Appendices for "Signaling Alliance Commitments: Hand-Tying and Sunk Costs in Extended Nuclear Deterrence"

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This document contains three appendices associated with the article "Signaling Alliance Commitments: Hand-Tying and Sunk Costs in Extended Nuclear Deterrence" (*American Journal of Political Science*, forthcoming). The file `Fuhrmann-Sechser-Appendices.do`, available at `http://dvn.iq.harvard.edu/dvn/dv/tsechser` and `http://www.matthewfuhrmann.com`, performs the operations described herein.

Appendix A

Foreign Nuclear Deployment Dataset: Cases and Sources

This appendix provides additional information about the new dataset on foreign nuclear deployments described in the paper "Signaling Alliance Commitments: Hand-Tying and Sunk Costs in Extended Nuclear Deterrence" (Fuhrmann and Sechser 2014b).[1] We offer short case descriptions for each deployment and provide a list of sources that we used to make coding decisions about where and when nuclear weapons were forward-deployed. The information provided here allows interested scholars to reproduce the dataset and assess potentially controversial coding decisions.

When we assembled the dataset, we were mindful of the potential for both "false positive" and "false negative" errors. To avoid the inclusion of deployments that did not actually occur (i.e., false positive errors), we set a high bar for entry into the dataset. We only included cases if there was definitive evidence that a deployment occurred from at least three independent sources. Given that deployments are sometimes shrouded in secrecy, the movement of nuclear weapons abroad may not always be reported in open source materials. It is therefore possible that deployments occurred about which we do not know (i.e., false negative errors).[2] To minimize this likelihood, we consulted declassified documents whenever possible.[3]

Still, it is impossible to know for certain whether we have identified all foreign nuclear deployments. If there are any missing cases, however, we think it is unlikely that they would significantly affect the findings. Because unknown deployments were probably not intended

[1] See also the description of the dataset in Fuhrmann and Sechser (2014a).

[2] Note, however, that governments must make their potential adversaries aware of forward-deployed nuclear forces in order for them to have any deterrent value. The location of these weapons is therefore often an open secret: elites may quietly signal that nuclear weapons are forward-deployed even if they do not directly confirm or deny their presence in public.

[3] We were able to obtain formerly classified documents on American and British nuclear deployments, but we were unable to access similar sources for the Soviet Union. However, we were able to locate what we believe to be accurate information about Soviet foreign nuclear deployments from three main sources. First, declassified American intelligence sources sometimes provide useful information on the location of Soviet nuclear forces. Second, after the end of the Cold War, the host countries often publicly acknowledged that they hosted Soviet nuclear weapons. Third, the historical literature on nuclear deployments often identifies the locations of Soviet forward-deployed nuclear weapons. For instance, many sources reported that Soviet nuclear weapons were in Hungary well before Budapest publicly confirmed the presence of the bombs.

to enhance extended deterrence, including them in the dataset would make it even less likely that we would find a negative relationship between hosting nuclear forces and being targeted in violent disputes. In any case, at the end of this appendix, we briefly discuss some "near misses," including some cases where nuclear weapons could plausibly have been deployed despite the lack of confirming evidence and others that do not meet our definition of a foreign nuclear deployment.

Foreign Nuclear Deployments, 1945–2000

- **Belgium – United States, 1963–2000**

  The United States introduced B61 nuclear bombs in Belgium in November 1963. Washington maintained this nuclear deployment throughout our period of study, and between 10 and 20 gravity bombs remain at Kleine Brogel air base in Belgium.

  Sources: United States Department of Defense (1978); Kristensen (2005); Sauer and van der Zwaan (2011, 16); Charles (1985).

- **Canada – United States, 1964–84**

  In July 1950, the United States placed nonnuclear bombs in Canada. Because these weapons did not contain their fissile cores, their placement on Canadian soil does not constitute a foreign nuclear deployment. The first "live" nuclear weapons (Bomarc surface-to-air missiles) were introduced in Canada in January 1964. Washington later placed nuclear gravity bombs, depth bombs, and air-to-air missiles (Genie and Falcon) in Canada. The last remaining nuclear forces were removed from Canadian soil in 1984.

  Sources: Clearwater (1998); United States Department of Defense (1978); Norris, Arkin, and Burr (1999).

- **Cuba – Soviet Union, 1962**

  The Soviet deployment of nuclear weapons to Cuba in 1962 led to the most significant nuclear crisis of the Cold War: the Cuban missile crisis. Moscow stationed nuclear-capable medium range ballistic missiles (SS-4) on the island, but U.S. intelligence detected these weapons before they became operational. However, the Soviets also deployed fully-assembled tactical nuclear forces in Cuba – including Luna rockets and ground-launched cruise missiles (FKR) – that were fully assembled during the fall of 1962. Moscow removed

the last of its nuclear weapons from Cuba in December 1962.

Sources: Allison and Zelikow (1999); Naftali and Fursenko (1997); Aribkov and Smith (1993); Savranskaya and Blanton (2013).

- **Cyprus – Great Britain, 1961–75**

  Britain housed nuclear gravity bombs at an RAF air base in Cyprus known as Akrotiri for a 15-year period during the Cold War. Nuclear forces were introduced in Cyprus in 1961, when London sent new Canberra Mk.15 and Mk.16 aircraft to Akrotiri. These bombers were replaced with Vulcans carrying the WE.177 bomb in 1969. Britain withdrew its gravity bombs in 1975, shortly after the Turkish invasion of Cyprus.

  Sources: Moore (2001, 62–63); Norris and Arkin (2001); Rhodes (2000).

- **Czechoslovakia – Soviet Union, 1969–90**

  The Soviet Union stationed nuclear weapons in Czechoslovakia during the Cold War. In 1965, Prague and Moscow signed a treaty that permitted the construction of nuclear storage facilities in Czechoslovakia. The absence of permanent Soviet troops in the country delayed construction of these facilities until 1969. The forward-deployed nuclear forces probably included short range ballistic missiles (SS-21 and SS-23), nuclear artillery, and gravity bombs. All Soviet nuclear forces were removed from Czechoslovakia in May 1990, shortly after the collapse of the Warsaw Pact.

  Sources: Arkin and Fieldhouse (1985, 12); Arkin and Fieldhouse (1999); Richter and Kalinina (2008); Lunak (2006); Bracke (2007).

- **Denmark – United States, 1958–65**

  The United States deployed nuclear gravity bombs and Nike Hercules surface-to-air missiles at Thule Air Base in Greenland from February 1959 to July 1965. This constitutes a deployment on Danish territory because Greenland was part of Denmark throughout the period that nuclear forces were stationed on the island. A B-52 bomber carrying thermonuclear bombs famously crashed in North Star Bay when attempting an emergency landing at Thule. This accident occurred in 1968, after nuclear weapons had been withdrawn from Denmark.

Sources: Moller and Pehkonen (2003, 8); United States Department of Defense (1978); Norris, Arkin, and Burr (1999); Sagan (1993, 156–203).

- **Germany (East) – Soviet Union, 1958–91**

  In March 1955, the Soviet Union approved a plan known as "Operation Atom" to station nuclear weapons in East Germany and Bulgaria. Moscow ultimately scuttled plans for the Bulgarian deployment, but introduced short range ballistic missiles (SS-3) in East Germany beginning in the fall of 1958. Based on the available historical evidence, this was the first Soviet deployment of nuclear weapons outside the homeland. All Soviet nuclear weapons were reportedly removed from East Germany in August 1991.

  Sources: Fursenko and Naftali (2006, 194); Wagner (2004, 224); Norris and Arkin (1991, 49); Uhl and Ivkin (2011).

- **Germany (West) – Great Britain, 1972–98**

  During the 1950s and 1960s, British bombers based in West Germany carried American tactical nuclear weapons. This does not constitute a British deployment since London did not own the bombs. However, beginning in 1972, WE.177 nuclear bombs owned by Britain were stored in West Germany. These bombs were to be initially delivered on RAF Buccaneers and, later, on Jaguar and Tornado aircraft. London withdrew the WE.177 in 1998.

  Sources: Moore (2001, 63); Wynn (1994, 59–64); Norris and Arkin (1996, 65); Burnell (2012).

- **Germany (West) – United States, 1955–2000**

  The United States deployed gravity bombs to West Germany in March 1955. Over the next five decades, Germany hosted 21 different types of nuclear weapons, including: short range ballistic missiles, nuclear artillery, Nike Hercules surface-to-air missiles, atomic demolition munitions, Falcon air-to-air missiles, Bullpup air-to-surface missiles, and Pershing medium range ballistic missiles. Many of the nuclear weapons that were once deployed have been removed from German soil, but a small number (10–20) of B61 gravity bombs remain at Buchel air base.

  Sources: Norris, Arkin, and Burr (1999, 28); United States Department of Defense (1978);

Kristensen (2012, 18); Moore (2001).

- **Great Britain – United States, 1954–2000**

  In September 1954, the United States placed nuclear gravity bombs on British soil. Washington later introduced Thor intermediate range ballistic missiles in Britain that were under dual-key control, meaning that both American and British commanders had to authorize a launch before the weapons could be fired. More than 100 gravity bombs remained at Lakenheath air base until the mid-2000s, when President George W. Bush ordered their withdrawal.

  Sources: Priest (2005, 763); Borger (2008); United States Department of Defense (1978); Norris and Arkin (1991); Norris, Arkin, and Burr (1999); Kristensen (2012).

- **Greece – United States, 1960–2000**

  The United States placed nuclear gravity bombs in Greece in the fall of 1960. Greece later hosted nuclear artillery (Honest John rockets and 8-inch Howitzers) and Nike Hercules surface-to-air missiles. Washington withdrew its remaining nuclear forces (B61 gravity bombs) from Greek soil in 2001.

  Sources: Sauer and van der Zwaan (2011); United States Department of Defense (1978); Sauer (2010); Norris, Arkin, and Burr (1999); Kristensen (2012).

- **Hungary – Soviet Union, 1974–89**

  Hungarian leader Janos Kadar signed an agreement with the Soviet Union in the late 1960s that permitted the stationing of nuclear weapons in Hungary. Although it is unclear precisely when the nuclear forces were introduced, the most authoritative source to which we have access indicates that Hungary hosted Soviet atomic weapons beginning in 1974. We do not know which weapons were stationed in Hungary, but the deployments may have included short range ballistic missiles (FROG, SS-21, Scud, and SS-23), gravity bombs, and nuclear artillery. The Hungarian government requested in 1987 that Soviet nuclear forces be removed from its territory and the withdrawal of the weapons was completed by 1989.

  Sources: Bandy (1991); Norris and Arkin (1991, 49); Kramer (2010); Diakov, Miasnikov, and Kadyshev (2004).

- **Italy – United States, 1956–2000**

  Italy hosted U.S. nuclear weapons beginning in August 1956 when Washington introduced short range missiles (Honest John and Corporal). The United States also stationed in Italy gravity bombs, Nike Hercules surface-to-air missiles, depth bombs, atomic demolition munitions, Jupiter medium range ballistic missiles, and other short range missiles (Sergeant and Lance). A number of B61 nuclear gravity bombs are still stationed at two bases in Italy, one of which is Aviano air base.

  Sources: United States Department of Defense (1978); Norris, Arkin, and Burr (1999); Kristensen (2012).

- **Malaysia/Singapore – Britain, 1963–70**

  In the late-1950s, Britain explored the possibility of stationing nuclear weapons at Tengah air base in Singapore, which was part of Malaysia from 1963 to 1965. Then, in 1962, Prime Minister Macmillan officially authorized the deployment of nuclear weapons to Tengah. Britain's so-called "V-bombers" were dispatched to Tengah and another RAF air base known as Butterworth from 1963 to 1966. A squadron of Canberra bombers tasked with low-altitude nuclear bombing exercises was also deployed at Tengah in 1963 and those aircraft remained in the region until 1970.

  Sources: Moore (2001, 62); Rhodes (2000); Jones (2003); Wah (2009).

- **Mongolia – Soviet Union, 1967–92**

  The Soviet Union and Mongolia signed a mutual assistance treaty in February 1966. This treaty led to a Soviet military buildup in Mongolia that included the deployment of strategic bombers and intermediate range ballistic missiles. Beginning in 1967, the Soviets deployed SS-12 tactical nuclear weapons along the border region. Nuclear forces were also eventually based at a site 20 miles from the capital, Ulan Bator. China repeatedly made references to the presence of Soviet nuclear forces in Mongolia, particularly as the 1969 crisis heated up. For example, a Chinese radio broadcast reported in June 1969 that nuclear intermediate range ballistic missiles were deployed near the Sino-Mongolian border, and that these forces were "ready at any time." U.S. intelligence sources also suggested that tactical nuclear weapons were present in Mongolia during the late 1960s. Moscow reportedly kept nuclear forces on Mongolian soil until the last Russian troops were withdrawn in 1992. That same year, in a speech before the UN General Assembly, Mongolian President

Punsalmaagin Ochirbat declared that Mongolia would become a nuclear weapon free zone (NWFZ). This initiative was designed to prevent the future stationing of nuclear weapons on Mongolian territory.

Sources: United States Central Intelligence Agency (1969, 33); Subrahmanyam (2011, 337–38); Zhao (2011); Goldstein (2000); Enkhsaikhan (2000); Gerson (2010, 16).

- **Morocco – United States, 1954–63**

  The United States sent nuclear gravity bombs to Morocco in May 1954, making this the first American foreign nuclear deployment. Washington also sent nuclear depth bombs to Morocco in the late-1950s, before removing all nuclear weapons from Moroccan soil in September 1963.

  Sources: Wright (1983); United States Department of Defense (1978); Norris, Arkin, and Burr (1999); Burns (1999); Petersen (1998, 29).

- **Netherlands – United States, 1960–2000**

  The United States stationed gravity bombs and nuclear artillery in the Netherlands beginning in April 1960. The Netherlands is one of five European countries that hosts U.S. nuclear forces today; about 20 gravity bombs remain at Volkel air base.

  Sources: United States Department of Defense (1978); Norris, Arkin, and Burr (1999); Sauer and van der Zwaan (2011).

- **Philippines – United States, 1957–77**

  In December 1957, the United States placed nuclear gravity bombs in the Philippines. Washington later sent depth bombs, Falcon air-to-air missiles, surface-to-air missiles (Terrier and Talos), and anti-submarine rockets to the country. All nuclear forces were removed from the Philippines in June 1977.

  Sources: McClintock (1969); Norris, Arkin, and Burr (1999); United States Department of Defense (1978).

- **Poland – Soviet Union, 1967–90**

The Soviet Union and Poland signed a deal in February 1967 that permitted the stationing of nuclear weapons on Polish territory. Tens of thousands of Soviet troops were stationed in Poland at the time the agreement was signed, meaning that there would have been few logistical impediments to implementing the agreement quickly – unlike in the case of Czechoslovakia. We therefore assume that Poland hosted Soviet nuclear forces beginning in 1967, although it is possible that the weapons did not arrive until a few years later. The same weapons that were in Czechoslovakia and Hungary (short range ballistic missiles, gravity bombs, and nuclear artillery) were also probably on Polish soil. All Soviet nuclear forces were removed from Poland in early 1990.

Sources: Norris and Arkin (1991, 49); Kramer (2010); Arkin and Fieldhouse (1985); Bracke (2007, 143).

- **South Korea – United States, 1958–91**

  The United States introduced nuclear bombs and nuclear artillery in South Korea in January 1958. Short range missiles (Lacrosse and Sergeant), Nike Hercules surface-to-air missiles, and atomic demolition munitions were also deployed in South Korea beginning in the 1960s. Washington removed all nuclear forces from the Korean peninsula in 1991. After North Korea's nuclear tests in 2006 and 2009 some elites in Seoul called for the reintroduction of American atomic weapons in South Korea but there is no evidence that such deployments have occurred.

  Sources: United States Department of Defense (1978); Ramstad (2011); Borger (2010); Hee-hyung (2012).

- **Spain – United States, 1958–76**

  Spain housed U.S. nuclear weapons – including gravity bombs, depth bombs, Falcon air-to-air missiles, Talos surface-to-air missiles, and depth bombs – beginning in 1958. All nuclear forces were removed in 1976, before Spain joined NATO.

  Sources: Arkin and Norris (1992, 6); United States Department of Defense (1978); Sauer (2010).

- **Taiwan – United States, 1958–74**

  The United States placed Matador surface-to-surface missiles in Taiwan in January 1958.

Washington also deployed nuclear gravity bombs on Taiwanese soil. Both types of weapons were withdrawn by July 1974.

Sources: United States Department of Defense (1978); Commander in Chief, U.S. Pacific Command (1975); Arkin and Fieldhouse (1985).

- **Turkey – United States, 1959–2000**

  American gravity bombs were first deployed in Turkey in February 1959; Washington later introduced nuclear artillery (Honest John rockets and 8-inch Howitzers) on Turkish soil. Jupiter medium range ballistic missiles were also housed in Turkey from October 1961 to June 1963. The United States agreed to remove these missiles after the Soviets withdrew its nuclear forces from Cuba. However, Washington continued to maintain a number of other nuclear forces in Turkey and nearly 100 B61 nuclear bombs remain at Incirlik air base.

  Sources: Bell and Loehrke (2009); Norris, Arkin, and Burr (1999); Norris (1992); United States Department of Defense (1978).

Select Cases Not Considered Foreign Nuclear Deployments

- **Algeria – France, 1960s**

  France conducted 17 nuclear tests in Algeria from 1960 to 1966, three years after Algeria gained independence. Transporting nuclear weapons to another country to conduct a nuclear test does not constitute a foreign nuclear deployment, however, and we did not find any evidence that France permanently based nuclear weapons in Algeria. This is not surprising given that the *force de frappe* may have been intended, in part, to deter threats from Algeria.

  Sources: Naylor (2000); Cirincione, Wolfsthal, and Rajkumar (2005, 190); Tertrais (2004); Rauf (1995); Chikhi (2010).

- **Bahrain and Oman – Great Britain, 1970s**

  Britain had facilities for handling nuclear weapons in transit in Bahrain (Muharraq) and Oman (Masirah). Yet there is no evidence that British bombers carrying WE.177 nuclear bombs ever did anything more than make brief stops at these bases before the weapons

were delivered to their final destination. It would therefore be inappropriate to classify these cases as foreign nuclear deployments.

Sources: Moore (2001, 63); Wynn (1994, 59–64).

- **Belarus, Kazakhstan, and Ukraine – Russia, 1990s**

  When the Soviet Union collapsed, nuclear forces were deployed in Belarus, Kazakhstan, and Ukraine. These deployments are excluded from the dataset because they were never meant to protect the former Soviet republics; those states just happened to inherit nuclear weapons from Moscow. All of the nuclear forces deployed outside of Russia were returned in the mid-1990s.

  Sources: Norris (1992); Chafetz, Abramson, and Grillot (1996); Potter (1995).

- **Bulgaria – Soviet Union, 1950s**

  As previously noted (see East Germany – Soviet Union), Moscow had plans to station nuclear weapons in Bulgaria during the 1950s as part of "Operation Atom." The Soviet Union did not follow through with this arrangement, however. Two other pieces of evidence appear to suggest that nuclear weapons may have been stationed in Bulgaria at a later date. First, according to the CIA, there were two storage facilities for nuclear warheads in Bulgaria during the Cold War. However, is unclear whether these sites actually housed nuclear weapons. Some analysts (e.g., Diakov, Miasnikov, and Kadyshev 2004, 45) equate the presence of nuclear storage facilities on Bulgarian soil with the deployment of nuclear missiles – but the CIA did not share this conclusion. It appears that the Soviets built these storage facilities so that they could quickly move nuclear weapons to Bulgaria in the event of war, not so they could permanently station forces there. Because war did not occur, Moscow may not have had the need to deploy nuclear forces. Second, the Soviets transferred nuclear-capable SS-23 missiles to Bulgaria during the mid-1980s. Yet it appears that these missiles were nonnuclear, meaning that they were not tipped with nuclear warheads. We think it is possible that Bulgaria hosted Soviet nuclear forces at some point during the Cold War. Yet we exclude this case from the dataset because we did not find any definitive evidence indicating that a nuclear deployment occurred. However, the findings we report in "Signaling Alliance Commitments" are largely unaltered if we include this case in the dataset.

  Sources: Fursenko and Naftali (2006, 194); Wagner (2004, 224); Norris and Arkin (1991,

49); Uhl and Ivkin (2011); Clyatt (1993, 41); Toth (1990); United States Central Intelligence Agency (1979, 45–46).

- **Cuba – United States, 1961–63**

  The United States placed nonnuclear depth bombs in Cuba from December 1961 to September 1963. This does not constitute a foreign nuclear deployment according to our definition because the weapons were not fully assembled.

  Sources: United States Department of Defense (1978).

- **Egypt – Soviet Union, 1973**

  During the 1973 Yom Kippur War, U.S. intelligence detected hints of radiation aboard a Soviet cargo ship – the *Mezhdurechensk* – that was bound for Egypt. This led to speculation that the Soviet Union was introducing nuclear-armed SCUD missiles on Egyptian soil. However, a top secret CIA document issued on October 30, 1973 did not draw a firm conclusion based on the intelligence that was available at the time: "The evidence should not yet be regarded as though it creates a strong presumption that the Soviets dispatched nuclear weapons to Egypt." The American sensor was prone to false positives and officials could not determine whether the type of radiation that was detected indicated the presence of nuclear weapons. Further inquiry (and a close examination of U.S. and Israeli intelligence sources) revealed that the Soviets had not in fact shipped nuclear missiles to Egypt.

  Sources: United States Central Intelligence Agency (1973); Paul (2009, 77); Karpin (2006, 334); Blechman and Hart (1982) Richelson (1996).

- **France – United States, 1958–60**

  Like Cuba, France hosted American nuclear bombs that did not include their fissile cores, essentially rendering the weapons nonnuclear. These weapons were in place from August 1958 to March 1960. Washington attempted to deploy nuclear weapons in France, in part, to dissuade Paris from building the *force de frappe*, but French leaders refused to accept them.

  Sources: United States Department of Defense (1978); Reiter (2014).

- **Japan – United States, 1954–72**

  The United States stationed nuclear weapons in three Japanese territories: Chichi Jima, Iwo Jima, and Okinawa. From 1956 to 1965, gravity bombs, Regulus submarine-launched ballistic missiles, and Talos surface-to-air missiles were in Chichi Jima; gravity bombs were in Iwo Jima from 1965 to 1966; and gravity bombs, depth bombs, surface-to-air missiles (Nike Hercules and Terrier), nuclear artillery, Falcon air-to-air missiles, anti-submarine rockets, and atomic demolition munitions were in Okinawa from 1954 to 1974. All three islands were occupied by the American military while nuclear forces were stationed there. We therefore exclude these cases from the dataset because they are not technically foreign nuclear deployments. In addition to the deployments on the islands, the United States placed nuclear bombs without their fissile cores on the Japanese mainland from December 1954 to June 1965.

  Sources: United States Department of Defense (1978); Norris, Arkin, and Burr (2000).

Appendix B

Bivariate Probit Analysis

We demonstrated in "Signaling Alliance Commitments" that alliances with nuclear-armed states appear to promote peace through extended deterrence while foreign nuclear deployments do not.[4] This appendix discusses the bivariate probit model we employed to examine whether the lack of a relationship between foreign nuclear deployments and militarized dispute initiation could be driven by strategic selection bias. The bivariate probit model is designed to jointly estimate two equations with dichotomous outcomes (Maddala 1983). As noted in the paper, one equation analyzes whether a state has foreign nuclear weapons on its territory and the other estimates the probability of conflict initiation while accounting for potential correlation of the disturbance terms between the two models.

We draw on an existing model of foreign nuclear deployment onset (Fuhrmann and Sechser 2014a) to construct the first equation.[5] Our nuclear deployment model contains three variables from the conflict initiation equation: DEFENSE PACT WITH NUCLEAR POWER, NUCLEAR TARGET, TARGET POLITY.[6] States with an existing nuclear alliance may be more likely to receive weapons from their ally, while countries with an independent nuclear deterrent have less of a strategic need for foreign bombs. Democracies might host nuclear forces more frequently than non-democracies because open political institutions could provide patrons with greater confidence that their weapons will remain safe and secure.[7]

We must also include independent variables in the deployment equation that are excluded from the conflict model (Maddala 1983, 122). To satisfy this requirement, we include the following covariates in the deployment model:[8]

[4]However, as we have argued elsewhere, nuclear weapons do not carry an equivalent ability to compel (Sechser and Fuhrmann 2013).

[5]Fuhrmann and Sechser (2014a) include some variables (e.g., NUCLEAR POWER'S ARSENAL SIZE) that would be inappropriate for this analysis. However, we replicate that deployment model as closely as possible.

[6]See Fuhrmann and Sechser (2014a,b) for a discussion of how these variables are coded.

[7]Additionally, democratic patrons may trust other democracies more and be more comfortable deploying nuclear forces to them (e.g., Russett and Oneal 2001). This is significant because democracies have stationed nuclear weapons abroad much more frequently than non-democracies.

[8]We exclude two variables from the deployment equation for theoretical and data-related reasons. First, recent research shows that countries are unlikely to build nuclear weapons if they have another state's nuclear forces stationed on their soil (Reiter 2014). Yet, only South Korea received foreign bombs while pursuing

- DISTANCE FROM THE UNITED STATES. This variable measures the distance between the United States and the potential target in thousands of miles.[9] The United States stationed nuclear weapons abroad, in part, to enhance its ability to hit distant targets more rapidly; distance from the United States therefore should be positively associated with deployments. The further a country is located from the United States, the more helpful it will be in augmenting the U.S. capacity to strike faraway targets. Although other nuclear powers had similar incentives when it came to foreign nuclear deployments, a target's distance from America should be particularly significant given that Washington forward-deployed nuclear forces much more frequently than any other country.[10]

- SHARED RIVAL WITH NUCLEAR POWER. Shared threat perceptions often motivate states to form alliances or cooperate in other ways (Walt 1987). Nuclear powers might want to protect states with whom they have a common rival, and one way to do this is to deploy nuclear weapons to those countries. Foreign nuclear deployments may serve this purpose even in the absence of a formal defense pact. The Soviet Union, for instance, deployed nuclear forces to Cuba, in part, to protect the Castro regime from a possible American invasion. We include a variable that measures whether the potential target in a dyad has a common enemy with any nuclear power.[11]

- DISTANCE FROM NUCLEAR POWER'S RIVAL. We include a variable that measures the shortest distance (in thousands of miles) between a potential target and a nuclear power's rival. This variable should be negatively associated with foreign nuclear deployments because nuclear powers have incentives to station nuclear forces close to their enemies to facilitate the use of nuclear force during a crisis.

- CIVIL WAR. We control for whether the target is experiencing a civil war because

the development of an independent nuclear arsenal (Singh and Way 2004). This suggests that concerns about proliferation may not motivate states to introduce nuclear weapons abroad, on average, even though deployments deter the host state from acquiring the bomb once they are in place. We therefore do not control for whether the target country is pursuing nuclear weapons in the deployment equation. However, the findings are largely unchanged if we add TARGET NUCLEAR WEAPONS PURSUIT to the model. Second, one might argue that right-wing governments would be more likely to accept nuclear deployments. Comprehensive data on executives' ideology unfortunately are not available for the period we study. Most studies that employ these data analyze a subset of countries and/or a relatively short period of time. For example, Palmer, London, and Regan (2004) examine eighteen parliamentary democracies in their study of right-wing governments and international conflict. We therefore are unable to include a measure of executives' ideology in our deployment equation without drastically shrinking the sample size.

[9]We code this variable using the standard Correlates of War distance data. However, the findings are similar if we construct this measure using CShapes (Weidmann, Kuse, and Gleditsch 2010).

[10]However, the findings are substantively similar when we include DISTANCE FROM THE SOVIET UNION in the deployment equation.

[11]We code this variable based on the New Rivalry Dataset (Klein, Goertz, and Diehl 2006).

nuclear states might be reluctant to station forces in unstable countries.[12]

- NPT. Many have argued that the nuclear Nonproliferation Treaty (NPT) prohibits foreign nuclear deployments. NPT members might thus be reluctant to host foreign nuclear bombs. This variable is coded 1 if the target state has ratified the NPT and 0 otherwise.

- POST-COLD WAR. The collapse of the Soviet Union may have reduced the need for nuclear deployments in Europe and elsewhere. We therefore include a variable that is coded 1 for all years in the sample from 1992 to 2000 and 0 for years from 1950 to 1991.

- DEPLOYMENT TIME, DEPLOYMENT TIME^2, DEPLOYMENT TIME^3. To account for temporal dependence, we include the three variables recommended by Carter and Signorino (2010).

The variables that are part of the deployment equation but not the conflict model should be (1) correlated with foreign nuclear deployment but (2) not associated with conflict. Prior research has shown that most of the covariates listed above are strong predictors of deployments. However, some may object to the identification of our model based on the second criterion. Recent research has shown, for example, that civil wars raise the risk of interstate conflict (e.g., Gleditsch, Salehyan, and Schultz 2008). One might also argue that several of the other variables – particularly SHARED RIVAL WITH NUCLEAR POWER, DISTANCE FROM NUCLEAR POWER'S RIVAL, NPT, and POST-COLD WAR – may be associated with violent conflict initiation.

To address this potential objection, we estimate a second bivariate probit model that includes additional variables from the deployment model in the conflict equation. This alternate specification relies on four variables to meet satisfy the exclusion restriction: DISTANCE FROM THE UNITED STATES, DEPLOYMENT TIME, DEPLOYMENT TIME^2, DEPLOYMENT TIME^3. There is little reason to believe that the controls for temporal dependence in the deployment equation should be included in the conflict model. The exclusion of DISTANCE FROM THE UNITED STATES warrants further discussion, however.

The distance between two states is a strong predictor of whether they will fight (e.g., Bremer 1992). Yet, there is little reason to believe that a target's distance from the United States is associated with a dyad's general propensity to experience conflict with other states. The likelihood that two states will engage in militarized disputes over territory, resources, or other issues has little relationship to their proximity to the United States.

[12]We code this variable based on (Gleditsch et al. 2002).

Distance from the United States could be related to conflict propensity in two other ways, however. First, dyads near to the United States might be less likely to experience conflict if the United States is seen as more likely to intervene in nearby areas. Yet the United States has both global reach and global interests to protect, and it is not clear that its propensity to intervene is related to a conflict's proximity to the U.S. homeland. Indeed, Washington would probably be much more concerned about a dispute between North Korea and South Korea (or Saudi Arabia and Iran) than a conflict between Costa Rica and Panama, which are much closer. Second, dyads containing the United States itself might be less likely to experience conflicts if the dyad partner is distant. Again, however, while geography is an important determinant of conflict for most states, its relevance for great powers such as the United States is less clear. Indeed, during our period of study, the United States fought many violent disputes against states located thousands of miles from its borders (e.g., China, Iraq, North Korea, and North Vietnam) but it rarely experienced militarized disputes with its neighbors. Distance from the United States therefore satisfies both requirements of a suitable exclusion restriction.

Table 1 reports the findings from two bivariate probit models. Model 1 represents the "base" model, while model 2 adds additional variables from the deployment equation to the conflict model. The estimate for ρ is statistically insignificant in Model 1 ($p = 0.107$), suggesting that the disturbance terms between the deployment and conflict equations are not correlated. In Model 2, ρ is significant at the 95 percent level ($p = 0.020$).

The findings displayed in Table 1 are substantively similar to what we reported in "Signaling Alliance Commitments." Foreign nuclear deployments fail to achieve statistical significance in both models of militarized dispute initiation, and nuclear alliances continue to be statistically associated with successful deterrence ($p < 0.001$ in both models). The direction and statistical significance of the control variables are also similar to the findings from the original probit analysis. This suggests that the original findings we reported are not driven by a strategic selection effect. Moreover, the consistency in the findings across Models 1 and 2 demonstrates that the results are robust to changes in the identification of the model.

	Model 1	*Model 2*
Foreign Nuclear Deployment		
DEFENSE PACT WITH NUCLEAR POWER	1.367^{***}	1.367^{***}
	(0.108)	(0.108)
NUCLEAR TARGET	0.420^{***}	0.419^{***}
	(0.084)	(0.084)
TARGET POLITY	0.031^{***}	0.031^{***}
	(0.006)	(0.006)
DISTANCE FROM THE UNITED STATES	0.037	0.037
	(0.025)	(0.025)
SHARED RIVAL WITH NUCLEAR POWER	0.232^{***}	0.234^{***}
	(0.063)	(0.063)
DISTANCE FROM NUCLEAR POWER'S RIVAL	-0.585^{***}	-0.585^{***}
	(0.031)	(0.031)
CIVIL WAR	0.202^{***}	0.203^{***}
	(0.045)	(0.045)
NPT	0.732^{***}	0.733^{***}
	(0.064)	(0.064)
POST-COLD WAR	-0.076	$-0.078^{\dagger}$
	(0.047)	(0.047)
CONSTANT	-0.858^{***}	-0.859^{***}
	(0.225)	(0.224)
Militarized Dispute Initiation		
DEFENSE PACT WITH NUCLEAR POWER	-0.365^{***}	-0.299^{***}
	(0.092)	(0.091)
NUCLEAR DEPLOYMENT	-0.009	-0.127
	(0.198)	(0.191)
NUCLEAR TARGET	0.106	-0.002
	(0.122)	(0.122)
TARGET POLITY	0.032^{***}	0.027^{***}
	(0.008)	(0.007)
DEFENSE PACT WITH NONNUCLEAR POWER	0.020	0.032
	(0.101)	(0.097)
U.S. TROOPS	-0.001	-0.001
	(0.002)	(0.002)
NUCLEAR CHALLENGER	-0.049	-0.109
	(0.102)	(0.098)
CONTIGUITY	1.146^{***}	1.100^{***}
	(0.090)	(0.085)
ALLIANCE WITH CHALLENGER	-0.021	0.011
	(0.088)	(0.087)
FOREIGN POLICY SIMILARITY	-0.323^{***}	-0.311^{***}
	(0.068)	(0.070)
POWER RATIO	0.099	0.185
	(0.163)	(0.148)
CHALLENGER POLITY	$0.018^{\star}$	$0.015^{\star}$
	(0.007)	(0.007)
CHALLENGER POLITY × TARGET POLITY	-0.002^{***}	-0.002^{***}
	(0.001)	(0.001)
SHARED RIVAL WITH NUCLEAR POWER		0.362^{***}
		(0.071)
DISTANCE FROM NUCLEAR POWER'S RIVAL		-0.041
		(0.029)
CIVIL WAR		0.242^{***}
		(0.069)
NPT		$0.196^{\star}$
		(0.083)
POST-COLD WAR		$-0.226^{\star}$
		(0.089)
CONSTANT	-2.830^{***}	-2.967^{***}
	(0.177)	(0.181)
ρ	0.186	$0.227^{\star}$
	(0.115)	(0.098)
N	85,174	85,174

NOTE: Robust standard errors in parentheses. Three time-dependence variables from each equation not reported.
*** $p<0.001$, ** $p<0.01$, * $p<0.05$, † $p<0.10$, two-tailed tests.

Table 1. *Bivariate probit estimates of foreign nuclear deployment and militarized dispute initiation.*

Appendix C

Additional Robustness Checks

Several empirical tests were excluded from "Signaling Alliance Commitments" because of space constraints. In this appendix, we present the results from several additional multivariate statistical tests.

Table 2 contains the findings from these tests.[13] We designed these tests to address a variety of potential objections that one might raise to the initial empirical analysis:

- *Only U.S. signals.* We were able to assemble a dataset of foreign nuclear deployments from 1950 to 2000 based on publicly available information, as we discussed in Appendix A. Our data collection efforts were aided by the release of formerly classified documents on American nuclear deployments during the Cold War. Yet, one might argue that our ability to code non-U.S. cases – particularly Soviet nuclear deployments – is constrained by a lack of formerly classified documents. We therefore replicated our analysis using a modified measure of NUCLEAR DEPLOYMENT that only coded U.S. cases, excluding Soviet and British deployments (Model 3).[14] The findings are largely unaltered.

- *Alternate DV.* Our dependent variable (MILITARY CONFLICT) only coded militarized disputes that resulted in at least one fatality. We adopted this criterion because there is little reason to believe that nuclear weapons would come into play during minor militarized episodes, such as the many fishing disputes that are contained in the MID dataset (e.g., Downes and Sechser 2012). However, some disputes can be quite serious even if they do not result in fatalities (e.g., the Cuban Missile Crisis), and some conflicts that result in violence may be relatively minor (e.g., a 1993 dispute between Chad and Niger involving the death of a Chadian border guard). We therefore code an alternate dependent variable based on the hostility level of the dispute: USE OF FORCE is coded 1 if a a dispute includes the use of force or war and 0 otherwise. Model 4 shows that the findings for DEFENSE PACT WITH NUCLEAR POWER weaken somewhat when we employ this alternate dependent variable, with the statistical significance declining to

[13] All of these models are based on Model 1 from Table 2 in "Signaling Alliance Commitments."

[14] This model also excludes alliances with non-U.S. nuclear powers when coding ALLIANCE WITH NUCLEAR POWER.

the 90% level. The findings for other variables in the model, however, remain broadly similar.

- *All directed-dyads.* We limited the initial analysis to "politically relevant dyads" because some countries lack the capacity to fight one another. For example, it would be exceedingly difficult for East Timor to attack Mauritania in light of the former country's inability to project power beyond its immediate borders. In Model 5, however, we include all directed dyads in the sample, yielding little change to the overall findings.[15]

- *Alternate troops measure.* If forward-deployed troops primarily serve a tripwire function, one might argue that 100 troops could perform this function as effectively as 10,000 troops. We use an alternate measure of U.S. TROOPS that is coded 1 if at least 100 troops are stationed in the target state and 0 otherwise. Model 6 shows, however, that this has little effect on the results.

- *Trade.* Some models of international conflict include trade as an independent variable (e.g., Russett and Oneal 2001), but we excluded it from the initial analysis. When we include it in the model, the effect of DEFENSE PACT WITH NUCLEAR POWER remains strong, and the other results are largely unaltered (Model 7).

- *Rare events logit.* We noted in "Signaling Alliance Commitments" that the findings were similar when we used rare events logit (King and Zeng 2001) instead of standard probit. Model 8 displays the findings that emerge when we employ this alternate estimator, showing the DEFENSE PACT WITH NUCLEAR POWER remains negative and statistically significant while NUCLEAR DEPLOYMENT is insignificant.

- *Alternate nuclear deployment measures.* We use two alternate codings of NUCLEAR DEPLOYMENT, both of which were noted in "Signaling Alliance Commitments." First, we only code cases that were at least partially meant to deter adversaries, excluding deployments that were meant mostly to extend the reach of the deployer's arsenal (Model 9). Second, we adopt a less stringent definition of nuclear deployments that allows us to include some additional cases in our coding of NUCLEAR DEPLOYMENT (Model 10).[16] Neither of these alternations significantly changes the results.

- *Recoding alliances and deployments.* In some dyads, the initiator and the target host nuclear weapons that are owned by the same country. During the 1974 Cyprus War, for instance, both Greece and Turkey had U.S. nuclear bombs on their soil. The initiator

[15]Note that this increases the size of the sample considerably, from around 85,000 to roughly 721,000.

[16]We add the "accidental" Soviet nuclear deployments to Belarus, Kazakhstan, and Ukraine; the U.S. nonnuclear deployments to Cuba and France; and the U.S. deployments to the Japanese islands Chichi Jima, Iwo Jima, and Okinawa.

and the target likewise may share a defense pact with the same nuclear power, as was the case during the 1982 Falklands crisis between Argentina and Britain. One might worry that including cases such as these could affect the results since the deterrent value of alliances and deployments could be weakened. However, Model 11 shows that the findings are similar when we only code alliances and deployments if the target has nuclear protection or hosts foreign nuclear weapons and the challenger does not.

	Model 3	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*	*Model 9*	*Model 10*	*Model 11*
DEFENSE PACT WITH NUCLEAR POWER	-0.375^{***}	$-0.143^{\dagger}$	-0.288^{***}	-0.407^{***}	-0.401^{***}	-1.097^{***}	-0.388^{***}	-0.374^{***}	-0.425^{***}
	(0.092)	(0.074)	(0.079)	(0.098)	(0.094)	(0.260)	(0.094)	(0.092)	(0.113)
NUCLEAR DEPLOYMENT	0.039	-0.018	0.079	-0.015	0.123	0.263	0.100	0.021	-0.038
	(0.187)	(0.116)	(0.132)	(0.149)	(0.154)	(0.444)	(0.174)	(0.149)	(0.137)
DEFENSE PACT WITH NONNUCLEAR POWER	0.016	-0.045	0.042	0.012	0.011	0.127	0.012	0.017	-0.014
	(0.101)	(0.079)	(0.084)	(0.101)	(0.102)	(0.275)	(0.102)	(0.101)	(0.099)
U.S. TROOPS	-0.001	-0.000	-0.000	0.132	0.000	-0.000	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.001)	(0.097)	(0.002)	(0.005)	(0.002)	(0.002)	(0.002)
NUCLEAR CHALLENGER	-0.050	0.012	$0.204^{\star}$	-0.059	-0.001	-0.079	-0.051	-0.049	-0.001
	(0.104)	(0.095)	(0.092)	(0.103)	(0.107)	(0.275)	(0.104)	(0.104)	(0.098)
NUCLEAR TARGET	0.105	$0.166^{\dagger}$	0.295^{**}	0.138	0.153	0.216	0.106	0.105	0.125
	(0.123)	(0.088)	(0.100)	(0.122)	(0.127)	(0.319)	(0.122)	(0.123)	(0.120)
CONTIGUITY	1.154^{***}	0.899^{***}	1.669^{***}	1.161^{***}	1.192^{***}	3.275^{***}	1.152^{***}	1.154^{***}	1.168^{***}
	(0.091)	(0.069)	(0.075)	(0.090)	(0.098)	(0.241)	(0.091)	(0.091)	(0.092)
ALLIANCE WITH CHALLENGER	-0.013	0.060	0.019	-0.009	0.019	-0.041	-0.011	-0.012	$-0.188^{\star}$
	(0.087)	(0.070)	(0.091)	(0.086)	(0.086)	(0.240)	(0.086)	(0.087)	(0.087)
FOREIGN POLICY SIMILARITY	-0.331^{***}	-0.277^{***}	-0.407^{***}	-0.328^{***}	-0.335^{***}	-0.771^{***}	-0.333^{***}	-0.331^{***}	-0.314^{***}
	(0.068)	(0.047)	(0.057)	(0.069)	(0.069)	(0.172)	(0.068)	(0.068)	(0.068)
POWER RATIO	0.109	$0.202^{\star}$	0.117	0.146	0.112	0.214	0.109	0.108	0.099
	(0.164)	(0.098)	(0.124)	(0.162)	(0.161)	(0.444)	(0.163)	(0.164)	(0.162)
CHALLENGER POLITY	$0.018^{\star}$	0.007	$0.013^{\star}$	$0.018^{\star}$	$0.017^{\star}$	$0.046^{\star}$	$0.018^{\star}$	$0.018^{\star}$	$0.014^{\dagger}$
	(0.007)	(0.005)	(0.007)	(0.007)	(0.007)	(0.020)	(0.007)	(0.007)	(0.007)
TARGET POLITY	0.032^{***}	0.025^{***}	0.025^{***}	0.031^{***}	0.031^{***}	0.083^{***}	0.032^{***}	0.032^{***}	0.029^{***}
	(0.008)	(0.005)	(0.007)	(0.008)	(0.008)	(0.021)	(0.008)	(0.008)	(0.008)
CHALLENGER POLITY × TARGET POLITY	-0.002^{***}	-0.002^{***}	-0.002^{***}	-0.002^{***}	-0.002^{***}	-0.006^{***}	-0.002^{***}	-0.002^{***}	-0.002^{***}
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
TRADE					$-0.000^{\dagger}$				
					(0.000)				
CONSTANT	-2.864^{***}	-2.206^{***}	-3.391^{***}	-2.906^{***}	-2.910^{***}	-6.276^{***}	-2.858^{***}	-2.866^{***}	-2.834^{***}
	(0.171)	(0.120)	(0.124)	(0.171)	(0.177)	(0.463)	(0.171)	(0.172)	(0.169)
N	85,306	85,403	721,132	85,306	85,258	85,306	85,306	85,306	85,306
Pseudo R^2	0.215	0.183	0.348	0.216	0.219	—	0.215	0.215	0.213

NOTE: Robust standard errors in parentheses. *** $p<0.001$, ** $p<0.01$, * $p<0.05$, † $p<0.10$, two−tailed tests. Three time-dependence variables not reported.

Table 2. *Probit and rare events logit estimates of militarized dispute initiation.*

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