Power At Sea: A Naval Power Dataset, 1865-2011[1]

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Abstract

Naval power is a crucial element of state power, yet existing naval datasets are limited to a small number of states and ship types. Here we present 147 years of naval data on all the world's navies from 1865 to 2011. This country-year dataset focuses on warships with ship-based weapons capable of using kinetic force to inflict damage on other structures or peoples. After identifying a country's active naval forces, we create a measure of naval power based on the aggregate tonnage of the active ships. Additionally, we create count variables for ship types such as aircraft carriers or battleships. This paper introduces the country-year data, describes variables of interests for use in country-year, dyadic, or systemic studies and suggests potential questions of interest scholars could explore using the naval power dataset.

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Naval power affects international interactions. Naval power made establishing and maintaining colonial possessions possible for major powers. Naval power left its mark in the first half of the twentieth century with famous battles such as Jutland, Atlantic, Midway, Pearl Harbor, and Leyte Gulf. More recently, naval power allowed the British to reclaim the Falkland Islands in 1982. Naval power also allowed the United States to send and support large invasion forces to Iraq in 1990 and 2003. Countries seeking to project influence and protect their interests across the world's waterways need a powerful navy.

Almost all of the world's great naval powers in the last few hundred years have hailed from the West, with Japan in the first half of the twentieth century being an exception. Increasingly, however, countries from other parts of the world are devoting significant resources to the development of their navies. India has launched a nuclear attack submarine purchased from Russia (INS *Chakra*), has a domestically produced nuclear ballistic submarine undergoing sea trials (INS *Arihant*), is preparing to launch an aircraft carrier purchased from Russia (INS *Vikramaditya*), and is also domestically building another aircraft carrier (INS *Vikrant*). The launching of China's first aircraft carrier, the ex-Soviet carrier *Varyag*, has increased tensions in the South China Sea. Recently, Brazil announced a partnership with France to commission their first nuclear attack submarine by 2023. Additionally, one of the strongest naval powers from the first half of the twentieth century – Japan – has again developed one of the strongest navies in the world. These developments suggest the West's naval dominance is waning.

While new naval powers are developing, traditional naval powers continue to improve their fighting forces. The United States' position as the world's dominant naval power remains secure and will be for quite some time. Currently, the US is developing a new class of aircraft carriers, the most important vessel for power projection and influence, set to replace the aging

Nimitz class carriers with the USS *Gerald R. Ford* set to launch in 2015. Additionally, the British Royal Navy is developing their *Queen Elizabeth* class of aircraft carriers along with the deployment of a new *Astute* class of nuclear attack submarines to halt their steady decline as a naval power. As we move deeper into the twenty-first century, naval strength remains a key focus in the plans of great and aspiring powers alike.

Despite the prominence of naval power and its importance for understanding foreign policy and international interactions, the academic community lacks a dataset on each state's naval capabilities. The foremost academic source of naval data comes from the work of Modelski and Thompson (1988), yet this data is limited to the great powers, only includes one or two ship types in a given period, and ends in 1993.[2] Here we present a much larger dataset of naval power for the years 1865-2011. We present data on all of the world's navies, not just the great powers. For these years we code data on 73 countries. In addition, our dataset includes information on a larger number of ship types, including but not limited to dreadnoughts, battleships, aircraft carriers, diesel submarines, nuclear attack submarines, and nuclear ballistic missile submarines. Armed with such expansive data we are able to construct a much clearer picture of the world's navies and changes in naval power over time. Furthermore, this new data allows us to create a new annual measure of state naval strength, which we believe will be of interest to many researchers.

The paper proceeds as follows. First, we make the case for the need of a new dataset and explores potential research programs that can benefit from new data. Second, we define what our measure of naval power will represent. Third, we describe the coding procedures used in constructing the dataset and for creating our variables of interest. Fourth, we verbally and

[2] While the data presented by Modelski and Thompson (1988) ends in 1993, the last five years of data are estimates based on knowledge of construction plans in 1988 (see Modelski and Thompson 1988, 90).

graphically explore some of the characteristics of our data, and then use the new data to replicate the findings of Bolks and Stoll (2000), and finally we offer some conclusions.

NEED FOR A DATASET

A new more comprehensive dataset on naval power has the potential to offer insights into numerous political phenomena of importance affecting all countries. Current data only provides information on a limited number of ships for a small number of great powers. To this end, our measure of naval power can serve as either a dependent or independent variable, and can be used across multiple levels of analysis.

Arms races are a popular and important topic in international relations. A few studies have focused particularly on naval arms races (Bolks and Stoll 2000; Levy and Thompson 2010). However, these studies only focus on a few prominent states – primarily because they utilize the data from Modelski and Thompson (1988). Yet, even minor states are concerned about the naval strength of enemies not traditionally viewed as major powers: witness the reaction of Israel to the entrance of an Iranian frigate into the Mediterranean Sea in February 2011.[3] Naval strength is also of interest to regional powers (Lemke 2002; Mullins 1987). Because of the cross-national coverage of our dataset, scholars can extend our understanding of arms races beyond the major powers. Moreover, given the limitations of existing naval data, a re-examination of existing research with the data presented here may yield different conclusions. Later, we undertake such a study.

Additionally, the acquisition of power projection capabilities is an important topic. Abundant resources may be a necessary condition for the development of power projection

[3] See "Israel Anger at Iran Suez Canal Warship Move." 2011. *BBC News*, February 16. http://www.bbc.co.uk/news/world-middle-east-12488908 (March 18, 2012). There was similar anger when Iranian warships again entered the Mediterranean Sea through the Suez Canal in February 2012.

capabilities, but they are not a sufficient condition. Not all countries choose to convert their resources into such capabilities; Germany after World War II is the most prominent example. Fordham (2011, 601) argues that the pursuit of power projection capabilities is strongly linked to economic interests. More specifically, as a country's economy grows, they are more likely to develop the military capabilities necessary to protect their economic interests, which may further increase or at least continue their economic growth. If this economic development argument is sound, then we should see expanding naval growth for the developing countries (the BRICS in particular). With our dataset, this could be investigated.[4] Pollins and Schweller (1999: 459) link the acquisition of more military capabilities to domestic and systemic factors. Because of incomplete information on systemic naval capabilities, this argument has only received some attention. Our data can remedy that neglect.

Examining the relationship between national interests and power projection capabilities raises additional questions about the development of power projection capabilities and their use. Fighting beyond ones immediate borders is quite difficult (Bueno de Mesquita 1981). As such, a dataset whose primary focus is on military capabilities that can be used to project power over great distances will be useful to exploring the links between distance and conflict. For example, does the acquisition of significant naval power increase the probability of non-contiguous conflict? Given China's recent naval increases, this question has significant policy implications.[5] Recent work suggests a link between economic resources and participating in militarized interstate disputes (MIDs) over great distances (Markowitz and Fariss 2013). These authors

[4] Fordham (2011) uses the military components of the CINC scores offered through COW to proxy for power projection capabilities. As we argue below, there is an imperfect correlation between our measure of naval power and the CINC scores. As such, the large temporal and spatial domain of our dataset would allow for a more precise test of the relationship between economic interests and the development of power projection capabilities.

[5] Disputes over the Spratly Islands for example involve China, Vietnam, Malaysia, Taiwan, the Philippines, and Brunei. Of these China only shares a land border with Vietnam.

include the COW measure of state military capability. An expansive naval dataset would allow the exploration between a more precise measure of power projection capabilities and non-contiguous conflict. Additionally, it may be worthwhile to explore the influence of regime type on the use of power projection capabilities. Do political institutions condition the use of naval power?

Other potential applications for a new naval dataset include the increasingly popular topic of maritime security. No longer relegated to history books and Hollywood movies, piracy has become a threat to global trade. Daxecker and Prins (2012, 2013) argue that state fragility is central to predicting pirate attacks. While a functioning central government is likely of great importance, additional insights may be gained by examining state and regional naval capabilities. Additionally, our measure of naval power can be used along with the Issues Correlates of War dataset (Hensel 2001) to test hypotheses regarding strategies of dispute settlement. In summary, a great deal of political phenomena will benefit from the use of the data presented here.

COMPARISON WITH MODELSKI AND THOMPSON DATASET

Perhaps the most well known dataset containing information on naval forces comes from Modelski and Thompson (1988). While their naval data is the most extensive in use, it has several limitations. Modelski and Thompson's data only records ships for a few countries, only records a few types of ships, and ends in 1993. We must remember, however, that Modelski and Thompson created the dataset for a specific purpose – to test their long-cycle theory of international politics. Therefore, the shortcomings of the dataset are only problematic for those using the dataset outside of its original purpose.

One significant difference between the data presented here and the Modelski-Thompson data is the cross-national coverage. Modelski and Thompson created their dataset to test long-cycle theory, a theory that applies only to the strongest naval powers in the system and examines global wars. As a result, the naval data used by Modelski and Thompson (1988) only covers 11 countries.[6] Yet, power – and power projection – is not only of concern to states with visions of global power. Regional powers and other minor powers share similar concerns even if on a smaller scale (Lemke 2002). As such, a naval dataset with broader cross-national coverage can be of great use to scholars. To provide such coverage, we collected naval data on all countries in the world with a navy of at least one frigate class ship or submarine with a displacement of 1000 tons (submerged). This yields data on 73 countries.

Modelski and Thompson's data also only records a limited number of ship types for a limited number of states. The ship types recorded, as well as the countries for which data is presented, depend on the naval period, where a naval period is demarcated by the introduction of a new primary capital ship. They identify four naval periods for the period 1860-1993. For each naval period, they identify capital ships for the strongest states in the system. If a state does not possess at least 10% of the capital ships in the international system, they do not report data for that country (Modelski and Thompson 1988, 44).[7] These criteria greatly restrict the number of ship types and countries for which data are recorded.

First, countries failing to meet their 10% threshold are not included, even if they possess capital ships. For example, in the 1906-1945 period, Modelski and Thompson identify

[6] These countries include; the United States, the United Kingdom, the Netherlands, France, Spain, Portugal, Germany, Austro-Hungary, Italy, Russia, and Japan.

[7] Although, they do offer data on some countries that while possessing some capital ships, failed to meet the 10% threshold of a great power. Specifically, Austro-Hungary and Italy are never designated as great powers, yet there is some data available for these countries. Conversely, China possesses some capital ships in the post-WWII era, yet there is no data given for this country.

dreadnoughts and aircraft carriers as the premier capital ships of the day, but they only record eight countries as having these ships. Our data shows 14 countries possessed at least one dreadnought or aircraft carrier. Argentina, Brazil, and Chile, for example, each possessed at least one dreadnought during the period, yet are not included in Modelski and Thompson's data. Similarly, Modelski and Thompson do not report data for China in the post-World War II period, though China possessed both nuclear attack and nuclear ballistic missile submarines since the early 1970s. The decision is odd as the Chinese were one of the few countries in the world to possess two out of the three ship types Modelski and Thompson classify as capital ships.

Second, in Modelski and Thompson's data when a new naval period starts, capital ships from the previous naval period are no longer recorded, though these ships are still in service and, even if they are not the premier ship of the day, they are still quite powerful and capable of power projection. For example, in the mid-1970s Modelski and Thompson (1988, 330) only define heavy attack carriers rather than all aircraft carriers as a capital ship – essentially based on the standards set by the latest class of US carriers, the *Nimitz* class. Because of this, countries operating carriers after the USS *Nimitz* was commissioned in 1975, such as Britain and France, no longer had recorded carriers in the Modelski-Thompson data by 1977. This is particularly problematic when we consider the British carrier, HMS *Hermes*, served as the flagship for the British naval task force in the Falkland Islands war.[8] As such, Modelski and Thompson (1988, 91-92) show the US possessed 100% of the world's aircraft carrier capacity from 1946-1990. Out dataset shows 13 countries possessing aircraft carriers during the same period. While the US employed the largest carrier fleet in terms of tonnage and number of ships, other countries possessed and pursued such capabilities as well.

[8] For 1982, the Modelski and Thompson data list Britain as having 0 aircraft carriers, 11 nuclear-attack submarines, and 4 nuclear ballistic missile submarines.

Third, Modelski and Thompson only record a few ship types, which vary by naval period. At no point do they record cruisers, destroyers, frigates, or diesel submarines. This decision leads Modelski and Thompson to view the Japanese and French navies as equally powerful in 1935. Our data shows the Japanese navy was much stronger. Where the French had 18 cruisers, 27 destroyers, and 80 submarines, the Japanese had 21 cruisers, 101 destroyers, and 57 submarines. In addition, Japan had 4 light carriers and 5 battlecruisers; the French navy had neither.

Modelski and Thompson's data may be fine for their purposes, but to study naval power, power projection more broadly, and a host of other topics it has significant limitations.

DEFINING NAVAL POWER

Ideally, a measure of state naval power would count all ships and have a perfect assessment of each ship's ability to inflict damage on an adversary's territory or weapons systems as well as operate in conjunction with other ships for these purposes. Such an assessment would consider a ship's displacement, weapons systems, total firepower, speed, armor, maneuverability, communication systems, etc. Unfortunately, such an assessment is not possible. The variation among the many warships traversing the world's waterways both past and present is too great and the multidimensionality of this ideal power measure is too great for an analyst to reduce it to a single number.

Notwithstanding the multidimensionality of naval power and the complexity of large-scale naval operations, we propose that a useful approach to gauging state naval power is to calculate the total tonnage of a country's primary warships.[9] Such a focus is not without

[9] Scholars should be mindful of the limitations of such a decision when using this data in future research. The aggregate tonnage of a state's navy may tell us about its overall strength, but it will not tell us how well their navy will perform in a combat capacity or whether their navy is qualitatively better than a navy of comparable tonnage.

precedent. The Washington Naval Treaty of 1922 uses displacement tonnage as its primary criterion for limiting the size of each state's navy. Additionally, in the conflict literature, Lemke (2002, 149) uses warship tonnage in order to define the military reach of countries – countries with ten ships of 10,000 tons were considered to have global reach and countries with ten ships of 1,000 tons were considered to have regional reach.

While the correlation between tonnage and overall capabilities is far from perfect,[10] in general, larger ships are more powerful. For instance, in the first half of the twentieth century, battleships ruled the waves. At the time of its launching, the revolutionary HMS *Dreadnaught* was the largest and most powerful fighting ship in the world displacing over 20,000 tons with an arsenal of ten 12-inch main guns capable of firing 850-pound shells. While also powerful, the cruisers of the same era such as the HMS *Warrior* lacked the size and firepower of the battleships.[11] Today the largest ships traversing the oceans are aircraft carriers. The United States' *Nimitz* class of aircraft carriers is the largest with a displacement of roughly 100,000 tons. While these are certainly the largest of the current aircraft carriers, even France's *Charles de Gaulle* at 42,000 tons is able to carry formidable air wings capable of destroying numerous targets.

An alternative approach could focus on weapons systems. To this end, one might sum the number of guns on all ships in a state's inventory. However, basing a measure solely on the number of guns fails to acknowledge that not all guns are equal. Around the turn of the twentieth century, one would find some ships with 12-inch guns and others with 8-inch guns. The introduction of the submarine (with torpedoes), aircraft carriers (with aircraft), and missile

[10] For example, in 1908 the Germans launched the SMS *Blücher* with a displacement of 17,250 tons and in 1909 the Austro-Hungarian Navy launched the SMS *Radetsky* with a displacement of 15,847 tons. Based on displacement alone, one might think the *Blücher* was the more powerful ship. However, the *Blücher* had 8.5-inch primary guns while the *Radetsky* had 12-inch primary guns.

[11] The HMS *Warrior* displaced over 14,000 tons and had six 9.2-inch main guns.

technology make an exclusive focus on weapons systems less useful. As such, we focus on tonnage.

While deciding on what characteristic of warships to focus on is crucial for determining a country's naval power, also crucial is deciding what ships to include in the dataset. Should we follow the path of Modelski and Thompson (1988) by only focusing on the largest of warships, generally referred to as "capital ships"? Or, should we include every naval vessel in a country's inventory from the largest aircraft carriers down to the smallest patrol boats? We believe the answer lies between these two extremes.

In general, our data includes all ships with the capability of using kinetic force to damage targets for purposes beyond self-protection and that can operate outside of their littoral waters. Thus, for example, our data does not include patrol boats or ships that have a coastal defense role. In the next section we describe the data in more detail.

CODING NAVAL POWER

Data Sources

Our primary source for data is 'Conway's All the World's Fighting Ships' (Chesnau, 1980; Chesnau and Kolesnik 1979; Gardiner and Gray, 1985; Gardiner, Chumbley, and Budzbon, 1995). We have also examined Modelski and Thompson (1988), who draw primarily on Conway for the post 1865 period. The Conway series ends in 1995. After 1995, our primary data sources are *The Military Balance* published by the Institute for Strategic Studies and 'The Naval Institute Guide to Combat Fleets of the World' published by the US Naval Institute.

There are two options for recording the first year of a ship, the launch date and the service date. For a large portion of the ships included in the Conway series, the launch date rather than

the service date is available. As such we opt for the launch date because of data availability and consistency. The primary difference between the two sources of data deals with determining the first year a ship is active. While we use the launch date from the Conway series, *The Military Balance* uses the service date (that is, a ship's commission date).[12] This results in some disparity between the two sources of data as we transition from the Conway series in 1995, to *The Military Balance* in 1996. However, the disparity is minimal and is resolved in the data within a few years.

Identifying Relevant Ships

As noted previously, we argue that a valid measure of state naval power, particularly for smaller countries, will include more than just capital ships. At the same time, it is not practical, and probably not helpful for any of the research questions we suggested above, to record every single naval vessel. Choices have to be made. We chose to focus on ships that can utilize ship-based weapons to destroy land, sea, or air targets outside of their own littoral waters. To this end, we code ships and/or ship types based upon minimum tonnage and weapons criteria that change as the prevailing naval technologies of the time change. In other words, we examine the last one hundred and forty-seven years of naval history to identify qualitative changes in naval technology affecting a minimum threshold for inclusion in the data. Next, we describe how we distinguish between naval periods and how these criteria affect our choices of which ships to include in the data.

[12] For instance, the USS *John C. Stennis* - a *Nimitz*-class aircraft carrier - was launched in 1993, but commissioned in 1995. Therefore, based on the Conway series, we would consider the ship active in 1993 and 1994, but T*he Military Balance* would not consider the ship active until 1995. However, by 1995, the two sources of data would be in agreement. Hence, the disparity is rather short lived.

Naval Periods and Minimum Recording Criteria

Naval technology has changed dramatically over time. A new naval period occurs with the emergence of a new war fighting technology that gives the actor with the technology a significant military advantage in head-to-head combat. In other words, a new naval period occurs when the most dominant type of warship in the previous year is no longer dominant in the current year. For example, a pre-Dreadnought battleship is not the most capable ship type in 1910 (the super-Dreadnaught class battleships are the most capable) but compared to the premier warships twenty years earlier, it is at least as capable. Drawing on the Conway series, and Modelski and Thompson (1988), we identify four naval periods.

Our first period extends from 1865 to 1879. This represents a transitional period as ship designers began coming to grips with the technological leaps in terms of hulls, guns, and munitions. Hulls were made thicker, sometimes out of iron and sometimes out of wood. For instance, the HMS *Agamemnon* was launched in 1879 and displaced 8,510 tons. The *Agamemnon'*s relatively large displacement was due both to the increase in armor she carried, and the four 12.5 inch muzzle-loading guns mounted in two separate turrets. Nevertheless, while heavier guns with longer ranges and more explosive shells were placed on board in other ships, maneuverability was greatly compromised due to poor ship design making them easy targets for faster ships with heavy weapons. Because of all of the technological innovations there was significant variation in ship design during this period. Some important warships were large, like the HMS *Agamemnon*, and some were smaller, like the first British armored cruiser – the HMS *Shannon* – that displaced 5,670 tons. With these thoughts in mind, we adopt generous minimum criteria. Specifically, we record all ships that displace at least 1,000 tons.

Around 1880, the pre-Dreadnought emerges as the dominant warship. This begins our second period that extends through 1905. An example of a pre-Dreadnought from the period is the British HMS *Royal Sovereign* launched in 1891. Whereas the *Agamemnon* displaced 8,510 tons, the *Royal Sovereign* displaced 15,580 tons. Additionally, the primary guns of the *Royal Sovereign* were four 13.5 inch breech-loading guns capable of firing a 1,250 pound shell 12,000 yards, while the guns of the *Agamemnon* could only reach 6,500 yards. Lastly, despite being vastly heavier than the *Agamemnon,* the *Royal Sovereign* had a maximum speed of 15.7 knots: 2.7 knots faster than the *Agamemnon*. In sum, the pre-Dreadnoughts were faster, heavier, and more powerful than the battleships of the preceding period. Of course, pre-Dreadnoughts comprise a small portion of the total ships in this period, but in general ship designers were better able to integrate size and speed. For these reasons, we increase our minimum criteria to at least 2,000 tons displacement and a primary gun of 5-inches or greater. Another way to think about it is that ships that do not meet these criteria are obsolete. Ships failing to meet these criteria are generally the older wooden warships such as the British *Amethyst* class of wooden-screw corvettes built throughout the 1870s yet obsolete by the 1880s.

Period three covers the years 1906 to 1946. The launch of the HMS *Dreadnought* in 1906 ushered in the era of the battleship. The *Dreadnought* at its launching was the fastest battleship in the world and could reach a speed of 21 knots (roughly 24 mph). Additionally, she displaced over 20,000 tons when fully loaded and was armed with ten 12-inch guns. Another notable battleship of this period was the German battleship *Bismarck.* At the time of its launch in 1939, the *Bismarck* displaced over 50,000 tons and carried eight 15-inch guns. These 15-inch guns were capable of firing 1,800 pound shells. Clearly, during this time battleships became bigger and more powerful.

Equally important, in Period three we witness the emergence of the aircraft carrier and submarine. While it took the naval battles of World War II for all to recognize that the aircraft carrier was the most significant power projection ship in a state's navy, its importance was recognized at least as early as 1922 with the Washington Naval Treaty, where aircraft carriers were recognized as capital ships and limited in size.

Period three also sees the development of lethal naval power that lurks beneath the seas. The torpedo played a prominent role for the first time in naval history during the Russo-Japanese War fought in 1904 and 1905.[13] Yet the *Kaiserlich Marine* brought the true destructive power of the torpedo to fruition with the development of their infamous U-boats. These submarines tormented Allied shipping lines in the North Atlantic during World War I. In the first four months of 1917, German U-boats sank over 2 million tons of ship including an amazing 860,334 tons in April, while only losing less than 10 ships of their own (Halpern 1994, 341).

With the landscape of naval technology undergoing dramatic changes in this period, it was necessary to alter our minimum criteria for recording ships as well. We record all aircraft carriers designated as such; thus, unlike our criteria for Period two we do not require that ships have any minimum gun size. We also record all submarines designated as such. Lastly, we record all non-carrier surface warships with at least 2,000 tons displacement and 5-inch guns, or ships with 1,000 tons of displacement and at least 3 torpedo tubes.

Period four covers 1947 to the present. As the primary naval power in the period, the US Navy focused on projecting power inland. This focus leads to an era of technological advances in armaments – notably the improvement in missile technology. For instance, in the early 1950s, the US developed the *Terrier* as an effective medium-range surface-to-air missile for defending against air attacks using radar guidance systems. Shortly afterwards, the Soviet's launched their

[13] The Russian battleship, *Knyaz Suvorov* became the first ever battleship to be sunk by torpedoes.

first naval surface-to-air missile with the *Berkut*. These developments began the trend of missiles replacing the traditional anti-aircraft guns that were the primary form of air defense during World War II. This era also saw the emergence of nuclear powered ships as the US launched the USS *Nautilus* in 1954 as the first nuclear attack submarine and the USS *Enterprise* in 1960 as the first nuclear powered aircraft carrier. Both developments allow ships to inflict an incredible amount of damage while staying at sea for as long as their crews can hold out.

For Period four (1947-present) we focus solely on ship types. We record information for submarines that displace more than 1,000 tons submerged (nuclear and non-nuclear alike), frigates, destroyers, cruisers, assault ships, and aircraft carriers.[14] We should note that for the 1996-2011 data, *The Military Balance* was inconsistent in their classification of certain ship types. For instance, on a few occasions, certain ships are classified as frigates in one year, as corvettes the next year, and back to frigates the following year. In these instances, if ships were ever recorded as frigates from 1996-2011, we considered them frigates as long as they were active. Additionally for 1996-2011, we also record the class of each type for tonnage purposes; we discuss this aspect in more detail below.

Variable Creation

To create a measure of state naval strength, we draw on the displacements recorded for the individual ships. The variable *Total Tonnage* equals the sum of the tonnage for each active ship coded. For 1865-1995, the Conway series provides detailed information for every ship we code including their displacement. In other words, we know the *USS Arizona* was a US

[14] For frigates, destroyers, and cruisers we also record the guided-missile variants of these ships. Additionally, assault ships here refer to the US style assault ship such as the *Wasp* class of assault ships. These ships are not included in the dataset for their ability to land troops on foreign soil. Rather, these ships are included because of their significant air wings capable of inflicting damage independent of ground forces. In future versions of the dataset, we hope to include information on more types of amphibious ships.

battleship launched in 1915 and had a full-load displacement of 31,567 tons. This information allows us to simply sum the tonnage of all active ships for a country to create the *Total Tonnage* variable. But the data for 1996-2011 from *The Military Balance* presents a special problem as there is no detailed information on individual ships. *The Military Balance* provides counts of active ships within various ship types. For instance, we know the US had 22 active guided-missile cruisers in 2011, but we do not know the names and displacements for each of those 22 ships. Hence, simply summing tonnage across individual ships is not possible for 1996-2011.

While indeed a problem, *The Military Balance* provides a solution. Information about individual ships is not provided, but the names of the classes of ships are provided. So, *The Military Balance* tells us the US had 22 *Ticonderoga*-class guided-missile cruisers in 2011. We can calculate the tonnage for a ship type using displacement information about each class within a ship type. [15] For US guided-missile cruisers in 2011, we can multiply 22 by the displacement of a *Ticonderoga*-class ship – 10,142 tons – and see that the total tonnage for guided-missile cruisers is 223,124 tons.[16] Hence, *Total Tonnage* for 1996-2011 is calculated with the following steps. First, we record the total number of ships within a given ship type (frigates, destroyers, cruisers…etc) for every country.[17] Second, we disaggregate the number of ships within these ship types by the various active ship classes. Third, we multiply the number of ships within a

[15] For the 1996-2011, we use the 'Naval Institute Guide to Combat Fleets of the World' for tonnage information.
[16] It was frequently the case that a country had multiple classes of ships within a given ship type. For instance, in 1996 the US had 31 guided-missile cruisers. The 31 cruisers were composed of *Ticonderoga* (27), *California* (2), and *Virginia*-class (2) ships. In these instances, we coded the number of ships within each class, multiplied the number of ships by the respective class tonnage, and summed the resulting products to reach a total tonnage for a given ship type. As such, the total tonnage of US cruisers in 1996 is (10,142*27) + (10,600*2) + (11,666*2).
[17] Because we aim to capture the conventional naval power of countries, we do not include nuclear ballistic submarines in our tonnage measure. The vast disproportion between a nuclear ballistic submarine's displacement and the destructive potential of their nuclear payloads makes equating displacement with power problematic for these particular submarines. Nevertheless, as data on nuclear ballistic submarines may be of interest to scholars, we include a count variable for these submarines in the dataset.

class by their displacement (footnote 11 shows one example of this step). Finally, we sum the resulting displacements from step 3 to reach a country's *Total Tonnage* for a given year. While using information on class displacement rather than individual ship displacement may remove some of the within class variation between individual ships, we believe this variation is apt to be minimal.

We use the *Total Tonnage* variable to create an additional variable that gives insight into a state's naval power. Specifically, we adopt a procedure similar to how the Correlates of War Composite Indicator of National Capability (COWCINC) is calculated (Singer, Bremer, and Suckey, 1972). First, we sum the total naval tonnage for all states in the system for each year. Then, we calculate each state's proportion of the system total. Thus, the variable *Tonnage Proportion* is calculated as:

$$Tonnage\ Proportion_{ij} = \frac{Total\ Tonnage_i}{\sum_{i=1}^{i=n} Total\ Tonnage_j}, \text{ where i = state, and j = year} \quad (1)$$

This measure allows one to assess relative naval strength in a given year and, under certain assumptions, over time. As a state develops a larger navy in relation to other states, this number will rise. However, as other states develop their navies this value could drop if a state is not building more ships to maintain its advantage. This measure, then, not only allows us to track how powerful a state's navy is, but also how powerful it is in relation to the other navies of the world. When thinking about over time comparisons, one needs to bear in mind that this is an annual measure of *relative* strength. One could, for example, use this data to make statements about the relative strength of the US Navy today versus the US Navy in 1911. In 1911, the US possessed 13.3% of the world's naval power while in 2011 it had the strongest navy in the world, possessing 43.4% of world naval power. The *Tonnage Proportion* measure, however, does not

offer a direct comparison between the 2011 US Navy and the 1911 US Navy. Even the tonnage variable is of limited use in this regard as it does not fully capture the multidimensional nature of ship capability. For example, in 1911 the US Navy had a total displacement score of 920,682 tons. In 2011, its displacement was 2,862,437 tons. While these displacement values indicate that the 2011 US is more than 200% greater than the 1911 US Navy, we think this understates the real difference in naval strength.[18]

In addition to the above variables, we also create count variables for aircraft carriers, battleships, diesel submarines, and nuclear attack submarines (non-ballistic). These variables represent the number of active ships within a given ship type a country had in a given year. The temporal domain for the first three variables is 1906-2011. The temporal domain for the nuclear attack submarines is 1959-2011 as the first nuclear submarine was launched in the year. Creating count variables beginning in 1906 means the indicator variable for battleships represents Dreadnaught, Super-Dreadnaught, and post-Dreadnaught battleships.[19]

DATA CHARACTERISTICS

The above coding rules results in a dataset with 4,971 country-year observations for 1865-2011. Within those observations, we identify 73 different countries with some appreciable naval power at various points within the temporal domain. On average, each country has 68 country-year observations with a minimum of two observations (Georgia and Eritrea) and a maximum of 147 observations. The data results in ten countries with the maximum number of observations.[20]

[18] We point this out to again show that our data will not reflect the qualitative differences between navies and researchers must take care when making causal inferences regarding the change in naval strength over time.
[19] An additional indicator variable for Pre-Dreadnought battleships will be completed in the future.
[20] The ten countries are Brazil, Chile, France, Germany, Italy, Netherlands, Russia, Spain, United States, and the United Kingdom.

Who are the strongest navies in the world between 1865 and 2011? From our measures of naval power we can rank the world's navies from strongest to weakest. Not surprisingly, one of two states has always ranked as the strongest navy: the United Kingdom and the United States. Figure 1 shows the top five powers based on *Tonnage Proportion* for selected years from 1870 to 2010. The rankings of the top five powers by decade can be found in Table 1 in the appendix.

[Figure 1 about here]

Figure 1 not only lists the five most powerful navies for selected years, it shows the gap that can exist even among the most powerful navies. For instance, in the 1870s and 1880s a roughly 10% gap existed between the British and French navies. However, by the turn of the century, the British navy nearly doubled France's percentage of the world's naval power cementing the supremacy of the British navy. The relative strength of the British began to wane during the interwar period from 1919-1938 as the US Navy grew in stature. However, entering 1942 and despite the attacks on Pearl Harbor, the US surpassed the size of the British navy.[21]

During WWII, the industrial might of the US catapulted her to the top of the rankings. By the end of 1939, the total tonnage of US warships measured 1.7 million. By the end of 1945, it was 11.3 million.[22] This represents a 535% increase in the total tonnage of US warships throughout the course of WWII. Figure 1 shows that the gap between the US and the rest of the world remained quite large in the post-WWII period. Still, during the Cold War the Soviets did challenge US naval supremacy. Figure 5 in the appendix shows the naval competition between the US and Soviet navies during the Cold War. The two countries represented nearly *80%* of the world's naval power during this period! Our data shows an 183,560 tonnage displacement increase for the US during the Reagan years (1981-1988), but the US share of the world's naval

[21] The US launched 55 ships in 1941 including three South Dakota class battleships displacing around 44,000 tons each.
[22] 11.3 million represents the maximum value of raw tonnage for any country-year in the dataset.

power decreased slightly, from 40% in 1981 to 37.7% in 1989. With the end of the Cold War, the US Navy's preeminence has increased markedly with no single country rising to fill the void left by the shrinking Soviet navy (see Figure 1).

Figure 2 shows the power transition between the US and British navies and highlights the incredible strength of the US relative to the rest of the world. Leading into World War I, the British were at the height of their naval power. Yet, Figure 2 shows the US closing the gap during the interwar period and surpassing the size of the British navy by 1941. The figure also shows that in the second half of the twentieth century, the US enjoyed preeminence in naval power the British could only dream about in the nineteenth century.

[Figure 2 about here]

One of the most striking characteristics from the dataset is the expansion of naval power, particularly in terms of regional concentration. Figure 3 shows regional total tonnage proportions for the five Correlates of War regions from 1913-2011. The graph in the upper-right quadrant in Figure 3 shows that in 1913, Europeans possessed over 70% of the world's naval power. Less than 20% was concentrated in the Americans and less than 10% in Asia. By the eve of World War II, however, non-European powers were rising. The exponential growth of the Japanese navy in the early twentieth century meant nearly 20% of naval power was concentrated in Asia. And the ever growing US Navy resulted in nearly 24% of naval power concentrated in the Americas. Figure 3 reflects the full rebalancing of the regional concentrations of naval power in 2011. The dominance of the US Navy means the Americas control nearly 50% of naval power. Additionally, the growth of the Chinese, Japanese, Indian, and South Korean navies means that 24% of naval power is concentrated in Asia. Europe controlled over 70% of naval power in 1913 but in 2011 it only possesses 23% of world naval power. In perhaps the most poignant sign of

European decline, in 2011 the Indian navy surpassed the British navy in terms of raw tonnage.[23] The once "Crown Jewel" of the British Empire now shines brighter than the Crown itself.

[Figure 3 about here]

One of the most popular measures of military capability is the Composite Indicator of National Capabilities (CINC) from the Correlates of War (COW) project. How well does our measure of naval power correlate with the COW composite capabilities components? Figure 4 shows the correlations between our measures of naval power, the COW capability components, and the composite indicator scores. From 1865 to 2011, *Tonnage Proportion* correlates at 0.73 with the COW indicator of military power (see Figure 4).[24] This highlights that the strongest states in the world tend to possess large and technologically advanced navies.

[Figure 4 about here]

The less than perfect correlation between naval strength and COWCINC is to be expected. COWCINC does not directly measure capabilities; rather it measures factors influencing the production of military capabilities. This makes COWCINC an excellent indicator of national power or military potential. Naval strength is a direct measure of a particular military capability. As such, it should not correlate perfectly with the COWCINC. If the decision to militarily threaten or attack another state abroad is more a function of one's present naval capabilities than one's military potential, then naval strength may well be a better indicator for understanding the onset and initiation of militarized disputes.

Lastly, to supplement the aggregate tonnage measures of naval power described above, we provide count variables illustrating ship type ownership. The variables show the countries

[23] Figure 6 in the Appendix shows the rise of the new Asian naval powers versus the decline of the British navy.
[24] Readers should also note the rather weak correlation between our measures of naval strength and military expenditure. This suggests military expenditures can be applied to a wide range of military systems. A more nuanced understanding of arms races would require direct measures of military capabilities. Our measure of naval strength could help to achieve such an understanding.

possessing aircraft carriers, battleships, diesel submarines, or nuclear submarines (non-ballistic) in the past and at present.[25] For instance, the aircraft carrier indicator shows that since their first launches in the early twentieth century, aircraft carriers have flown under the flag of 14 countries and nine countries still operate aircraft carriers as of 2011. Fourteen countries have also had battleships since 1906, although no battleships are in commission today. As expected the ship type with the fewest owners are the nuclear attack submarines. Only six countries own nuclear attack submarines with India the last country to join this elite group of countries in 2010. Finally, perhaps the most common ship type are diesel submarines. As of 2011 54 countries have operated diesel submarines at some point and in 2011, 39 countries were actively operating diesel submarines.

APPLICATION

In addition to the research topics discussed above, we demonstrate the utility of the data presented here by re-examining Bolks and Stoll's (2000) research on naval arms races. They investigate whether the development of capital ships by one state increases the development of capital ships in a competitor state. They find that for most competitors this is the case. Central to their argument is that naval arms acquisition, among competitors, is significantly influenced by a count of one's competitor(s)' capital ships. We agree that this is a reasonable idea--particularly since until now there was no other naval data available for investigating alternative measures of naval power and competition—but it is not clear that decision-makers solely focus on capital ship counts.

Britain's two-power standard is the primary example of a state seemingly focusing on a count of capital ships, battleships in this case. However, when the Naval Defence Act was

[25] Tables for each ship type can be found in the appendix.

enacted in 1889, it not only called for an increase in battleships but also an increase in cruisers, a non-capital ship. Moreover, when Britain revisited the two-power standard following the destruction of the Russian fleet in 1905 (Russo-Japanese War), they took stock of their advantage in battleships *and* cruisers. Indeed, "From 1893 until the Russo-Japanese War, 26.5% of the Royal Navy's budget was devoted to building battleships. After Tsushima until the crucial year of 1909, this figure was 14.2%" (O'Brien 1998, 28). In brief, Britain was concerned about the relative size of its battleship fleet, but they also based policy on a broader view of naval strength.[26]

During the Cold War, naval competition was based more on fleet size and relative advantages than a count of the other side's capital ships. The Soviets, for example, never attempted to compete with the US in making the most important capital ship, aircraft carriers, as their naval and foreign policy strategies did not call for that type of power projection asset. Instead, the Soviet Union focused on submarines and surface ships that could engage in anti-submarine warfare (Polmar 1992).[27] As the Modelski and Thompson data only includes capital ships, it misses much of the defensive focus of the Soviet navy. Further, because of the Soviet focus on submarines, the US made a concerted effort to develop destroyers and frigates to track and destroy Soviet submarines. To this end, the Reagan administration's goal of a 600-ship navy did not involve a significant acquisition in capital ships; it was primarily geared around non-capital ships. In other words, one should think of the Cold War naval competition less in terms of an arms race and more in terms of a strategic naval rivalry. In a strategic naval rivalry, the focus

[26] Similarly, Japanese policy in this period also focused on developing battleships, destroyers, and cruisers. The Russo-Japanese War began when Japanese destroyers attacked the Russian fleet at Port Arthur, destroying two battleships in the process.

[27] Indeed, Khrushchev stated that, "I'll admit I felt a nagging desire to have some [aircraft carriers] in our own navy, but we couldn't afford to build them." He went on to say that, "submarines represented an effect defensive capability as well as reliable means of launching a missile counterattack" (quoted in Polmar 1992, 79).

is on the composition of the entire fleet and how that fleet serves the state's larger political and military objectives. In summary, capital ships do not seem to be the major focus of either side during the Cold War. With these thoughts in mind, we substitute our measure of naval tonnage for the count of capital ships and re-run Bolks and Stoll's (2000) models. The findings are quite a bit different (see Table 6).[28]

Bolks and Stoll (2000) offer two pieces of evidence for the claim that major power naval buildups are influenced by competitors' naval acquisitions. First, they find that a variable measuring the three-year lag in a competitor's capital ships has a statistically significant and positive influence on a state's capital ships total. Second, they estimate a seemingly unrelated regression and reject the null hypothesis that each country's capital ship development is independent of the others.

In their seemingly unrelated regressions for the period 1860-1939, Bolks and Stoll find a positive and statistically significant estimate on the competitor variable for the following states: Great Britain, United States, France, Germany, Austria-Hungary, and Russia; the variable is not significant for Italy and Japan. Our findings are not entirely the same (see Table 6). We find that the competitor variable is statistically significant for Great Britain, Germany, France, Japan, and Russia; the variable is not significant for Italy and the United States; and it is significant and negative for Austria-Hungary. These differences are noteworthy. Most observers, for example, probably think of Japan as engaged in a naval arms race with its competitors, which our data confirms. Further, it is less clear that the US was arming against anyone prior to World War I. First, Bolks and Stoll list Germany as the US's competitor for 1899-1915, but historiography around the German Naval Laws makes no mention of the United States (see for example, Massie, 1991, 179-185). From the US perspective, while there was some overstated fear of

[28] Full model estimates are in the online appendix.

Germany naval activity in the Caribbean and South America that may have warranted US naval growth, the reality is that from 1899 through 1915 the US lacked any coherent naval policy (O'Brien 1998, 105). This only began to change with World War I and a new policy enacted in 1916 that sought for the US Navy "to be equal to the most powerful maintained by any other nation" (O'Brien 1998, 117). Second, for much of the period after World War I, the US bound itself to the Washington Naval Treaty and did not engage in competitive arming. We also find that the competitor variable has a negative effect on Austria-Hungary's tonnage. Given the weakness of the Austro-Hungarian Empire, this is not surprising. It simply could not keep up with others. Our data suggests that while Austria-Hungary did show a minor increase in capital ships for a couple of years it came at the expense of building other ships. Moreover, in contrast to Bolks and Stoll, we reject the null hypothesis, at conventional significance levels, that the individual equations are not related. In brief, we find more evidence for naval arms racing in this period than Bolks and Stoll.

In our replication of Bolks and Stoll for the period 1946-1986, we also reach different conclusions. Specifically, our estimates show that there is no relationship between the tonnage of the Soviet navy and the tonnage of the US Navy and we accept the null hypothesis that each equation in the seemingly unrelated set of equations is independent.

We believe this is not surprising due to the nature of the arms competition occurring during the Cold War and our measure of naval power. First, as discussed above, the US and the Soviet Union were not competing in capital ships. Naval acquisitions were one part of the larger nuclear and geopolitical competition. Where the US placed a much larger focus on developing traditional power projection capabilities (that is, aircraft carriers), the Soviet Union had a much greater focus on sub-surface vessels to deter or weaken American involvement in Eurasia in case

of a war; as a result, the Soviet Union never sought to challenge US supremacy in terms of aircraft carriers yet managed to be on par with the US in terms of nuclear attack submarines by the end of the Cold War. Second, the measure of naval power used in this replication, total tonnage, shows that the US decreased in naval power for much of the Cold War. This results from the huge World War II arsenal being slowly decommissioned,an aspect of naval power one would miss with the Modelski and Thompson data.

CONCLUSION

As we move deeper into the twenty-first century, naval power will continue as a key topic in the international community. This article introduces a new dataset on naval power that can help us understand the relationship between naval power and numerous political phenomena. The naval power dataset we present here includes six variables – state naval tonnage (continuous), state tonnage proportion (continuous), aircraft carriers (count), battleships (count), diesel submarines (count), ballistic and non-ballistic nuclear submarines (count) – measured annually from 1865-2011. The expansive spatial domain of our dataset allows scholars to apply naval power to studying the actions of major and minor powers alike. Additionally, the temporal domain of the dataset allows for studying contemporary issues as well as historical issues. We believe scholars will find this data helpful as they seek insights into numerous topics in international relations and foreign policy.

Figure 1: Top Five Naval Powers by Proportion

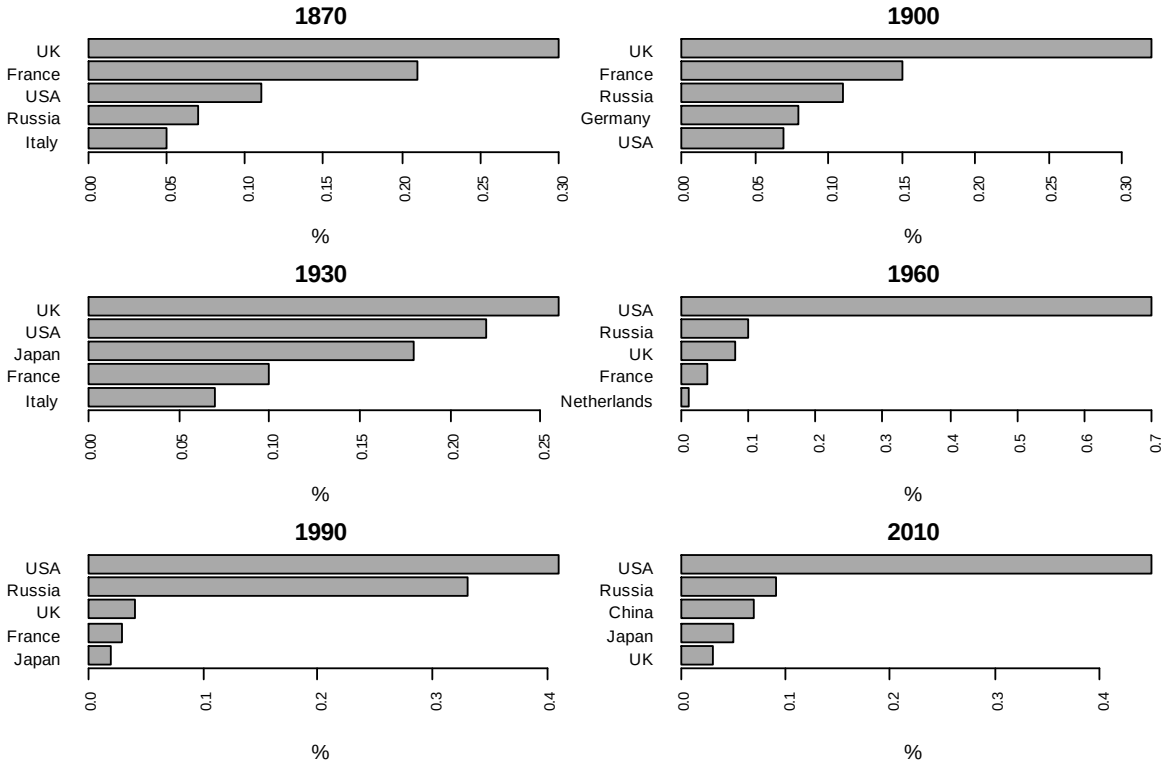


Figure 2: Britain vs USA: 1870-2011

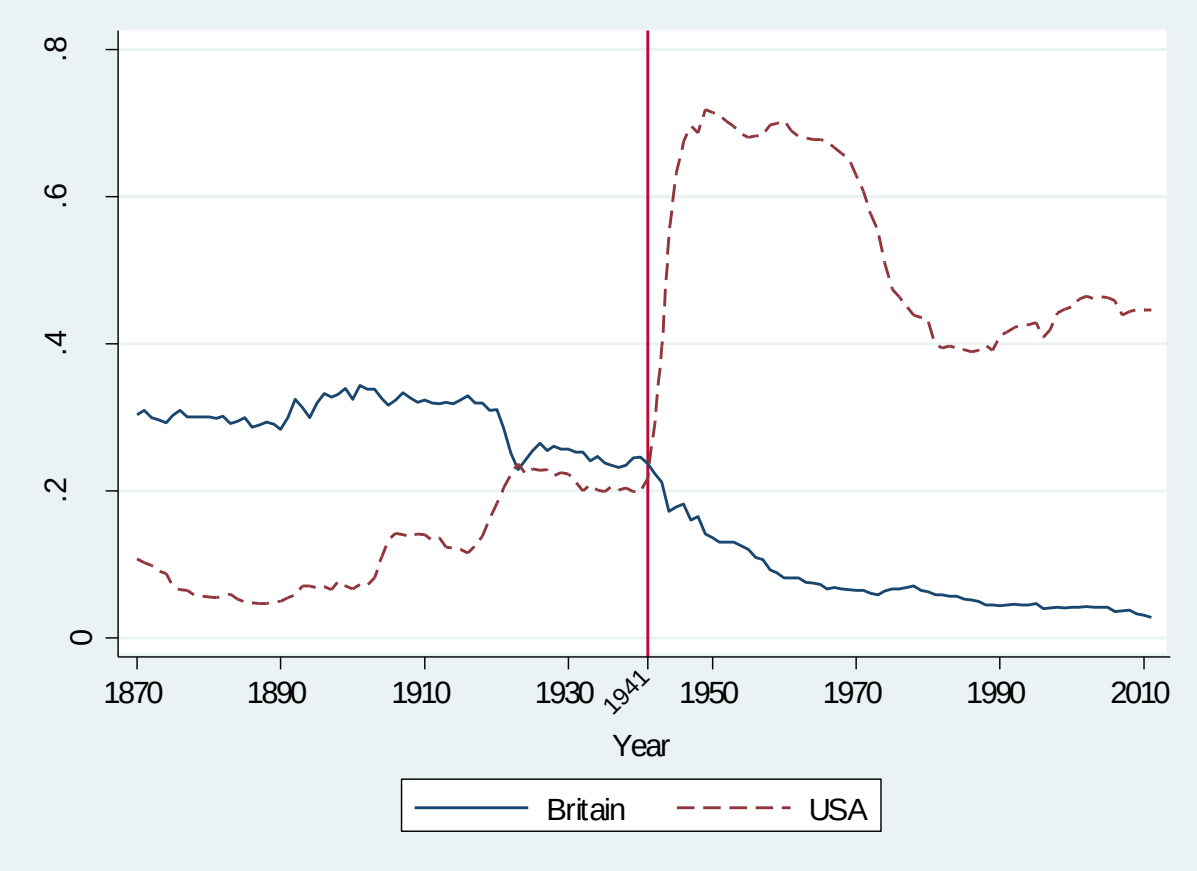


Figure 3: Tonnage Proportions by COW Regions

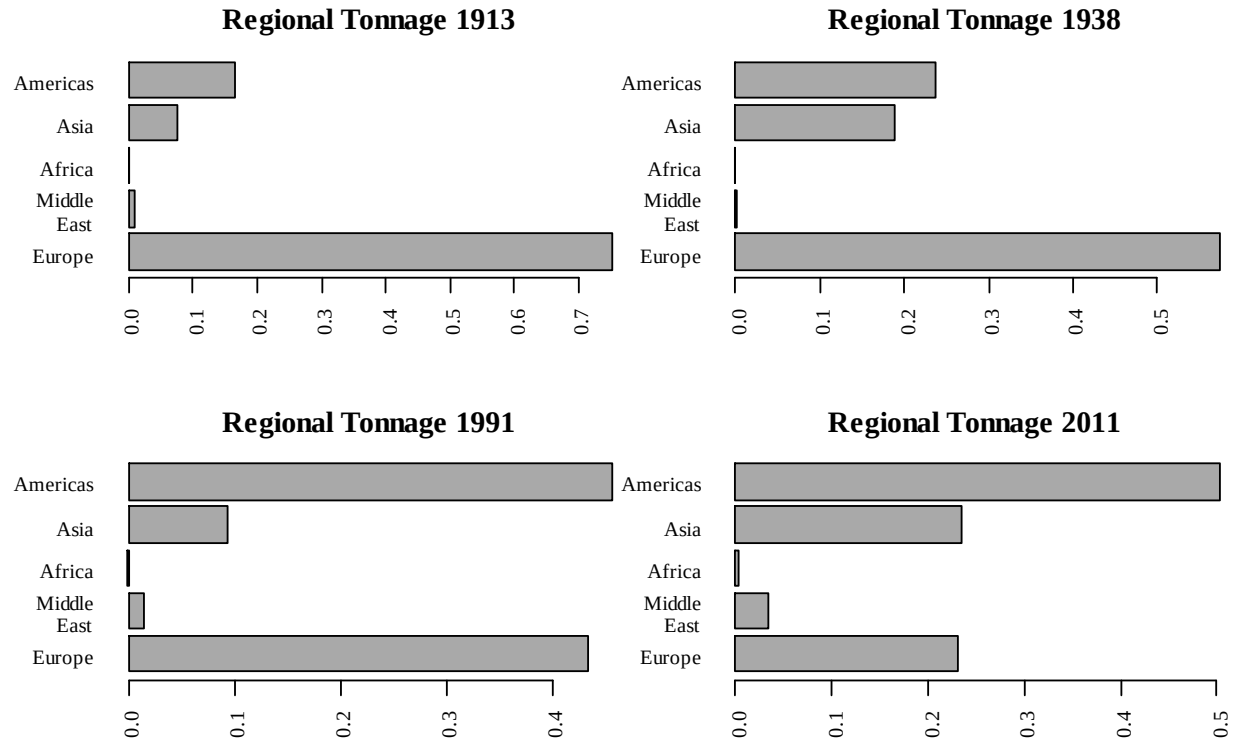
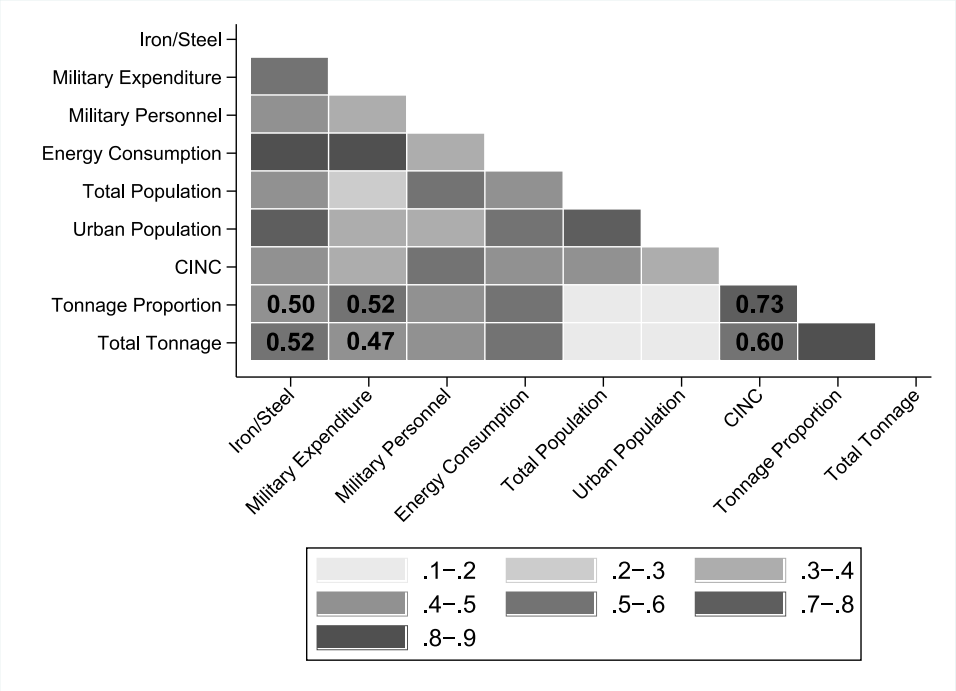


Figure 4: Correlations Between Naval Measures and CINC Components



Appendix:

Table 1: Top 5 Naval Powers by Decade

1870		1910		1950		1990	
Country	Tonnage	Country	Tonnage	Country	Tonnage	Country	Tonnage
United Kingdom	379356	United Kingdom	2020544	USA	9220999	USA	4044135
France	259044	USA	872891	United Kingdom	1752134	Russia	3255723
USA	133852	France	793473	Russia	608294	United Kingdom	432107
Russia	83413	Germany	792020	France	434748	France	247990
Italy	68852	Japan	415630	Italy	134864	Japan	202330

1880		1920		1960		2000	
Country	Tonnage	Country	Tonnage	Country	Tonnage	Country	Tonnage
United Kingdom	542720	United Kingdom	2785282	USA	9438732	USA	2830827
France	381419	USA	1640243	Russia	1283973	Russia	671070
Germany	150157	Japan	900067	United Kingdom	1094343	China	303348
Russia	122644	France	889689	France	476614	Japan	286680
Italy	109375	Germany	859935	Netherlands	100646	United Kingdom	278020

1890		1930		1970		2010	
Country	Tonnage	Country	Tonnage	Country	Tonnage	Country	Tonnage
United Kingdom	672207	United Kingdom	1624701	USA	7592741	USA	2764547
France	429532	USA	1407196	Russia	2019941	Russia	545830
Italy	211011	Japan	1112424	United Kingdom	773344	China	429168
Russia	210129	France	667013	France	354538	Japan	320680
Germany	169949	Italy	423648	Netherlands	99540	United Kingdom	201000

1900		1940		1980	
Country	Tonnage	Country	Tonnage	Country	Tonnage
United Kingdom	1354192	United Kingdom	2414086	USA	4187127
France	641268	USA	1956867	Russia	3080838
Russia	446686	Japan	1865236	United Kingdom	612251
Germany	351919	France	880240	France	267545
USA	275272	Italy	863777	China	116366

Table 2: Countries with Battleships: 1906-2011

Country	Number of Years with Battleships
United States	74
Brazil	45
Chile	46
Argentina	45
United Kingdom	54
France	62
Spain	25
Germany	25
Austria-Hungary	18
Italy	48
Greece	18
Russia	48
Turkey	1
Japan	40

The above numbers represent the number of years a country operated at least one battleship.

Table 3: Countries with Aircraft Carriers: 1906-2011

Country	Number of Years with Carriers
United States	100
Canada	23
Brazil	56
Argentina	38
United Kingdom	95
Netherlands	21
France	92
Spain	30
Italy	29
Russia	40
Japan	27
India	51

Thailand	15
Australia	37

The above numbers represent the number of years a country operated at least one aircraft carrier.

Table 4: Countries with Diesel Submarines: 1906-2011

Country	Number of Years with Diesel Subs
United States	84
Canada	50
Cuba	21
Colombia	16
Venezuela	52
Ecuador	16
Peru	93
Brazil	85
Chile	81
Argentina	81
United Kingdom	89
Netherlands	99
France	95
Spain	84
Portugal	77
Germany	71
Poland	67
Austria-Hungary	12
Italy	89
Albania	3
Croatia	16
Yugoslavia	70
Greece	80
Bulgaria	29
Romania	53
Russia	106
Estonia	43
Latvia	15
Ukraine	3
Finland	17
Sweden	90
Norway	67
Denmark	74
South Africa	14
Algeria	16
Libya	36
Iran	20
Turkey	85
Egypt	55

Syria	4
Israel	30
China	57
Taiwan	39
North Korea	16
South Korea	16
Japan	94
India	44
Pakistan	40
Thailand	14
Vietnam	14
Malaysia	3
Singapore	14
Indonesia	16
Australia	47

The above numbers represent the number of years a country operated at least one diesel submarine.

Table 5:

Countries with Nuclear Submarines (non-ballistic): 1959-2011

Country	Number of Years with Nuclear Subs
United States	53
United Kingdom	52
France	38
Russia	53
China	42
India	2

The above numbers represent the number of years a country operated at least one nuclear attack submarine.

Figure 5: Superpower Naval Development: USA vs USSR (1946-1991)

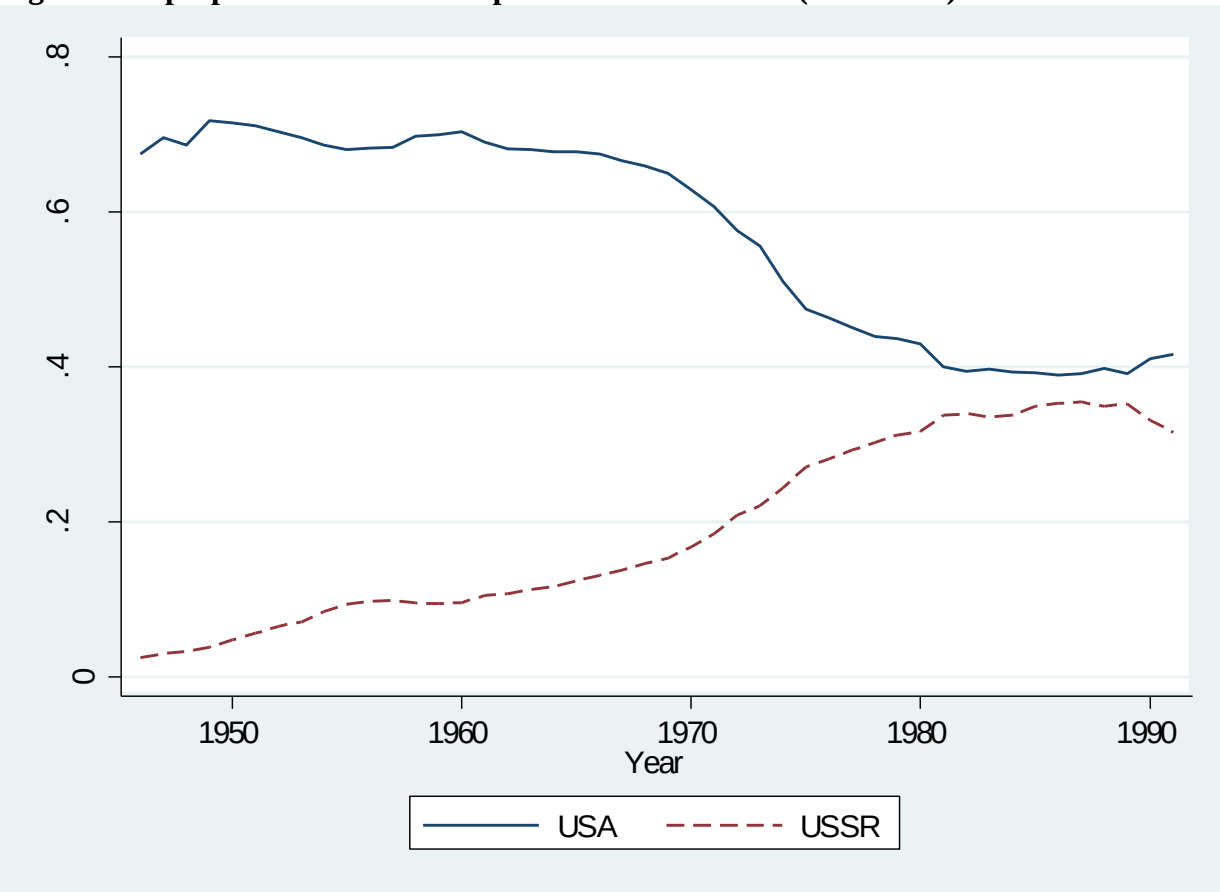


Figure 6: UK vs Rising Asian Powers: 1980-2011

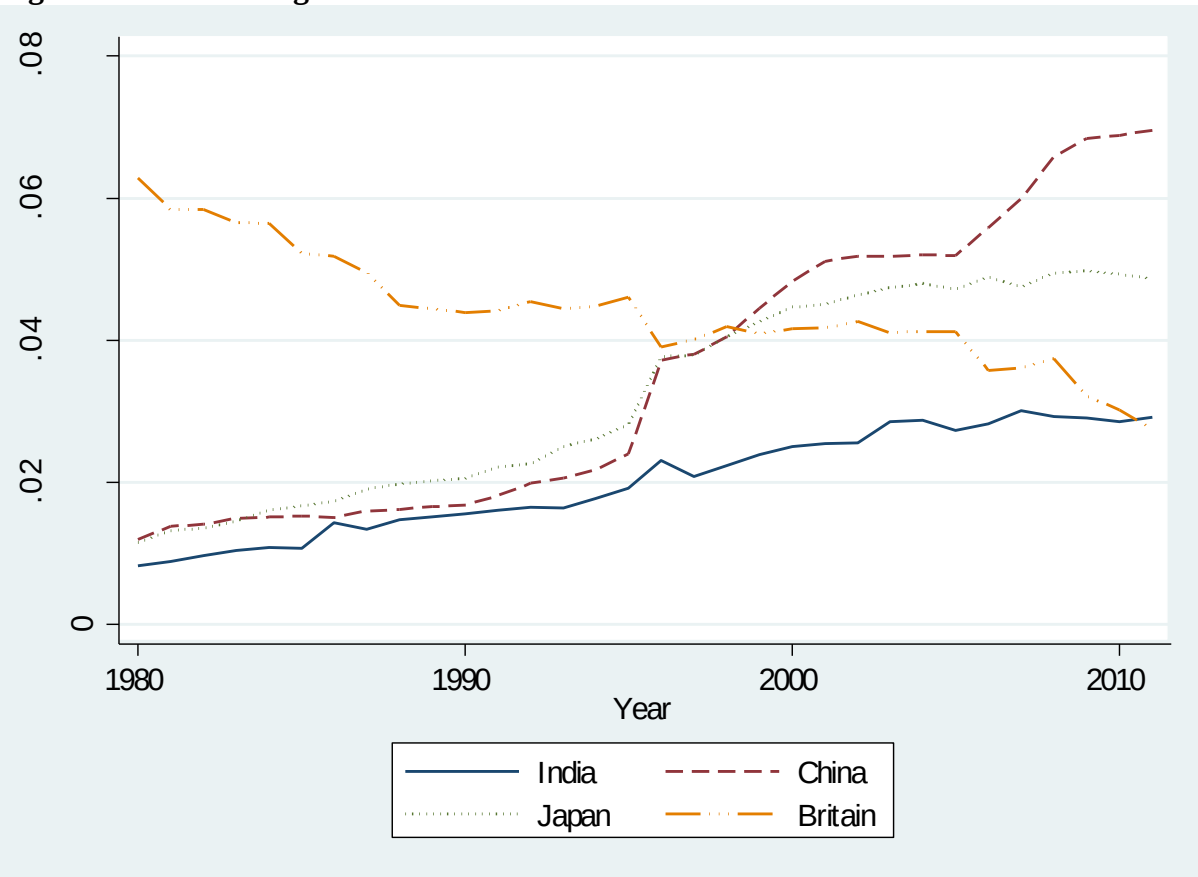


Table 6: Replication of Bolks and Stoll (2000) Tables 1 & 2 Substituting State Naval Tonnage for Capital Ship Count

Table 6a: 1860-1939								
	Britain	France	Germany	Italy	Russia	Japan	USA	Austria-Hungary
Competitor Tonnage	0.370 (0.081)*	0.128 (0.021)*	0.045 (0.021)*	-0.007 (0.031)	0.092 (0.018)*	0.114 (0.047)*	0.041 (0.039)	-0.074 (0.024)*
Table 6b: 1946-1986								
	Britain	France	Soviet Union	USA				
Competitor Tonnage	-	-	-0.030 (0.040)	-1.19 (0.627)				

* indicates significance at the 0.05 level. Estimates are from Seemingly Unrelated Regressions. Chi-square for Breusch-Pagan: 78.67 p = .00 for Table 6a; 4.792, p = .57 for Table 6b
All models contain the following control variables: hostility, deficit, institutions, lag of tonnage, war involvement, war outcome, 1880 dummy, 1910 dummy, and allocation. See Bolks and Stoll (2000) for more discussion of the variables and our online appendix for full model results.

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