

“The Determinants of Nuclear Force Structure”

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Data Appendix

Nuclear Force Structure Dataset (1950-2000)

This dataset provides force structure estimates for the nine de jure and de facto nuclear states through the year 2000. Our dataset includes deployed nuclear platforms for the United States (1950-2000), the Soviet Union/Russia (1956-2000), the United Kingdom (1961-2000), France (1961-2000), China (1964-2000), Israel (1972-2000), South Africa (1982-1990), India (1988-2000), and Pakistan (1990-2000). Although in several cases states deployed nuclear weapons before their coverage in our dataset begins, reliable nuclear platform information was only available for the dates listed.

The dataset was compiled from a number of secondary sources, primarily the National Resources Defense Council’s *Nuclear Weapons Databook* (Cochran, Arkin, and Hoenig 1984; Cochran et al. 1989; Norris, Burrows, and Fieldhouse 1994), the *Air Force Digest* (Air Force Historical Studies Office), the *SIPRI Yearbook* (Oxford University Press, Stockholm International Peace Research Institute), and the *Military Balance* (London: IISS, 1961). To construct the dataset, we examined these and other references to identify deployment and retirement dates for each platform. We then totaled the number of individual platforms present in each country-year to determine the number of unique deployed platforms per year for each state in the dataset. We distinguish in the data between the number of unique strategic platforms and the total number of platforms, both tactical and strategic.

Sources

The NRDC’s Databook includes data on global nuclear stockpiles (warheads and weapons) for the US and Soviet nuclear programs, and a general overview of the nuclear forces that make up the British, French, and Chinese nuclear arsenals. For the US and Soviet nuclear arsenals, the Databook provides counts of the number of warheads, launchers, and bombers per year from 1945-1994 (although we censor some of these years to ensure the accuracy of the remainder of the data).

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For data on more recent deployments, we referred to the “Nuclear Notebook” column in the *Bulletin of Atomic Scientists*. These reports provide data on the deployment of nuclear weapons by state as well as global nuclear inventories since 1945.

For data on US forces, we consulted the *Air Force Digest* (AFD), an annual publication of the U.S. Air Force Historical Studies Office. All data gleaned from this source is unclassified and available to the general public for the years 1945-2010. Due to the changing standard of publication throughout the years, there exist a number of differences between the various eras covered in the AFD source. The data was collected so as to best maintain a uniform count across all eras and minimize the effect of changes to reporting standards.

In addition, we collected data from the SIPRI *Annual Yearbooks* from 1969-2000. Written by both SIPRI researchers and invited outside experts, the *Annual Yearbook* provides details of nuclear platforms for most years and for most nuclear states. We also used the annual *Military Balance* volume from the International Institute for Strategic Studies (IISS). It contains a state-by-state accounting of the major military holdings, including nuclear forces.

Other country-specific sources were consulted as necessary.¹

Coding Decisions

In this section, we briefly describe some of our coding decisions.

Unique vs. Similar Platforms

Platforms need not be associated with different legs of the nuclear triad to be considered unique. For example, in the US arsenal, the B1-B bomber and the B2 bomber are treated as unique platforms, even though both are aircraft. Similarly, we differentiate between the Minuteman I, Minuteman II missiles, and Minuteman III missiles despite some commonalities in the types of warheads carried, accuracy, yield etc. Some key differences, such as range or mobility, generally warrant the distinction among similar platforms.

Variants of existing platforms are not treated as unique unless they have substantially different capabilities. In France’s arsenal, for example, the M-4 SLBM has two forms, A and B that are not different enough to be treated as unique. Similarly, Pakistan’s bomber, F-16A/B Falcon, has two variants that are similar enough to be considered as only one unique platform. When in doubt, we yield to various source materials on whether the delivery vehicle really represents a different nuclear platform. There tends to be substantial agreement across sources on whether two platforms should be considered minor variants or distinct.

Strategic vs. Tactical

We attempt to distinguish between tactical and strategic platforms. This is not always straightforward. There exist no clear criteria by which to distinguish between strategic and tactical (also known as theater or non-strategic) weapons systems (Kristensen 2012; Millar and Alexander 2003). We rely heavily, therefore, on our data sources to at least capture the prevailing view of analysts about particular weapons systems. In general, there is fairly broad agreement among sources on which platforms should be considered tactical and which strategic.

¹ Please see the references section below for a full list of sources used.

Tactical weapons are often characterized by a shorter range, reduced yield, or exclusion from arms control agreements, although there are many exceptions.

We follow our source material (and the countries themselves) in considering all weapons systems of Israel, South Africa, India, and Pakistan to be strategic. There is some uncertainty about whether China has deployed tactical nuclear weapons. Our measures assume they have not, but we vary this assumption in robustness checks.

We established several additional coding rules related to tactical weapons. First, to avoid double counting, we consider as strategic any weapons platform that is engaged in both a tactical and strategic mission for a particular country-year. If the strategic version of the platform is retired, but the tactical version of the platform continues to be deployed, we will then count the platform as tactical. Second, we count any nuclear artillery in a country's arsenal as a single platform and do not distinguish between different types of nuclear artillery. This is because of wide discrepancies in our source material on nuclear artillery and the similarities of individual nuclear munitions. Finally, we consider the aircraft carrying a nuclear payload to be the nuclear platform of interest; we do not count bombs, air-to-surface missiles, or air-launched cruise missiles.

Manufactured vs. Deployed

In deciding which measures to use, we opted to use the number of unique platforms deployed in a given year (rather than authorized, manufactured, in storage, etc.) because, theoretically, deployed weapons systems are most likely to have a deterrent effect on a potential adversary. In the SIPRI *Yearbook*, the *Military Balance*, and the "Nuclear Notebook", most of the data provided was for 'deployed' or 'ready' platforms. In the *AFD*, however, the categorized service status of weapons platforms experienced a number of changes over the years. In order to keep as close to a uniform count as possible across all eras, the number of platforms given are for "Possessed" from 1945-1974, "POSS" from 1977-1980, "Total active" from 1981-1988 and "Total inventory" from 1990-2010.

Source Discrepancies

We collected data on all platforms for all nine countries from as many sources as possible. Some platforms were not mentioned in all sources. Whenever possible, we erred on the side of the most comprehensive sources: the *Nuclear Weapons Databook*, the *Air Force Digest*, the SIPRI *Yearbook*, and the *Military Balance*. In some cases, when these sources omitted a platform mentioned elsewhere or were ambiguous about whether a platform had a nuclear function, we consulted other sources for validation.

Military Personnel Dataset (1950-2000)

This dataset provides the number of military personnel in the army, navy, and air force for the country-years included in the Nuclear Force Structure Dataset. The data is primarily drawn from the IISS *Military Balance*. We also used additional Soviet data from Odom (2000), UK data from Berman and Rutherford (2012), and US data from the US Census Bureau's Statistical Abstract.

Missing data

Data were not available for all country-years in our dataset. We lack Soviet army data for 1956-1959, Soviet navy data for 1955-1960, Soviet air force data for 1955-1964, and French data for 1960.

For Soviet army data, we use linear interpolation to fill in missing values, assuming a constant percentage change over the missing period. We then impute the remaining Soviet military service data by assuming for the navy and air force the same percent annual change experienced by the army.

For our missing year of French data, 1960, one source gives the total number of military personnel (Martin 1981). This total is roughly the same as the total given by the *Military Balance* in 1961. We thus repeat the personnel levels for each of the military branches in France in 1960 and 1961.

Replication Dataset

Our dataset has a country-year data structure. Additional variables necessary to replicate the findings of the study are summarized below. All variables are available in a one-year lagged variant (**_lag*).

ccode: Correlates of War country code

year: Year

diffnum_triad: Number of unique strategic platforms

diffnum_tot: Number of unique platforms of all types (both strategic and tactical)

actreatyplus2: A dummy variable that takes on the value of one if a state is the United States or the Soviet Union and has signed any of the SALT I, SALT II, START I, or START II agreements in the previous two years

airforce: The size, in personnel, of the state's air force (no imputed values included)

airforcei: The size, in personnel, of the state's air force (includes imputed values for missing data)

airforce_pct: The share of total military personnel that are in the air force (no imputed values included).

airforcei_pct: The share of total military personnel that are in the air force (includes imputed values for missing data).

alliancenum: Number of alliances with both nuclear and non-nuclear states (Gibler and Sarkees 2004)

allytotdiffnum_triad: Allies' number of unique strategic platforms

allytotdiffnum_tot: Allies' number of unique platforms of all types (tactical and strategic)

allymindist: Minimum geographic distance to a nuclear ally (Weidmann, Kuse, and Gleditsch 2010; set to 0 if there is no nuclear ally).

allynukenum: Number of nuclear weapons possessed by a state's allies (from NRDC data)

army: The size, in personnel, of the state's army (no imputed values included)

armyi: The size, in personnel, of the state's army (includes imputed values for missing data)

army_pct: The share of total military personnel that are in the army (no imputed values included)

armyi_pct: The share of total military personnel that are in the army (includes imputed values for missing data)

coldwar: A dichotomous variable that takes on a value of one for years up to 1991.

conthreat: A measure of conventional threat. First, we sum the CINC scores of a state's rivals. We then divide the summed CINC scores by the given state's own CINC score. Finally, after adding 1 to the ratio, we take the natural log of the ratio (Jo and Gartzke 2007; Klein, Goertz, and Diehl 2006; Singer 1988).

lnukeyearsplus: Log transformation of one plus the number of years since the state became a nuclear power

midslast5: Number of Militarized Interstate Disputes (MIDs) over preceding 5 years (Ghosn, Palmer, and Bremer 2004)

milex: Military expenditures from the Correlates of War project (Singer 1988)

n_cap7: Composite index of latent nuclear weapons production capability (Jo and Gartzke 2007)

navy: The size, in personnel, of the state's navy (no imputed values included)

navyi: The size, in personnel, of the state's navy (includes imputed values for missing data)

navy_pct: The share of total military personnel that are in the navy (no imputed values included)

navyi_pct: The share of total military personnel that are in the air force (includes imputed values for missing data)

nukenum: Total number of nuclear weapons held by the state in a given year (from National Resources Defense Council data with additions by the authors)

nukepact: A dummy variable representing the presence of a defense pact with another nuclear state (Gibler and Sarkees 2004)

nukeriv: A dummy variable that takes on the value of one if a state has a nuclear rival (Klein, Goertz, and Diehl 2006)

rgdp: State's real GDP (Gleditsch 2002)

rivotdiffnum_triad: Nuclear rivals' number of unique strategic platforms

rivotdiffnum_tot: Nuclear rivals' number of unique platforms of all types (tactical and strategic)

rivmidnum5: Number of MIDs between a state and its nuclear rivals in last five years (Ghosn, Palmer and Bremer 2004)

rivmindist: Minimum geographic distance to a nuclear rival (Weidmann, Kuse, and Gleditsch 2010; set to 0 if there is no nuclear rival)

rivnukenum: The number of nuclear weapons possessed by the state's nuclear rivals (from NRDC data)

usrussia: A dichotomous variable that takes on a value of one for the United States or Russia.

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