An Index of Country Power: Military Capabilities, 1494-1945

Peter Brecke
The Sam Nunn School of International Affairs
Georgia Institute of Technology
Atlanta, GA 30332-0610

peter.brecke@inta.gatech.edu

An Index of Country Power: Military Capabilities, 1494-1945

ABSTRACT

This article introduces and describes a new, long-term index of country power defined in terms of four measures of a country's war-fighting capabilities. Two components of the index are direct combat capability measures: the number of major naval combat vessels and the number of field combat troops. The other two components serve as measures of a country's latent capabilities to fight a war: the country's population and its level of industrial production. The index, which is operationalized as each country's share of the total power of the set of countries, has been constructed for 12 countries. The article describes the design of the index with respect to the concept of power and details the data sources used and how the four measures and power index were created. Different aspects of the power share time series, including comparisons with previous time series measures of country capabilities, are discussed. The paper also suggests potential applications of the new index. Interested individuals can obtain the raw data and power shares indices from a webpage set up by the author.

KEY WORDS: power, capabilities, index, evidence, conflict early warning

INTRODUCTION

The question motivating this paper is: What is the impact of international system structure on the level of violent conflict in the international system?

That is, do changes in system structure matter in terms of having an effect on the amount and perhaps severity of warfare? An entire corpus of research asserts that it does (James, 2002). To be precise, we need to be clear about what we mean by changes in system structure. Change in the international system's structure can most simply be defined as differences or changes in the following variable: the number of countries that have, at least potentially, a significant independent effect on the tenor of international relations at any given point in time. It can also be defined as differences in the variable: the relationships between the countries in terms of how much significant independent effect they have with respect to each other. The latter definition is probably more important.

This paper attempts to improve our ability to answer the question posed above by enhancing our ability to identify changes in the international system. One area in which enhancements can be made is the measurement of the variable used to define system structure. That variable is power. This paper strives to provide a measure of country power that is at least equal to and in some ways superior to existing measures of country power.

The first goal of this paper is to demonstrate three things. First, that the index described in this paper is at least equal to if not superior to any existing measures of country power or capabilities with respect to how well the index represents the concept of power through how it encompasses the components of power; that it possesses construct validity. Second, that this index is superior to existing measures in terms of the time frame spanned and with that the ability to discern large-scale, long-term patterns of the international system such as the situation of power parity or preponderance or the power polarity of the system. Third, that the index is in fact on a par with the best existing measures in terms of the reliability of the data.

From that basis there is a second goal. That is to make the case that by combining the three virtues, this index is a significant empirical step forward that will perhaps enable us to answer some fundamental questions with respect to structural realism, especially neorealism. Beyond that, the paper also points out a methodology for answering other questions with respect to the causes of war.

The practical benefit of reading this paper for those not normally interested in measures of country power is that it may instigate a reevaluation of who was powerful when and in what ways each had power.

THEORETICAL BACKGROUND

If one examines the conflict early warning literature, or perhaps more tellingly, the recent and current efforts to achieve practical, usable early warning, one finds an emphasis on variables or indicators quite divorced from theoretical work. The lists one can find consist either of what is readily collectable or of almost anything feasible, often with limited theoretical input (Dolynykova, 1986; Esty, et. al., 1999; Barringer, 1972). Our theorizing is not guiding practice. Why is that? First, current theories tend to be abstract and general and provide little guidance as to what collectable indicators for particular conflicts should be. Second, even allowing for that and limiting oneself to explicitly stated variables, the guidance from the theories as to which variables are most important or what conditions of the variables are potentially dangerous is at best confused.

For example, even as fundamental a tenet (and hypothesis) of the realist school of thought and, especially, neorealist theory as '*the structure of the international system is one (perhaps even an important) determinant of the stability of the system and amount of war between the most powerful countries in the system*' has not yet been answered (Cashman, 1993). And that failure needs to be considered in light of the facts:
1. structural realism and neorealist theory have to a significant extent been developed around that very topic,
2. the topic has enjoyed the attention of a comparatively large amount of careful thinking, and,
3. a significant body of empirical work has been conducted to test that tenet.

How can this failure of a fundamental tenet of a major theoretical tradition to rest on or be supported by a sound empirical foundation continue? While many academics in international affairs/relations/politics believe realism or neorealism to be essentially correct, or at least part of the answer, there yet needs to be a determination whether this tenet is soundly supported and thus a good foundation. Some, perhaps most, academics who examine these questions believe that the international system probably does have some impact, but the question is how and how much. And of course there are many who think that realism and neorealism are totally ineffective or at best limited, either in the domain of situations for which they are accurate or in terms of their accuracy for any domain.

We may operate as if the tenet is true, but it has not yet been proven to the level of reasonable certainty. And if this tenet is not true, then we have to seriously question the theoretical traditions, especially neorealism, that rely, at least in part, on it.

The problem may lie in that theorizing has not been sufficiently constrained by empirical evidence for it to really move forward. Part of the reason for that *may* be that theorists are not heeding and responding to the empirical findings, but given that the findings are often contradictory and not compelling (Cashman, 1993; James, 2002), we should not be surprised that this may occur.

Another culprit may be that the empirical research is not really compatible or commensurate with the concepts manipulated by the theorists. The empirical variables being tested do not really correspond to the theoretical variables. This possible problem can be explored.

Let us consider what needs to happen or needs to go right for theory and evidence to truly speak to each other in order for us to make progress and create new knowledge. What we need is to navigate a set of process steps or pathways, as detailed in Figure 1. There we see that getting the process to work right and actually bringing the two pathways together entails considerable effort and attention. Even reading the figure demands unusual attention. The ideal sequence for reading the figure is as follows: Start at the upper left and move "southeast" to Hypotheses of variable behavior, examining the explanatory text on the second page of the figure to make clear what I am referring to. Then, start from the lower left and move "northeast" to Analytical methods..., again referring to the second page of the figure. Then it makes sense to look at the feedback mechanisms whereby each of the steps can be improved.

The take-home point of this figure is to make clear that refinement in analytical methods is not a sufficient cure, a conclusion one could infer from Bremer, Regan, and Clark (2003). As we shall see later, there are many other challenges that need to be overcome.

Figure 1

Pathways from Theory and Information to New Knowledge

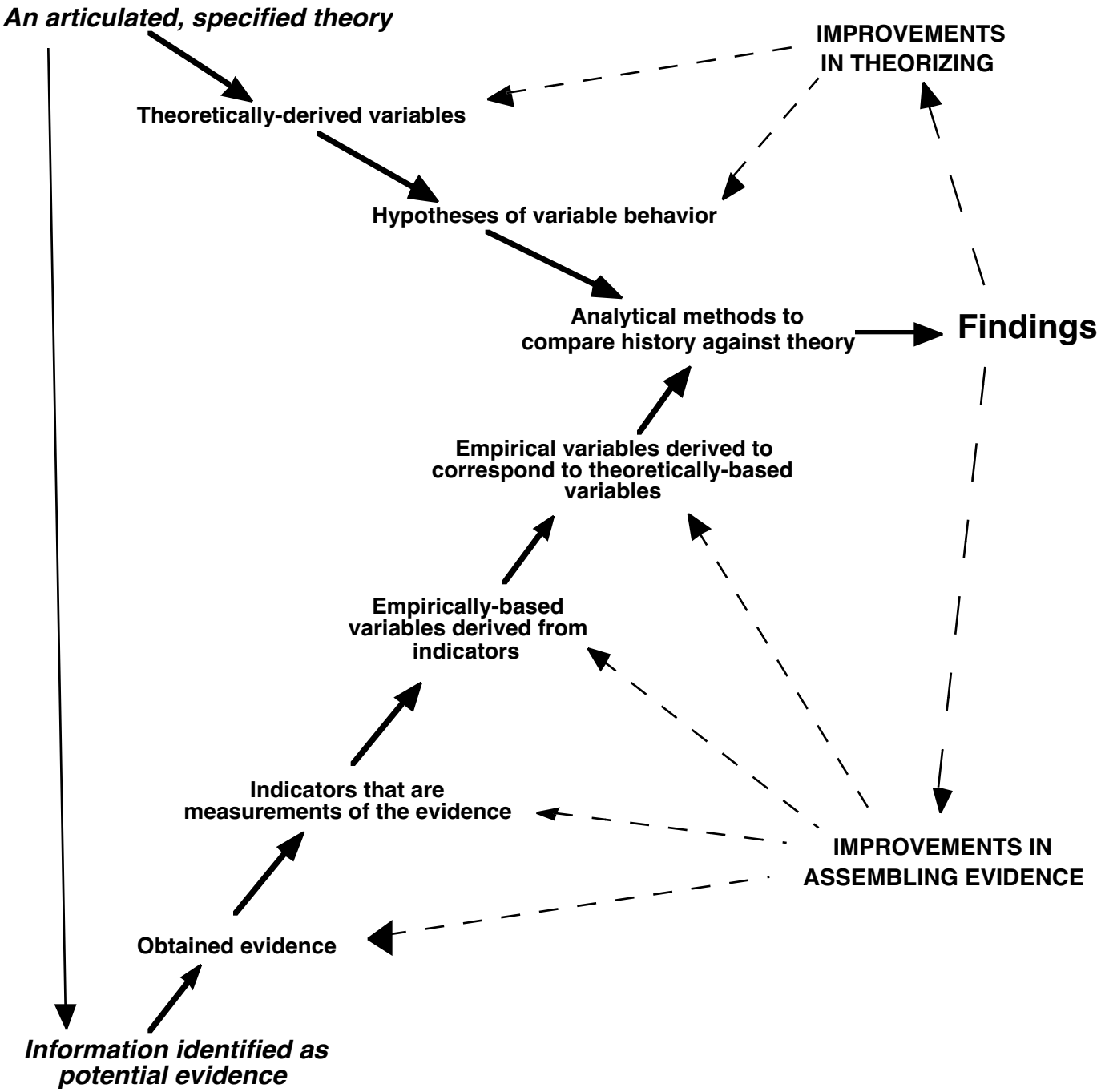


Figure 1, page 2

An articulated, specified theory
- at any given level of detail with respect to the larger problem or phenomenon
- for example, Marxism
- for example, the effect of system polarity on the stability of that system
- for example, how and why left-leaning governments support central bank independence

Theoretically-derived variables
- correspond to some aspect of the theory
- describe behavior of an important aspect of the phenomenon
- ideally defined with considerable precision
- for example, power parity, power preponderance, power polarity

Hypotheses of variable behavior
- especially behavior in particular situations
- for example, systems with a balance of power experience greater stability
- for example, bipolar systems experience less violent conflict than other polarities

Analytical methods to compare history against theory
- appropriate to data and hypotheses

Empirical variables derived to correspond to theoretically-based variables
- not always necessary
- a transformation made to equivalence the variables
    * theoretically-derived ones to empirically-based ones
- may be a measure of a variable's behavior across cases or time
- for example, calculated power polarity, power parity, etc.
- for example, phases of a power cycle

Empirically-based variables derived from indicators
- of theoretical and/or practical interest
- typically proxy variables, indices, or scales
- for example, power derived from troops, ships, people, and industrial production

Indicators that are measurements of the evidence
- appropriate to what they are to comprise or represent
- for example,
    - size of field combat armies
    - number of major naval combat vessels
    - population
    - amount of industrial production

Obtainable evidence
- information may be useful but not available
- preferable to have an understanding of the evidence's representativeness, comprehensiveness, and reliability
- look for nonstandard sources such as in different languages

Information identified as potential evidence
- guided by theory

While we can undoubtedly make improvements in our execution of each of the steps, there is reason to believe that significant flaws on the empirical side exist at two steps in Figure 1: 1) Empirically-based variables derived from indicators and 2) Variables derived to correspond to the theoretically-derived variables. For instance, when we examine the empirical research relating system structure to violent conflict, we find that a country's power is measured solely in terms of its GDP relative to other countries (Kugler and Organski, 1989; Mearsheimer, 2001), or that the simple number of major or great powers (and not taking into account the distribution of power among them) serves as the definition of the polarity of the system (Levy, 1984), or that power parity exists when a challenger has more than only 2/3 the power of the more powerful country (Moul, 2003). It is difficult to believe these measures truly correspond to what most theoreticians intended.

To address likely problems at the step: Empirically-based variables derived from indicators, we need to evaluate the character and specification of probably the most important variable underlying research in this area, power. Executing this task serves as the focus of this manuscript. Other papers by the author address problems with the step: Variables derived to correspond to the theoretically-derived variables

As we move forward, the paper first defines the character of power that seems to be what at least most theorists have in mind. It compares that character with measures of power that have been used up to this point in empirical tests. Because that comparison demonstrates a significant disjoint between theory and current practice, the paper then develops a measure of power that exhibits three virtues: 1) better compatibility with theory, 2) at least as reliable as existing measures, and 3) of sufficient scope in terms of the length of the time series so that there can be significant samples of the variables that describe the nature of the international system. The third virtue is desirable because it enables (and in this research project generates) greater variation in the independent variable, a desirable trait of one's research design (King, Keohane, and Verba, 1994). With respect to answering questions about the effect of system structure, one only need look at the figures in Doran and Parsons (1980)—we see only parts of cycles—or consider that Organski and Kugler (1980) had a sample size of only 6, forcing creative extensions (Lemke, 1996), to see that going back to 1816, as long a time span as that may seem for many purposes, is insufficient for answering the question at the beginning of this paper.

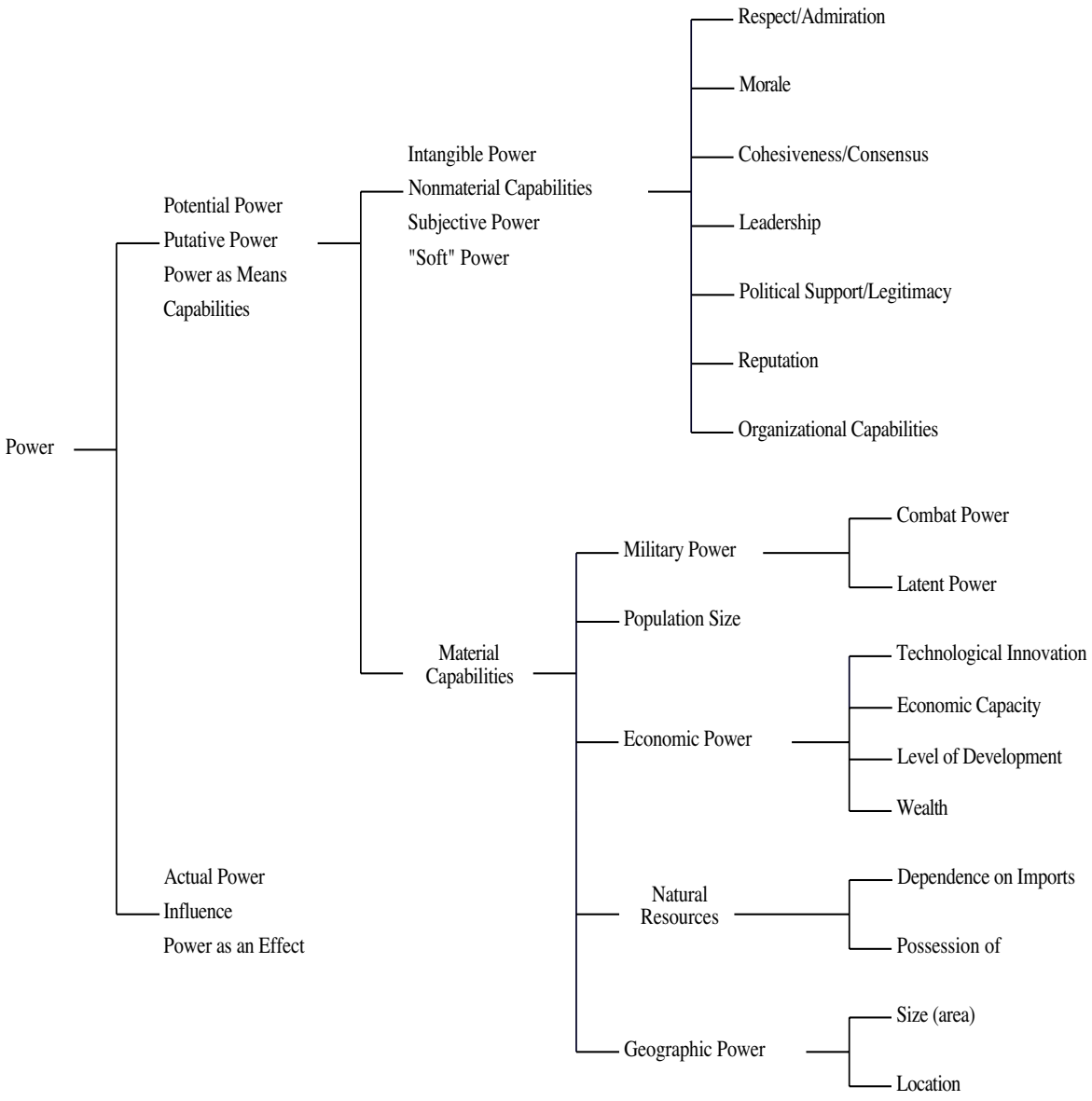
The paper describes the components of the new power index, the sources for the components, how the time series were generated from the data in the sources, and special notes about the components that a potential user should know. After that the paper shows some examples of the resulting power or capabilities measure and compares it to alternative measures such as the share of GDP and the CINC score (Composite Index of National Capabilities) of the Correlates of War project.

THE CHARACTER OF POWER

The starting point for this section is the desire to determine what aspect or type of power is most relevant to the question of the relationship of system structure to the amount of conflict in the system. The academic literature is replete with many different kinds or definitions of power and lists of the components of power (Spanier, 1975). A retelling or relisting of those definitions and components will not be done. Instead, Figure 2 attempts to portray the structure of the concept of power. It combines the contributions of many authors and aspires to properly combine those terms that seem to be essentially the same and at the same time to distinguish those terms that have been proposed as elements of what we think of as power.

Figure 2

Components of Power



The most fundamental distinction in (or, alternatively, the first step for deconstructing) power is whether one is referring to actual power or putative power (Knorr, 1975).

Actual power is power as an effect; actual power is the degree of influence on events and outcomes that a social actor, in this case states, enjoys; actual power is something we know after the fact.

Putative power is power as means; putative power is potential power; putative power is defined in terms of a country's capabilities. Putative power is the power you and others perceive a social actor to have and can employ now or in the future.[1]

This paper focuses on power conceived of as capabilities as opposed to power as the ability to bring about a particular outcome (influence). At one level, the distinction is fairly subtle, but there is a difference if one is concerned about power evaluations involved in a decision to go to war or not, or if one is concerned with who will or did prevail in a war. Power thought of in terms of capabilities is probably more germane to the decision of going to war because decision makers presumably assess a potential opponent's capabilities before making the decision. In contrast, power thought of in terms of the ability to bring about a particular outcome is probably more relevant to the question of who prevailed or will prevail and is likely to incorporate the more intangible or "soft" components of power that are often decisive but hard to discern in advance such as morale or leadership (Nye, 1990).

When one examines Figure 2, a question that may come to mind is what are the components of actual power? They are almost certainly the same components, or a subset, as for putative power. How could something be a component of actual power and not be part of putative power? It is difficult to imagine that a factor known to be important in the past would not be considered when attempting to determine potential power. There is thus only one way for the list of components of actual power to exceed the list of components of putative power. It is possible there may be important factors not currently included in enumerations of putative power, for example, the manner or approach by which children, especially males, are raised that may in the future emerge as an important factor. We would hope those instances of unanticipated factors emerging to be relatively rare. But in any case, there is not much we can do about that except to try find new, unanticipated factors that would then become components of the lists for both actual and putative power.

On the other hand, it is easy to accept that some factor considered as part of potential power may not actually be important. The components of actual power are that subset of the components of putative power that have been demonstrated to actually determine outcomes. Consequently, the list

---

[1]Another way to consider the distinction between actual and putative power is to consider the degree to which one knows the power of the other. If one knows with a high degree of certainty the power of the other and especially that other's power in comparison with oneself, the knowledge shapes behavior. If you know the other country, for example, is much more powerful than you, then you are more likely to cede some disputed object, such as control of territory, to the other because you know they can take it by force if they want, and you are likely to face greater sanction or punishment during or after they take it because of the cost to the other of your resistance. When one knows the level of power with a high degree of certainty, it is actual power.

If one does not know (or is at least more uncertain) about the power comparison, then one's behavior is likely to be very different. There is greater room for vagueness and maneuver. There can be very different responses depending upon the specific situation and the risk averseness of the actors, and there are likely to be more misjudgments resulting in costly mistakes. This situation, which is more common, places us in the realm of putative power.

of components of actual power is less than or equal to, in terms of the number of elements, the list of components of putative power. Most likely, it is a considerably shorter list. Alternatively, and a much more difficult problem, is that the list of what comprises actual power changes over time and perhaps regions, or perhaps even across different types of conflicts.

Let us assume the easier problem that a fixed list of variables is sufficient. With that, let us then define a variable that consists of a subset of the components of putative power that scholars believe actually have an influence. Use variables that are on both lists.

If we move to the right on the path of components, the most important distinction relating the components (or types) of putative power is whether the power is material or nonmaterial. Can the factor be measured in terms of primarily physical, hopefully measurable, characteristics such as population or number of troops? If so, that factor is a component of material capabilities. Conversely, is the factor primarily nonphysical and resistant to measurement? Those factors comprise nonmaterial capabilities. They are essentially intangible. They help define subjective power, and they are often now referred to as components of "soft" power (Nye, 1990).

The third dimension on which to distinguish different types or components of power is the domain over which the power resides. For material capabilities those domains include natural resources or military power or economic power. For nonmaterial capabilities, those domains include leadership, morale, organizational skills, and cultural power.

While there is not a one-to-one correspondence, there is a strong correlation between a factor being material and it being measurable. Kugler and Domke's (1986) effort to measure power making use of the concept of political capacity to extract resources, what they call relative political capacity (RPC), illustrates the difficulties involved in creating measures of essentially nonmaterial capabilities. The determination of RPC is quite involved (see pages 46-49), comparing the share of total economic activity that goes to government expenditure or investment against an expected level of expenditure and investment based on an econometric model. The intent behind that effort is correct and laudable, but the difficulty if not impossibility of extending the RPC measure back to 1816 or 1494 highlights the value of finding a nonmaterial capabilities measure that is sufficient for the question motivating this paper. The reader should also note that their focus is more on actual than potential power.

The fourth level for distinguishing different types of power is the actual variables used for determining the capability. The tree could be extended even farther to the right with measures or indicators comprising the variables.[2]

QUANTITATIVE MEASURES OF MATERIAL CAPABILITIES

Since Figure 2 sets out a target of what might comprise an ideal measure of potential power based on capabilities, it makes sense to compare currently employed quantitative measures against that

---

[2]The reader might note that the structure of the "tree" in Figure 2 expresses in greater detail the two steps mentioned earlier: Empirically-based variables derived from indicators and Variables derived to correspond to the theoretically-derived variables. Power is a theoretically-derived variable; the possible but not included extensions to the right are the indicators; a measure of material capability is the empirically-based variable. The step of Variables derived to correspond to the theoretically-derived variables comes into play when there is a calculation of power polarity, for example, from empirical power or capabilities measures in order to have a measure corresponding to the theoretically-derived variable power polarity. That is why the attention to seeming details.

target. The comparison is revealing.

The two measures of country capability employed by almost all researchers of a quantitative bent are GDP (or GNP) and CINC. GDP is well known and popular because gross domestic product is the broadest and in that respect the best measure of total economic activity and thus economic production (a component of economic capacity in Figure 2). GDP also possesses the virtue of combining two other variables in Figure 2. GDP combines population (size) with wealth(iness) as the following equation reminds us:

GDP = GDP per Capita x Population

GDP per capita is, of course, a common measure of how wealthy different countries (and their populations) are. GDP thus directly embodies three measures of material capabilities found in Figure 2, two of them components of economic capabilities.

GDP also possesses other characteristics of value if the purpose is to test neorealist and structural realist theories. First, one can find GDP or GNP estimates for significant time frames for a relatively large number of countries. Bairoch (1976, 1979, 1981, 1997) and Maddison (1995, 1998, 2001, 2003) present considerable data going back to earlier centuries with a number of cases going to 1800 or even earlier for the former, and quite precisely for a large number of countries to 1820 with a number of less precise estimates going back as far as 1500 for the latter. Second, the existence of two differently derived estimates of gross production (GDP and GNP being synonymous for this purpose), especially if they differ—and Maddison (2001) claims they do—makes it possible to test hypothesized relationships with alternative measures.

The CINC measure consists of six components for each country: population (size), the size of the country's population that lives in urban areas, iron and steel production, energy consumption, the number of military personnel, and expenditures on the military. When compared against Figure 2, CINC appears to encompass three of the components of material capability: Military power, population, and economic capacity. Energy consumption and population living in urban areas are sometimes considered measures of the level of economic development. However, the actual definitions used in CINC for energy consumption (not per capita) and size of population living in urban areas (not share) do not make them good candidates for measures of a country's level of economic development. As a result, while CINC, like GDP, has measures of three components of material capabilities, the nature of the measured capabilities in CINC is broader than GDP, and probably superior. For the purpose of resolving the effect of system structure on conflict, the inclusion of measures of military power is certainly an important contribution.

The CINC data go back to 1816, exist for a large number of countries (22 in 1816 growing to 187 by 2001), and in its current, 3.01, edition is a quite carefully developed data set and measure (Correlates of War 2 Project, 2004).

A NEW MEASURE OF POWER FOR TWELVE COUNTRIES: 1494-1945

To improve on the existing measures, any new measure of power offered must possess five characteristics:

1. A long time series so that questions about long-term trends and even cycles can be addressed, which means that the series must extend farther back than 1816.
2. Encompass a number of countries so that questions pertaining to system structure, power transitions, and alliances can be addressed
3. Consist of components or sub-measures that do not bias against particular countries or at

least as a group offset any biases caused by a single component
4. Consist of a set of components of non-negligible breadth in terms of domains of material capabilities
5. Result in an assessment of the relative power of countries that is not grossly at variance with assessments made in other ways and that possesses face validity

Mearsheimer (2001) argues that an index of country power should capture two key traits of a country, its military power and its latent power. Military power is, at least until the nuclear era, generally conceived of as being closely, but not perfectly, related to the size of the armed forces. Latent power is the capacity to support the machinery of war (Waltz, 1979; Mearsheimer, 2001). Proxies for that notion of latent power typically include the size of the economy and the size of the population.

This paper follows Mearsheimer's basic design. It differs from Mearsheimer in that his military power is renamed to combat power and his more general notion of country power is referred to as military power. This is done to distinguish this, a military-oriented concept of country power, from alternative notions of country power centered on economic power or a combination of military and economic power (reference to work by author removed for peer review process). This paper thus creates a measure of country power that is a measure of the country's military power consisting of its direct ability to wage war through its armed forces (combat power) and its capacity to support that direct ability (latent power). Let us begin with the definition of the index.

The size of the armed forces can be measured with a number of yardsticks. The simplest measures are the number of troops and the number of major pieces of military hardware. The Correlates of War project chose as their measures of military capability the number of military personnel and the government's military expenditures (Singer, 1987). Unfortunately, this author is not aware of any compilation of total military personnel or military expenditure statistics that extend to years earlier than 1816. Happily, data pertaining to the simplest measures are available and are described below.

In what is perhaps the first attempt to create a power measure that encompasses a very long time frame (400-500 years), Thompson (1986) created an index of global reach capabilities derived from shares of state-owned, major, naval combat vessels. Clearly a measure operationalized in terms of major pieces of military hardware, this index is both useful and important because it gives a measure of seapower. The data used to generate that index can be found in Modelski and Thompson (1988). Thompson used this index because (he argued) there is no data set encompassing a number of capabilities that contribute to determining a country's power that spans a timeframe commensurate with testing long cycle theory. The global reach capabilities index (he argued) at least provides a measure that goes from 1494 to 1983 and is a reasonable proxy for other capabilities measures. The data set described in this paper hopes to address (and rectify) Thompson's assertion that there is no data set consisting of a number of capabilities.

For 11 of the 12 countries for which I was able to make the power index (Portugal, Spain, Holland, Italy, Austria(including Austria-Hungary), United Kingdom, France, Germany (starting from Prussia), Russia (including the Soviet Union), Sweden, Japan, and the United States), I took Modelski and Thompson's data for each country for each year and entered them into my spreadsheet. Sweden needed to be treated differently. Modelski and Thompson have a variety of estimates for the number of major naval combat vessels possessed by Sweden in an appendix. I took those estimates and made a time series by entering them into the spreadsheet and interpolating between the values using STATA's *ipolate* command. If there was more than one estimate for a particular time, I used the value that was most comparable to preceding and succeeding values (a

perhaps debatable decision but at least explicitly enough described for someone else to replicate or change). For each year the number of ships was summed and each country's share of the total calculated. This is the seapower component of the power index.

A significant limitation of Thompson's global reach capabilities index is that it does not provide a measure relevant to essentially non-naval states such as Austria-Hungary or Prussia. Luckily, Rasler and Thompson (1994) provide the data to address that limitation by including a time series of the size of field combat armies for 11 major countries from 1490 to 1945. I took the Rasler and Thompson data for each country and entered them into my spreadsheet. Rasler and Thompson provide estimates for 5-year intervals (e.g. 1490-1494). I used those estimates for the midpoint of the interval and interpolated. That interpolation approach is not perfect, but it removed anomalies in the calculated variables that were simply a result of the step function character of the Rasler and Thompson data. Portugal, like Sweden above, is treated differently. For the period 1494 to 1580 (the period during which Portugal was a major power), Portugal appears to not have had a standing army.[3] For the wars that occurred, armies were mustered and contained mostly mercenaries.[4] In the spreadsheet Portugal thus has zeros for all years. For each year the number of troops in each country was summed and each country's share of the total calculated. This is the landpower component of the power index.

Seapower (major naval combat vessels) and landpower (field army troops) together comprise the direct combat power component of the power index. The latent power component consists of population and economic capacity.

Fortunately, estimates of the population of different countries going back to 1400 and even earlier are available in McEvedy and Jones (1978) and back to 1500 in Maddison (2001, 2003) and de Vries (1984). Even better, the McEvedy and Jones estimates include taking into account changes in the character and expanse of the countries as they have changed, sometimes dramatically, over the years for which we are concerned.

Consequently, the population component for the power index was created as follows. For each of the 12 countries, estimates of the populations at different points in time (e.g. 1600, 1650, 1700 and more precise dates where there were inflection points) were extracted from the graphs (and numerals on the graphs) provided by McEvedy and Jones and from tables provided by Maddison and de Vries. These points served as the skeleton or anchor points for interpolation. As the interpolation for the earlier centuries involved significant stretches between data points and exhibited essentially exponential growth, a simple interpolation procedure as before would cause distortions. At each data point there would be a discontinuous change of slope which is entirely an artifact of the interpolation procedure. To eliminate that source of error, the common logarithm operator ($\log_{10}$) was applied to each of the data points, interpolation was done between the logged values, and then the entire series had the anti-log operator (10^x) applied. The resulting numbers served as the year-by-year population figures. The country population numbers were summed to a total population number for each year, and each country's share of the total population was calculated for each year. More details about the population component can be found in (reference

---

[3]William R. Thompson informed me via email correspondence that his research led him to believe Portugal did not have a standing army for that period.

[4]Corroborating William Thompson's belief about the absence of a Portuguese standing army, one can find statements about the essentially mercenary nature of Portuguese armies in Kohn (1999) and Howard (1976).

to work by author removed for peer review process).

Thompson (1996) and Kim (1992) created long-term, three-component indices of country power consisting of navy ships, army troops, and population. However, a power index based on those three components is not sufficient. Using such an index, the emergence of the United Kingdom as the leading world power in the 19th century simply does not take place. That type of three-component index fails to capture that aspect of a country's power that made the United Kingdom in the eyes of virtually all observers the most powerful country in the world at that time, economic power. We need to include a measure of a country's economic capacity to support a war effort.

The question is: what is the best measure of a country's economy for that purpose? Mearsheimer argues that GNP is an erratic measure of a country's latent power. Indeed, GNP is heavily influenced by population, and GNP includes economic activities such as agriculture and services that are quite far removed from a war fighting capability. While it can be argued that the possession of an agricultural production capability can and should be included in a measure of latent economic power, especially for the earlier centuries covered by the power index, the fact that armies during that time to a significant degree "lived off the land" reduces agriculture's importance as a resource to support a war effort (Delbrueck, 1985).

It is the manufacturing sector of an economy that is most essential to supporting a war effort. In that light, a measure of a country's industrial production capacity is arguably superior to a country's GNP when trying to establish a measure of a country's latent power. Mearsheimer effectively does this by using for latent power a combined index of iron and steel production and energy consumption from the Correlates of War project for the period 1816 to 1960 in his study.

Fortunately, relevant industrial production data going back farther than 1816 exist, although they do not go as far back as 1494. Specifically, a compilation of various countries' industrial production potential going back to 1750 can be found in Bairoch (1982). Such a start date for industrial production data is reasonable as industrial production as we think of it started at about that time.

Consequently, the fourth component of the country power index was generated as follows. For 11 of the 12 countries, Bairoch's industrial production data for different dates (Tables 8, 11, 15, and 16) served as the anchor points for an interpolation procedure as was done for the population data. The resulting interpolated numbers served as the year-by-year industrial production figures. The country industrial production numbers were summed to a total industrial production number, and each country's share of the total was calculated for each year.

Holland was treated slightly differently. The first two data points for Holland were for 1800 and 1830 and had the value of .6. That value was also used for 1750 under the plausible (but admittedly debatable) assumption that industrialization did not take off in Holland until after that date and thus the level of industrial production in the earlier period was probably fairly stable and thus reasonably close to the 1800 value.

The index of country power, which is each country's share of the 12 countries' total power, was determined by calculating the simple average of the components, three components for 1494 to 1749 and four components from 1750 to 1945. To be precise, the index of country power developed here should be thought of as the countries' relative potential military power and shall henceforth be referred to as MPI. It should be noted that the start and end dates of the index were determined by the overlapping years of the seapower and landpower data.

With respect to the components of power in Figure 2, MPI is comparable in breadth to CINC. They each have two military power indicators, and each has a measure of economic capacity and population. CINC has an additional measure of economic capacity and an additional measure of population, but they do not provide much new information. The simple size of the urban population is quite dependent upon the size of the total population. If the level of development were the same (and to a degree that is correct with the major powers), we would expect that the degree of "urban-ness" would be similar and thus differences in the size of the urban population would be almost completely a function of the total population. Similarly, energy consumption and iron and steel production are quite closely correlated. One does not tell us much about a country that the other does not except in the extreme cases of countries whose economy is dominated by oil production or those countries who must import a very large share of their energy.

Since many arguments regarding the relationship of country power to conflict focus on major powers, an alternative calculation of the MPI was made by taking an additional step so that the index is based on the shares possessed by just the major powers. If a country did not possess at least 5% of the total system power in the calculation described above, the country was excluded from the ranks of major powers. This adjustment was implemented by zeroing the country's data for those years in which the country's share was less than .05, which forced the spreadsheet program to recalculate all of the sums and resulting shares for the remaining countries. After this additional step was taken, a table containing the list of major powers and when they were major powers was generated. Table 1 presents that information.[5]

Table 1

Major Powers and Period of Major Power Status

Country	Years of Major Power Status (1494-1945)
Portugal	1494-1580
Spain	1494-1808
Austria(-Hungary)	1494-1919
Empire of Spain and Austria (Charles V)	1519-1556
United Kingdom	1494-1945

[5]From this information a table containing the number of major powers at any given time can be generated and is presented below.

Period	# of Powers				
1494-1518	5	1700-1737	7	1860-1895	7
1519-1556	4	1738-1740	8	1896-1919	8
1557-1573	5	1741-1754	7	1920-1940	7
1574-1578	6	1755-1808	6	1941-1943	6
1579-1580	7	1809-1832	5	1944	5
1581-1699	6	1833-1859	6	1945	6

With this one can test whether changes in the number of major powers relates to the outbreak of wars as was done by Morton and Starr (2001) using a determination of who was a major power when arrived at through different means.

France	1494-1940, 1945
Sweden	1574-1740
Netherlands	1579-1754
Russia/Soviet Union	1700-1945
Germany/Prussia	1738-1944
United States	1833-1945
Italy	1860-1943
Japan	1896-1945

One question a reader may reasonably ask is: Do these data time series incorporate the changes in country borders that have occurred for some of the countries? The sources for the population and industrial production data distinguish between fixed (late 20th century) and "current" boundaries. The data used are those that pertain to the political units we are concerned about at any given point in time ("current") and thus incorporate border changes. The sources for the seapower and army data do not explicitly make that distinction, but given the nature of the data and sources they used, it is highly likely that border changes are taken into account.

A second concern may revolve around Moscow's distance from the other European powers and its involvement in Asian affairs and how its (Russia's) power should thus be attenuated because of that distance or involvement. Doing that is very problematic. With respect to other involvements, if one applies such a condition to Russia, one must then take into account the overseas activities of other countries such as the United Kingdom or France. With respect to the relatively long distance from Moscow to the other European capitals, it is not clear that an attenuation adjustment along the lines of a loss-of-strength gradient (Lemke,2002) is appropriate. The loss-of-strength gradient formulas Lemke discusses make sense with respect to dyadic power comparison only. Using something like a gradient approach may seem desirable, but in the context of general as opposed to dyadically-focused power, using such an approach probably adds as much error as it subtracts.

A third concern about this index relates to the even weighting of the component measures (why it is called an index) as opposed to giving different weights to different components as alternative weighting schemes may be relevant and even important to different research questions. This author could not find compelling, precise alternatives to even weighting and thus presents only that alternative.[6]

COMPARISON WITH PREVIOUS MEASURES

As part of validating the MPI, it needs to be compared with other measures used to represent country power or capabilities. This section compares MPI with GDP, the CINC measure, and a three-component power measure from my data that should be quite similar to those employed by both Thompson (1996) and Kim (1992) but to my knowledge have not been published. Space limitations preclude a comparison against the single-component measures employed by Thompson and his co-authors (Modelsky and Thompson, 1988; Rasler and Thompson, 1994). Their narrow focus makes them suited only for research questions pertaining to specific types of power, not as measures of generalized country power.

---

[6]However, as the data sets on the author's website contain the raw data as well as the component shares and final index numbers, anyone can make alternative measures if they need or want to do that.

First we look at GDP, or more precisely, share of total GDP. This measure does not capture the capabilities of countries with what is typically referred to as military power as well as MPI (or CINC). If we consider their respective merits on theoretical grounds, examination of Figure 2 reveals that an index of power based on GDP share is a much narrower measure than MPI. GDP share combines two measures, GDP per capita and population whereas MPI employs four. Moreover, GDP share is not as close to the conceptual variable most germane to the decision of whether to go to war: the opponent's ability to wage a war. The MPI explicitly includes direct measures of military capabilities, combat ships and troops; GDP share does not.

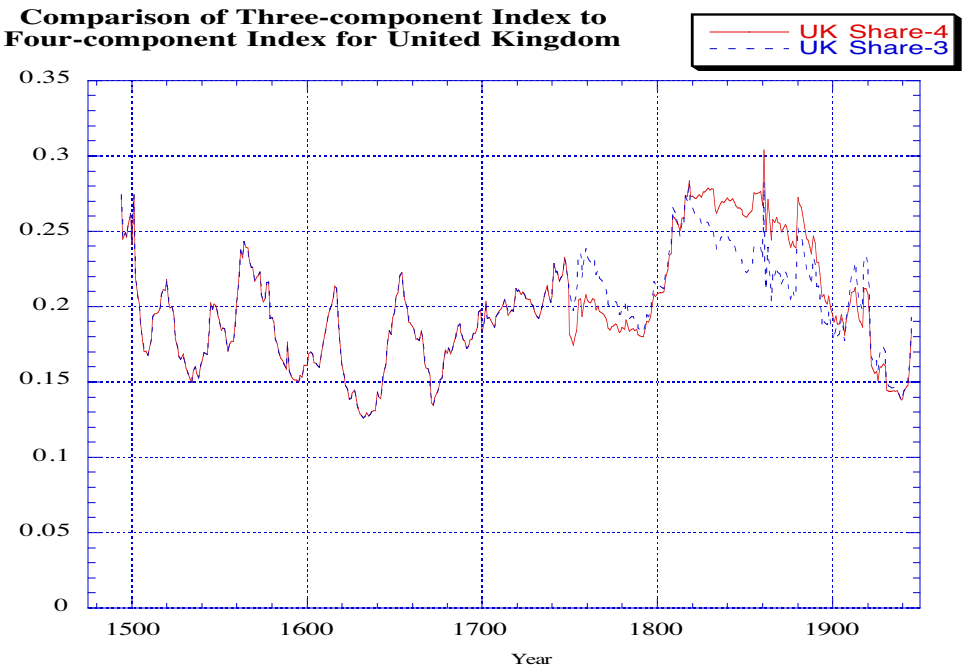
These distinctions would not be important if power measured in terms of GDP share highly correlated with MPI or CINC. Kugler and Organski (1980) assert that GDP share closely correlates to CINC, but they provide no evidence to support the claim. Using data for calculating GDP that I have assembled, which I believe are the best available at this time for the time frame 1500 AD to 1945 (or relevant portion thereof), the correlations of GDP share to MPI (and to CINC) are:

	MPI	CINC
Austria(-Hungary)	.9300	.9500
France	.8649	.9231
Germany/Prussia	.4102	.2977
Italy	-.7737	-.4255
Japan	-.2057	-.1174
Netherlands	.7561	
Portugal	.0139	
Russia/Soviet Union	.6481	.2844
Spain	.8681	
Sweden	-.1966	
United Kingdom	.9153	.9102
United States	.9697	.9673

These correlations range from very good to very bad. GDP is a good measure of economic power, but we need a measure of military capabilities in order to have a variable reasonably close to what both theoreticians discuss and probably practitioners use (implicitly) when they consider going to war.

Second, we look at the three-component measure. Earlier I asserted the inadequacy of the three-component index and the need for an economic component. Here we see how adding an economic component makes a positive difference. Examination of the data reveals that adding the industrial production component has the greatest impact on the United Kingdom and Russia, a mainly positive impact for the former and a primarily negative impact for the latter. Figure 3 illustrates the effect for the United Kingdom. Instead of declining from the end of the Napoleonic Wars, the United Kingdom maintains its power and emerges as the most powerful state in the system in the 1850's until the early 1900's. The four-component index presented in this paper simply generates a much more plausible trajectory for the United Kingdom (and also for Russia) than the three-component index, evidence of its superiority.

Figure 3



Third, we examine the CINC score. Since most if not all potential users of MPI wonder how it compares to the CINC measure employed in a number of studies, I present here the correlations between the eight relevant countries' CINC time series and their MPI time series for the years in which the two series overlap (1816-1945).

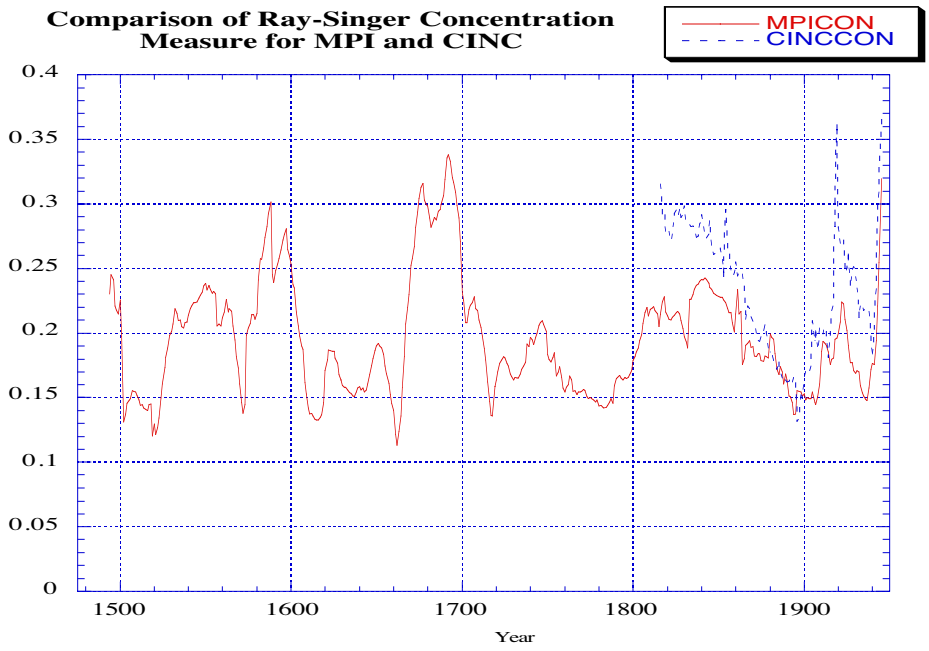
Austria-Hungary	.9537
France	.9035
Germany	.7477
Italy	.7291
Japan	.9175
Russia/Soviet Union	.3734
United Kingdom	.9239
United States	.9455

With the notable exception of Russia and to a much lesser extent Germany and Italy, these correlation coefficients demonstrate that MPI closely matches CINC and can therefore be considered a comparable indicator of a country's capabilities. Russia's comparatively low correlation results from a divergence in the two indices for the period approximately 1865 to 1905. CINC shows Russia's relative capability for the most part slowly rising while MPI has Russia's capability essentially slowly declining. From this author's understanding of history, the MPI description of Russia's power for this time is more believable than CINC's description.

It is perhaps useful to calculate the Ray-Singer (Ray and Singer, 1973) concentration measure (sometimes referred to as CON) for both indices. The concentration measure tells us that most capabilities are concentrated in one or a small number of countries when the measure is high and capabilities are dispersed when it is low. Change in power concentration has certainly happened historically. If one compares the trajectories of either MPI (R-S-CON) or CINC (CINCCON) in Figure 4 with one's own assessment of how concentrated power probably was from 1816 to 1945, one will see that periods of power concentration seem to correspond to periods of dominance by one or two countries. Both indices appear to capture that change over time, although possibly in a crude manner. CINC scores tend to be higher. The two indices share a .7967 correlation coefficient. Although CINC is perhaps a more sensitive measure of change, the two indices exhibit high congruence.

This figure also demonstrates the true value of MPI. The power index provides us a much longer time span with more variation. As MPI is highly comparable empirically and at least as good theoretically as CINC, MPI is a superior measure in the sense that it gives us a longer time series of country data and of measures computed from the index. We can calculate traits of the international system, for example power concentration or power polarity with potentially greater variation in order to better test theories relating power or capabilities to the amount of warfare that takes place.

Figure 4



POWER TRAJECTORIES

Having made the case that MPI is a viable measure of capabilities in the international system, this section provides the reader with four examples of the time series plots of a country's MPI score. These plots portray each country's trajectory in terms of the country's power relative to that of the other countries in the system at that time. The reader should note that the plots differ in their vertical scale. The goal is to give the measure face validity through enabling the reader to compare what happened for each country according to MPI with her or his own assessment of the country's power over time. Comparison plots appear later.

The four trajectories presented below in Figures 5 through 8 illustrate the four different paths with respect to evolution of country power experienced by the 12 countries. The four trajectory types are:

1. Extended period of significant power followed by a slow decline to a low level (with occasional resurgences)
2. Rapid rise from a very low level followed by slower decline to very low level
3. Rapid rise from a very low level with no decline
4. Sustained significant power

The reader should note that the sine wave portrayal of country power found in Doran's various works (Doran, 1991; Doran and Parsons, 1980) related to Power Cycle theory is quite an idealization. Even when the data are smoothed, the trajectories seldom resemble a sine wave. More interestingly, the reader can in some cases, such as the United Kingdom, discern cycles within cycles, an unanticipated benefit of the long time series.

Figure 5

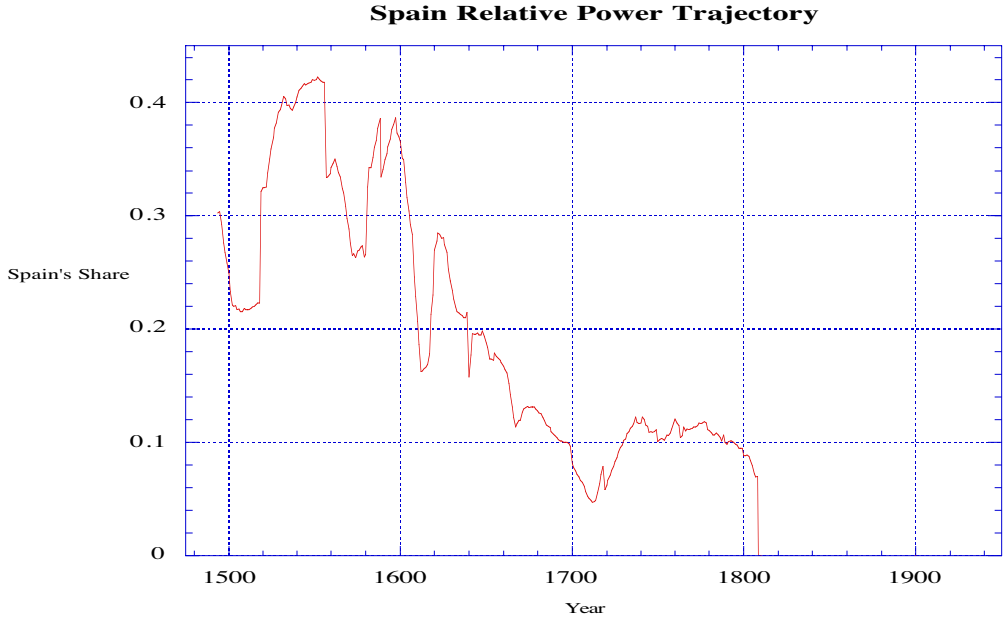


Figure 6

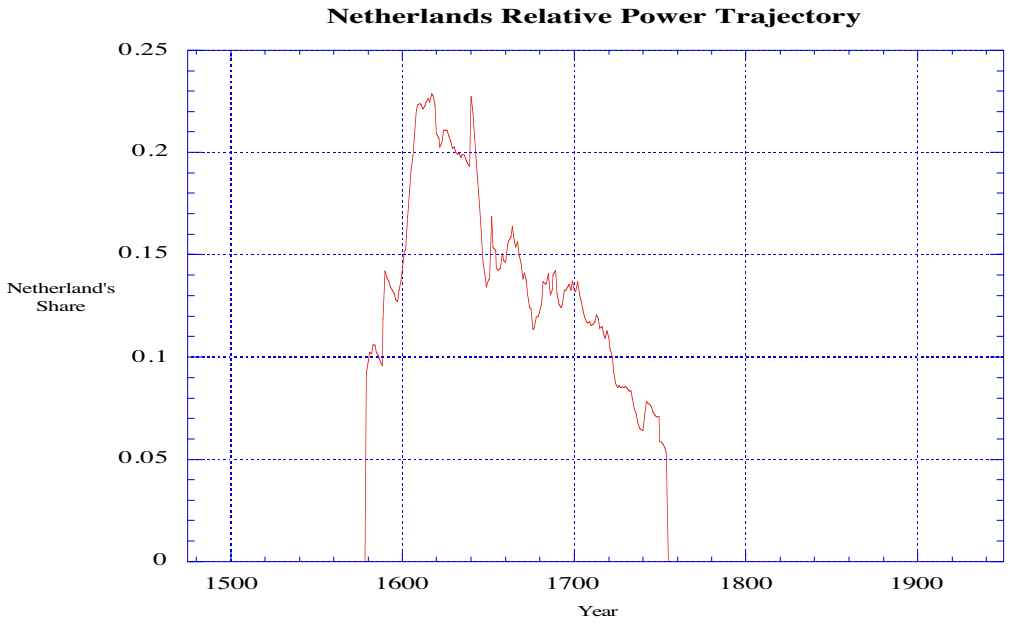


Figure 7

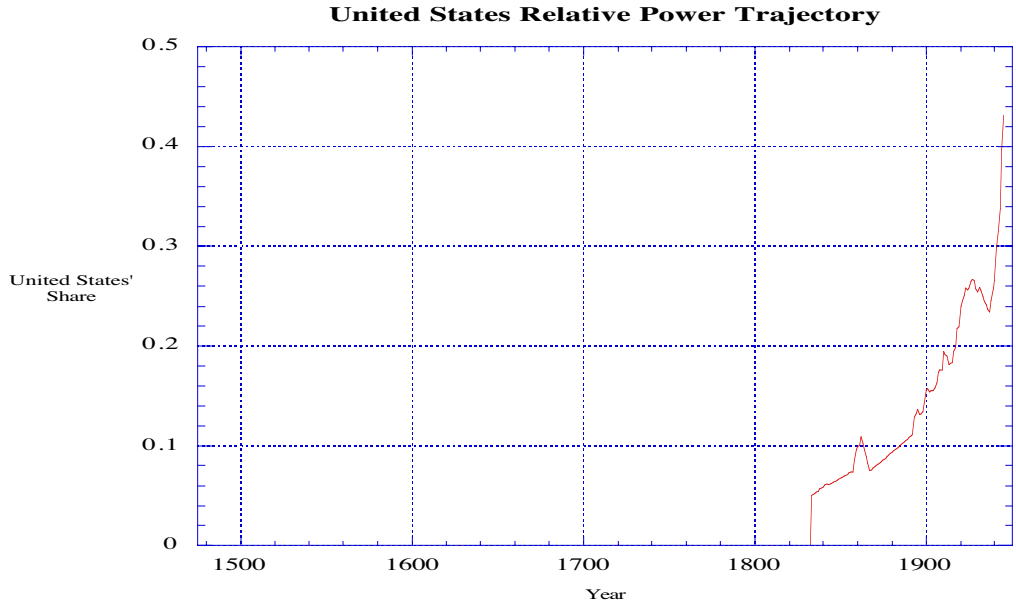
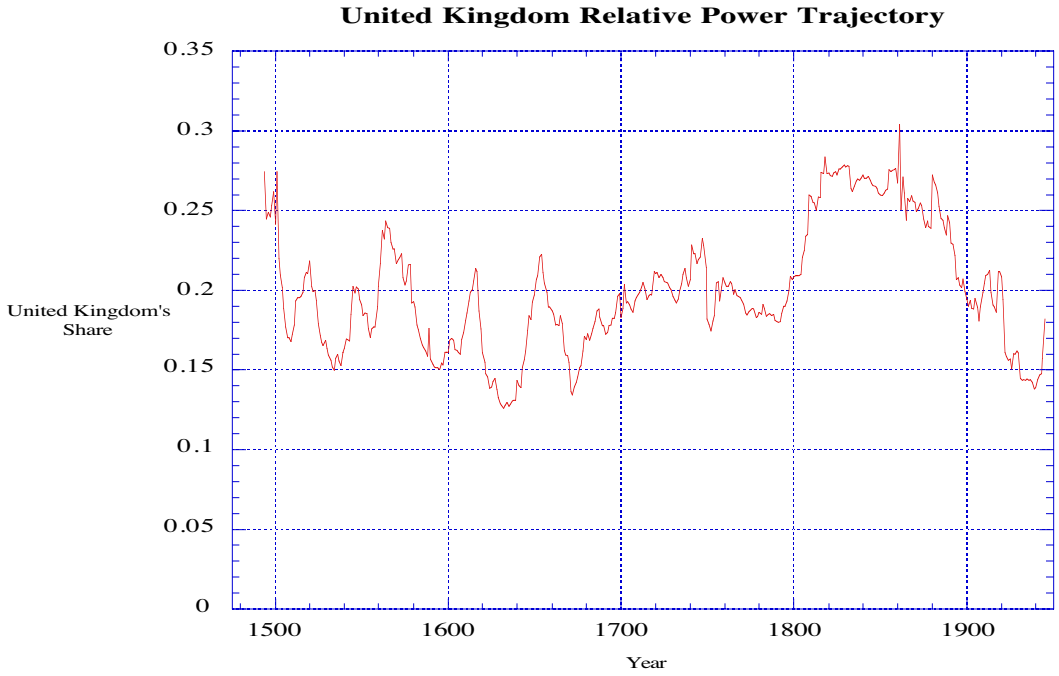


Figure 8



Upon looking at these graphs (and others the reader can generate from the downloadable data set), MPI appears quite plausible as a measure of country capabilities. Each of the countries' period of greatest power, for example, corresponds to what historians generally consider the times when the countries were at their relative peak. The index has notable face validity.

OTHER BASIC TRAITS OF THE DATA

Three other aspects of the information in the data set merit mention. The first is that different countries get their power from different capabilities. Some countries such as the United Kingdom rely on naval power and industrial power whereas other countries such as France exhibit greater "balance" in their sources of power.

The second aspect is perhaps that of most interest: direct power comparisons across countries. Below are two sample graphs (Figures 9 and 10) with selected countries to give the reader a feel for how different countries compared to each other at different points in time. Of note are those times in which one country dominates as opposed to those times in which two or three countries vie for leadership. The reader interested in viewing other comparisons can easily do so by downloading the appropriate data set, importing it into a program such as Excel or JMP, and then generating the graph of interest.

The third aspect concerns indices of power concentration. This paper uses the CON measure presented in Ray and Singer (1973). Mansfield (1993) argues for an alternative measure that has been developed by economists. In terms of tracing trends over time, the two indices turn out to be essentially identical. The correlation coefficient exceeds .99.

Figure 9

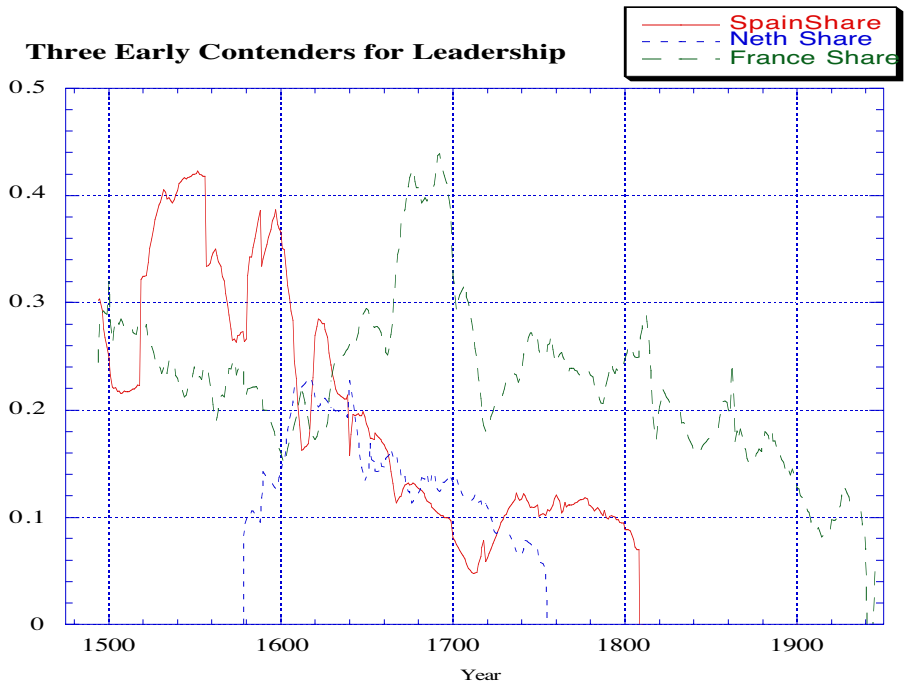
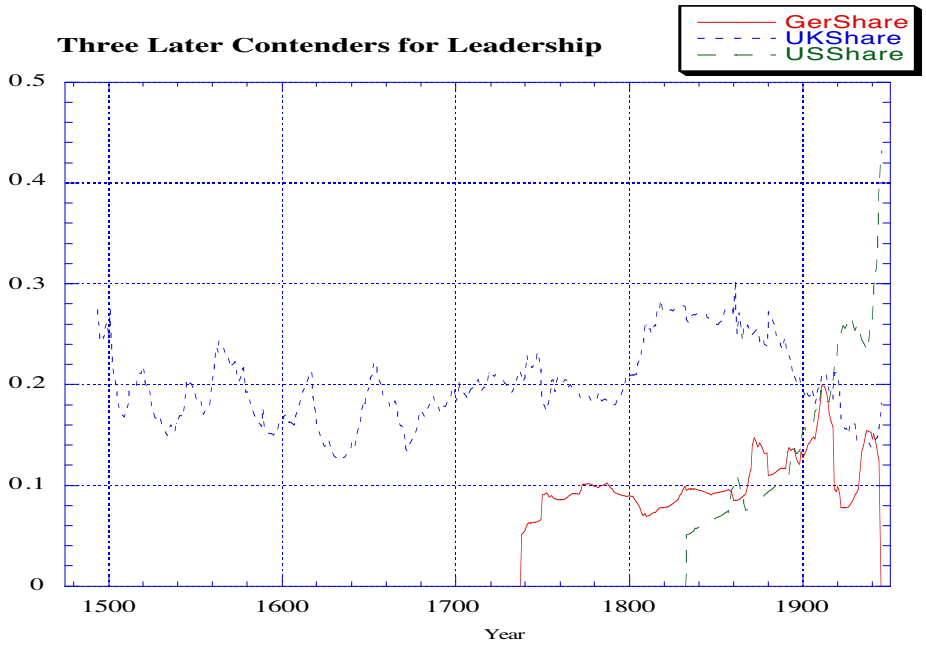


Figure 10



USES FOR THE DATA SET

A time series of country power for twelve of the most powerful countries in the international system for the period 1494-1945 can be used for a number of studies. Potential studies include:

1. Determining the changing polarity of the European interstate system and then determining the impact that polarity has on the level of violent conflict in that system
2. Determining the phases of each county's power cycle(s) and then determining the impact of those phases on the number of violent conflict the countries initiate
3. Determining when leader transitions occurred and then determining the circumstances under which those transitions lead to war and when they are peaceful
4. Determining the combined power of alliances and then determining the impact of alliance capabilities on war initiation and outcomes

While these questions have been addressed before, the much longer time span encompassed by MPI compared to previous time series of power or capabilities and the resulting much larger sample sizes they can generate will enable scholars to arrive at more authoritative conclusions than has been possible up to this time.

At a different level, these data could be used to help inform current events. For instance, with these data one can determine when in post-1494 European history there have been countries whose relative power in the state system rivaled the dominance we see with current US dominance of the world system.

CONCLUSION

This paper presents a new data set of country power that contains both the raw data and the calculated power share indices for 12 countries from 1494 to 1945. The data set and accompanying documentation as well as additional data generated in the process of making the power share index can be found at [address removed for peer review process]. The additional data consist of industrial production and industrial production per capita time series going back to 1800 and in many instances 1750, GNP and GNP per capita time series going back as far as 1500, and population time series for most of the world's countries or regions going back to 1400. Hopefully these data will be of interest and use to other researchers who wish to employ long time series to answer questions relating country power, military capabilities, population, and economic size or capability to other variables such as the amount of violent conflict or the emergence of democratic states.

The reader hoping to have seen the data applied to particular theoretical questions may be disappointed. Applications of the data will appear in forthcoming papers. Preliminary analysis finds, for example, that power bipolarity is a superior system structure in terms of the amount of warfare since 1494. I faced a chicken-egg problem: findings first or data first. I opted for data because I want the upcoming theoretical findings to have as much credibility as possible. Moreover, I believe the findings presented here have their own usefulness. They show us with much more precision than before what have been the ebbs and flows in the distribution of power in the international system and what have been the trajectories for individual countries.

BIBLIOGRAPHY

Bairoch, Paul. 1976. "Europe's Gross National Product: 1800-1975." *The Journal of European Economic History*. Vol. 5, No. 2 (Fall). pp. 273-340.

Bairoch, Paul. 1979. "Le Volume des Productions et du Produit National Dans Le Tiers Monde (1900-1977)." *Revue Tiers Monde*. Tome XX, No. 80 (Octobre-Decembre). pp. 669-691.

Bairoch, Paul, 1981. "The Main Trends in National Economic Disparities since the Industrial Revolution." in Paul Bairoch and Maurice Levy-Leboyer, eds. *Disparities in Economic Development since the Industrial Revolution*. New York: St. Martin's Press. pp. 3-17.

Bairoch, Paul. 1982. "International Industrialization Levels from 1750 to 1980." *The Journal of European Economic History*. Vol. 11, No. 2 (Fall). pp. 269-333.

Bairoch, Paul. 1997. *Victoires et Deboires: histoire economique et social du monde du XVIe siecle a nos jours*. Paris: Gallimard.

Barringer, Richard E., with the collaboration of Robert K. Ramers. 1972. *Patterns of Conflict*. Cambridge, MA: MIT Press.

Bremer, Stuart, Patrick M. Regan, and David H. Clark. 2003. "Building a Science of World Politics: Emerging Methodologies and the Study of Conflict." *Journal of Conflict Resolution*. Vol. 47, No. 1 (February). pp. 3-12.

Cashman, Greg. 1993. *What Causes War? An Introduction to Theories of International Conflict*. Lanham, MD: Lexington Books.

Correlates of War 2 Project. 2004. *National Material Capabilities Data Documentation Updated for Version 3.0*. http://cow2.la.psu.edu/COW2 Data/Capabilities/NMC_Documentation.pdf.

Delbrueck, Hans. 1985. *The Dawn of Modern Warfare: History of the Art of War, volume IV*. Translated by Walter J. Renfroe, Jr. Lincoln: University of Nebraska Press.

De Vries, Jan. 1984 *European Urbanization 1500-1800*. Cambridge: Harvard University Press.

Dolnykova, R. N. 1986. Metodologiia i metodika prognozirovaniia vneshnei politiki nesotsialisticheskikh gosudarstv : opyt sistemnoi organizatsii poniatii (Methodology for Forecasting the Foreign Policy of Nonsocialist States: the systematic classification of terms). Moskva: Izd-vo "Nauka" (Moscow: Nauka). Akademiia nauk USSR (USSR Academy of Sciences, Institute of Oriental Studies). (Text in Russian, Summary in English.)

Doran, Charles F. and Wes Parsons. 1980. "War and the Cycle of Relative Power." *American Political Science Review*. Vol. 74, No. 4 (December). pp 947-965.

Doran, Charles F. 1991. *Systems in Crisis: New Imperatives of High Politics at Century's End*. Cambridge Studies in International Relations: 16. Cambridge, UK: Cambridge University Press.

Esty, Daniel C., Jack A. Goldstone, Ted Robert Gurr, Barbara Harff, Marc Levy, Geoffrey D. Dabelko, Pamela T. Surko, and Alan N. Unger. 1994. "State Failure Task Force Report: Phase II Findings," *Environmental Change & Security Report*. Issue 5 (Summer 1999). pp. 49-72.

Howard, Michael. 1976. *War in European History*. Oxford, UK: Oxford University Press.

James, Patrick. 2002. *International Relations & Scientific Progress: Structural Realism Reconsidered*. Columbus: The Ohio State University Press.

Kim, Woosang. 1992. "Power Transitions and Great Power War from Westphalia to Waterloo." *World Politics*. Vol. 45, No. 1 (October). pp. 153-172.

King, Gary, Robert O. Keohane, and Sidney Verba. 1994. *Designing Social Inquiry: Scientific Inference in Qualitative Research*. Princeton: Princeton University Press.

Knorr, Klaus. 1975. *The Power of Nations: The Political Economy of International Relations*. New York: Basic Books.

Kohn, George Childs.1999. *Dictionary of Wars, Revised Edition*. New York: Facts on File.

Kugler, Jacek, and William Domke. 1986. "Comparing the Strength of Nations." *Comparative Political Studies*. Vol. 19, No. 1 (April). pp. 39-69.

Kugler, Jacek, and A.F.K. Organski. 1989. "The Power Transition: A Retrospective and Prospective Evaluation." in Manus I. Midlarsky, ed. *Handbook of War Studies*. Ann Arbor: University of Michigan Press. pp. 171-194.

Lemke, Douglas. 1996. "Small States and War: An Expansion of Power Transition Theory." in Jacek Kugler and Douglas Lemke, eds. *Parity and War: Evaluations and Extensions of The War Ledger*. Ann Arbor: University of Michigan Press. pp 77-91.

Lemke, Douglas. 2002. *Regions of War and Peace*. Cambridge Studies in International Relations: 80. Cambridge, UK: Cambridge University Press.

Levy, Jack S. 1984. "Size and Stability in the Modern Great Power System." *International Interactions*. Vol. 10, Nos. 3-4. pp. 341-358.

Maddison, Angus. 1995. *Monitoring the World Economy, 1820-1992*. Paris: Development Centre of the Organisation for Economic Co-operation and Development.

Maddison, Angus, 1998. *Chinese Economic Performance in the Long Run*. Paris: Development Centre of the Organisation for Economic Co-operation and Development.

Maddison, Angus. 2001. *The World Economy: A Millennial Perspective*. Paris: Development Centre of the Organisation for Economic Co-operation and Development.

Maddison, Angus. 2003. *The World Economy: Historical Statistics*. Paris: Development Centre of the Organisation for Economic Co-operation and Development.

Mansfield, Edward D. 1993. "Concentration, Polarity, and the Distribution of Power." *International Studies Quarterly*. Vol. 37, No. 1 (March). pp. 105-128.

McEvedy, Colin, and Richard Jones. 1978. *Atlas of World Population History*. New York: Facts on File.

Mearsheimer, John J. 2001. *The Tragedy of Great Power Politics*. New York: W. W. Norton & Company.

Modelski, George, and William R. Thompson. 1988. *Seapower in Global Politics, 1494-1983*. Hampshire, UK: Macmillan Press.

Morton, Jeffrey S., and Harvey Starr. 2001. "Uncertainty, Change, and War: Power Fluctuations and War in the Modern Elite Power System." *Journal of Peace Research*. Vol. 38, No. 1 (January). pp. 49-66.

Moul, William. 2003. "Power Parity, Preponderance, and War between Great Powers." *The Journal of Conflict Resolution*. Vol. 47, No. 4 (August). pp. 468-489.

Nye, Joseph S. 1990. *Bound to Lead: The Changing Nature of American Power*. New York: Basic Books.

Organski, A.F.K., and Jacek Kugler. 1980. *The War Ledger*. Chicago: University of Chicago Press.

Rasler, Karen A., and William R. Thompson. 1994. *The Great Powers and Global Struggle 1490-1990*. Lexington, KY: University Press of Kentucky.

Ray, James Lee, and J. David Singer. 1973. "Measuring the Concentration of Power in the International System." *Sociological Methods and Research*. Vol. 1. pp. 403-436.

Singer, J. David. 1987. "Reconstructing the Correlates of War Dataset on Material Capabilities of States, 1816-1985" *International Interactions*, 14. pp. 115-32.

Spanier, John. 1975. *Games Nations Play: Analyzing International Politics*. Second Edition. New York: Praeger Publishers.

Thompson, William R. 1986. "Polarity, the Long Cycle, and Global Power Warfare." *Journal of Conflict Resolution*. Vol. 30, No. 4 (December). pp. 587-615.

Thompson, William R. 1996. "Balances of Power, Transitions, and Long Cycles." in Jacek Kugler and Douglas Lemke, eds. *Parity and War: Evaluations and Extensions of The War Ledger*. Ann Arbor: University of Michigan Press. pp. 163-185.

Waltz, Kenneth N. 1979. *Theory of International Politics*. Reading, MA: Addison-Wesley.