NUK_A_P: A dummy for the presence or absence of a nuclear weapons program.

NUKE_DF: A dummy for the *de facto* status of nuclear weapons possession.

NUK_APL: A dummy for the presence of a nuclear weapons program lagged by one year.

NUKE_DFL: A dummy for *de facto* nuclear weapons possession lagged by one year.

N_CAP7: This is the composite index of latent nuclear weapons production capability, which contains the sum of all seven indicators. This coding of the variable assumes that states preserve technologies and materials to manufacture nuclear weapons, even when they no longer produce the items in the seven indices.

N-CAP7t: This is another composite index of latent nuclear weapons production capability, summing up the seven component indicators. This coding assumes that states have technologies and materials to manufacture nuclear weapons only when they continue to produce all seven items in the indices.

NEW_ECON: The variable measures of economic capacity, and is calculated as follows:

$$\text{Economic Capacity}_i = \left({Energy}\Big/{\sum Energy} + {Iron/Steel}\Big/{\sum Iron/Steel} \right)\Big/{2} .$$

L_YEAR_T: The log transformation of the number of years since 1938.

LN_RI_T: A measure of conventional threat. The variable is calculated as follows:

$$\text{Conventional threat}_{i,t} = \ln\left(\sum_{j=1}^{n} \frac{CINC_{j,t}}{CINC_{i,t}} + 1 \right).$$

R_NUKEP: A dummy for the status of any rival's nuclear weapons program.

NUKE_A_D: A dummy for the presence or absence of a nuclear defender.

D_ISOL: A measure of diplomatic isolation. The variable uses the COW diplomatic recognition data to measure the ratio of states with which a given state lacks diplomatic relationships over the number of neighboring states and major powers.

LN_XST1: A measure of domestic unrest. The variable (from Banks 1999) weighs the number of domestic conflicts in three categories, including anti-governmental demonstrations, strikes, and riots by the population size.

DEMOC: Polity III's democracy score.

NPTRATIT: NPT ratification except for the five declared nuclear powers.

NPT_EFF: The percentage of NPT joiners (as a proportion of states in the world).

MAJPOW: COW Project's major power status.

REGPOWT: Regional power status, coded "1" for countries possessing "at least half of the resources of the most powerful state" in a region" and "0" otherwise (Schweller 1998, 46). The COW project's code of region and national composite capability index (CINC) are used to construct this variable.

References

Albright, David and Corey Gay. 1998. Taiwan: Nuclear Nightmare Averted. *The Bulletin of Atomic Scientists* 54(1):54-60.

Albright, David. 1994. South Africa and Affordable Bomb. *The Bulletin of Atomic Scientists* 50(4):37-47.

Banks, Arthur S. 1999. *Cross-National Time-Series Data Archive.* Binghamton, NY: Banner Software, Inc.

Central Information Agency. 1982. North Korea: Nuclear Reactor (July 9, 1982). http://www2.gwu.edu/~nsarchiv/NSAEBB/NSAEBB87/nk01.pdf.

Clark, Ronald W. 1961. *The Birth of the Bomb: The Untold Story of Britain's Part in the Weapon that Changed the World.* London: Phoenix House Ltd.

Cohen, Avner. 1998. *Israel and the Bomb.* New York: Columbia University Press.

Cole, Paul M. 1996. *Atomic Bombast: Nuclear Weapon Decision Making in Sweden 1945 – 1972.* Occasional Paper 26. Washington, D.C.: The Henry L. Stimson Center.

Cordesman, Anthony H. 1994. *Iran and Iraq: The Threat from the Northern Gulf.* Boulder, CO: Westview Press.

Einhorn, Robert J. 2004. Egypt: Frustrated but Still on a Non-Nuclear Course In *The Nuclear Tipping Point: Why States Reconsider Their Nuclear Choices*, edited by Kurt M. Campbell, Robert J. Eihnorn, and Mitchell B. Reiss. Washington, D.C.: Brookings Institution Press.

Goldschmidt, Bertland. 1990. *Atomic Rivals.* New Brunswick: Rutgers University Press.

Hamza, Khidhir. 2000. *Saddam's Bombmaker.* New York: Scribner.

Holloway, David. 1994. *Stalin and the Bomb: The Soviet Union and Atomic Energy, 1939 – 1956.* New Haven, CT: Yale University Press.

Jones, Rodney W. & Mark G. McDonough. 1998. *Tracking Nuclear Proliferation: A Guide in Maps and Charts, 1998*. Washington, D.C.: Carnegie Endowment for International Peace.

Levite, Ariel E. 2002. Never Say Never Again: Nuclear Reversal Revisited. *International Security* 27(30):59-88.

Lewis, John Wilson and Xue Litai. 1988. *China Builds the Bomb.* Stanford, CA: Stanford University Press.

Mazarr, Michael J. 1995. *North Korea and the Bomb: A Case Study in Nonproliferation.* New York: St. Martin Press.

Meyer, Stephen M. 1984. *The Dynamics of Nuclear Proliferation.* Chicago, IL: The University of Chicago Press.

Nichols, K.D. 1987. *The Road to Trinity.* New York: William Morrow and Company.

Perkovich, George. 1999. *India's Nuclear Bomb: The Impact on Global Proliferation*. Berkeley: University of California Press.

Potter, William, Djuro Mijanic & Ivo Slaus. 2000. Tito's Nuclear Legacy. *The Bulletin of Atomic Scientists* 56(2):63-70.

Reiss, Mitchell. 1995. *Bridled Ambition: Why Countries Constrain Their Nuclear Capabilities.* Washington, DC: The Woodrow Wilson Center Press.

Reynolds, Wayne. 2000. *Australia's Bid for the Atomic Bomb.* Melbourne, Australia: Melbourne University Press.

Rhodes, Richard. 1986. *The Making of the Atomic Bomb.* New York: Simon and Schuster.

Rose, Paul Lawrence. 1998. *Heisenberg and the Nazi Atomic Bomb Project: A Study in German Culture.* Berkeley, CA: University of California Press.

Schweller, Randal L. 1998. *Deadly Imbalance: Tripolarity and Hitler's Strategy of World Conquest*. New York: Columbia University Press.

Spector, Leonard S. 1984. *Nuclear Proliferation Today*. Cambridge, MA: Ballinger Publishing Co.

___. 1990. *Nuclear Ambitions: The Spread of Nuclear Weapons, 1989-1990*. Boulder, CO: Westview Press.

Stoll, J. Richard. 1996. World Production of Latent Nuclear Capacity. http://es.rice.edu:80/projects/Poli378/Nuclear/Proliferation/proliferation.html.

Sublette, Carey. 1999. Nuclear Weapons Frequently Asked Questions (version 2.19: 20). http://nuclearweaponarchive.org/Nwfaq/Nfaq0.html.

United Nations. 1948 – 2002. *UN Statistical Yearbook*. New York, NY: The United Nations.

___. 1997. UN Statistical Yearbook (CD-rom). New York, NY: The United Nations.

Waisman, C.H. 1975. Incentives for Nuclear Proliferation: The Case of Argentina In *Nuclear Proliferation and the Near-Nuclear Countries*, edited by Onkar Marwah and Ann Schulz. Cambridge, MA: Ballinger Publishing Co.

Weissman, Steve and Herbert Krosney. 1981. *The Islamic Bomb*. New York: New York Times Book.

Wilcox, Robert K. 1995. *Japan's Secret War*. New York, NY: Marlowe & Company.

Table 1: States with Nuclear Weapons Programs and Nuclear Weapons

States	Nuclear Weapons Programs	Nuclear Weapons Possession
Declared nuclear states		
United States	1942 -	1945 -
Soviet Union/Russia	1943 -	1949 -
United Kingdom	1941 -	1952 -
France	1954 -	1960 -
China	1956 -	1964 -
De facto **nuclear states**		
Israel	1955 -	1966 -
South Africa	1971 - 1990	1979 - 1991
India (1)	1964 - 1965	
India (2)	1972 -	1988 -
Pakistan	1972 -	1987 -
Near nuclear states		
Germany	1941 - 1945	
Japan	1943 - 1945	
Sweden	1946 - 1969	
Yugoslavia (1)	1953 - 1963	
Yugoslavia (2)	1982 - 1987	
Taiwan	1967 - 1976	
South Korea	1971 - 1975	
Iran (1)	1974 - 1978	
Iran (2)	1984 -	
Iraq	1973 - 2002	
Argentina	1976 - 1990	
Brazil	1978 - 1990	
Romania	1981 - 1989	
North Korea	1982 -	

Table 2: Resource Demands for Low-Technology Nuclear Weapons

Resource demand component	Meyer's resource demand list	Meyer's indicators	Authors' indicators
Nuclear material	* Indigenous uranium deposits	* Uranium deposits	* Uranium deposits
	* Previous national mining activities	* Work force in mining/quarrying	
	* Metallurgists	* Steel production	* Steel or aluminum production
	* Nuclear graphites (production capacity)	* Coal coking or distilling petroleum	
Munitions fabrication	* Chemical engineers	* Nitric or sulfuric acid production	* Nitric or sulfuric acid production
	* Nitric Acid (production capacity)	* Non-organic nitric fertilizer production	* Non-organic nitric fertilizer production
	* Nuclear engineers/physicists/chemists	* 3 nuclear reactor years	* 3 nuclear reactor years
	* Electronic/explosive specialists	* Vehicle and radio (or TV) production	* Vehicle and radio (or TV) production
Nuclear facilities (construction & operation)	* Capital costs of various plant facilities		
	* Initial operating costs of the process plants		
	* Research, development, testing and engineering costs		
	* Steel		
	* Cement/concrete	* Cement production	
	* Construction work force		
	* Industrial engineers: civil structural, electrical, and mechanical specialists		
	* Electricity (production capacity)	* Production of at least 200 MWs	* Production of at least 200 MWs