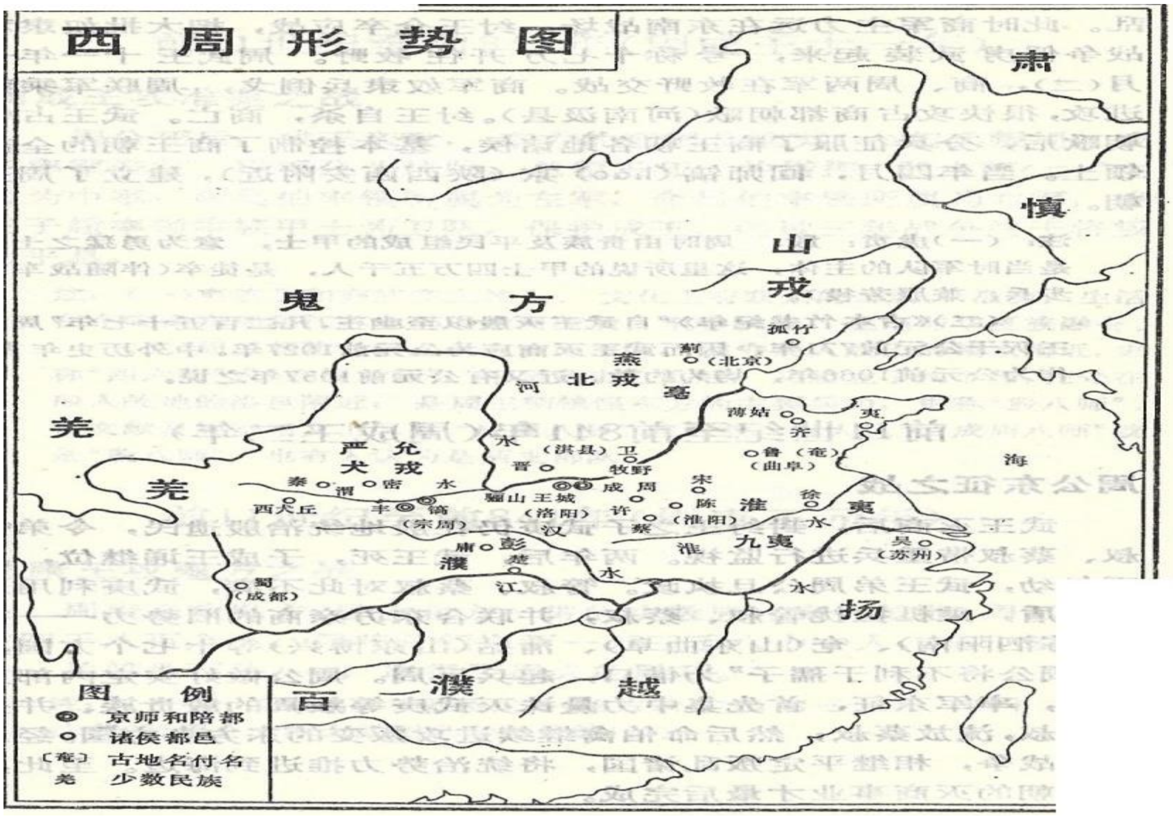
WARFARE, POWER AND SIZE: COMPARING WORLD-SYSTEMS



16 bce wars in china

Christopher Chase-Dunn, Hiroko Inoue,
Levin Welch and
Manjing Gao

For presentation at the SSHA19 conference in Chicago November 21-24, 2019

Institute for Research on World-Systems
University of California-Riverside

V 2-26-19; 13996 words

IROWS

This is IROWS Working Paper **#108** available at
http://irows.ucr.edu/papers/irows108/irows108.htm

The data Appendix to this paper is at http://irows.ucr.edu/cd/appendices/powsize/powsizeapp.htm

Abstract: This study examines the temporal relationships between the growth and decline of cities and empires and changes in the distribution of power among states and changes in the amount of interstate warfare in five whole interstate systems (world-systems) since 2700 BCE. World historians have long recognized that the population sizes of settlements and the territorial sizes of polities have both increased over time and have gone through cyclical growth and decline phases. This study uses whole interpolity

systems as the unit of analysis to address these questions: what are the causal relationships between changes in the sizes of largest cities and empires? Does empire growth cause city growth? Does city growth cause empire growth? And what are the other causes of these size changes? Our earlier studies have found that urban and polity **upsweeps** (large increases in scale) are correlated over time. But the number of these instances of large-scale change (upsweeps) is few. Much more numerous are the smaller **upswings** in which the sizes of the largest city or polity increased but did not become significantly larger than earlier increases. Sweeps are large changes and swings are smaller changes. In this study, we examine these more numerous urban and polity swings in those five political-military interaction networks (PMNs) in which we have enough size estimates to quantitatively study changes in the sizes of the largest cities and empires. We will also take out the sweeps to see if there are patterned differences in causation between larger and smaller changes. The interstate systems that we study are those centered in Mesopotamia, Egypt, East Asia, South Asia and the expanding central Political-Military Network. Our main unit of analysis is the political/military interaction network – a whole system of interacting polities that are making war and military alliances with one another. This is what international relations scholars call an "international system." We also examine the relationships between urban and polity swings and changes in the power configuration of these same systems. Interstate power configurations vary from decentralized to centralized based on the relative sizes and power of the interacting states in each system. We also test the relationship between urban and polity swings and changes in the intensity of warfare in these systems. And we consider other potential causes of upswings and upsweeps such as population growth, population pressure and trade intensity. We also consider the possibility that the causes of downswings are different from the causes of upswings.

Our earlier studies (Inoue *et al* 2012, 2015) identified big changes in the sizes of the largest settlements and polities in interstate systems and world regions, which we call sweeps. An upsweep is an increase in size that is at least 1/3 larger than the size of the three earlier size peaks. But these upsweeps are somewhat rare. We found a total of eighteen urban upsweeps in the five PMNs (interstate systems) studied (Inoue 2015: Table 7) while there were thirty-six upswings. And we found only five urban downsweeps[1], while there were thirty-two downswings (Inoue 2015: Table 8). Regarding polity size changes, we found twenty-two upsweeps and fifty-nine upswings (Inoue 2012: Table 1); and nineteen downsweeps versus fifty-eight downswings (Inoue 2012: Table 2). Our earlier work identifies and focusses on sweeps because it is these large changes that constitute the instances that account for the long-term trends toward larger settlements and larger polities. But we also would like to know the patterns and causes of smaller scale changes, and so here we analyze swings and see if we get similar results when upsweep and downsweep events are taken out the time series.

We deploy the comparative evolutionary world-systems perspective (Chase-Dunn and Hall 1997; Chase-Dunn and Lerro 2014) to study and compare relatively small regional world-systems[2] with larger continental and global systems in order to study sociocultural evolution.[3] The concepts of the world-system perspective as developed by Immanuel Wallerstein and others have been broadened to be useful for the analysis of pre-capitalist systems. Thus, we must be able to abstract from scale in order to examine changes in the structural patterns of small, medium and large whole human interaction networks. But, in this article, we focus on **medium-term change in the scale of settlements and polities**.[4]

[1] A down sweep is a low point (trough) that is at least 1/3 lower than the average of the three previous troughs.

[2] World-systems are defined as being composed of those human settlements and polities within a region that are importantly interacting with one another (Chase-Dunn and Hall 1997; Chase-Dunn and Lerro 2014). When communication and transportation technologies were less developed world-systems were small.

[3] Scientific studies of patterned social change do not need to make any assumptions about progress (or regress). Sociocultural evolution involves long-term changes in the degree of complexity and hierarchy displayed by human polities and networks of interacting polities. Whether this is seen as progress is a normative judgement that is up to the observer.

[4] Settlement is a general term that includes camps, hamlets, villages, towns, cities and the great megacity urban regions that compose the contemporary global urban system.

In the long run human settlements have tended to get larger, but our research has focuses on medium-term sequences of growth and decline in order to identify those upward sweeps (upsweeps) in which the scale significantly increased. Accurate identification of these events facilitates our understanding of sociocultural evolution because these were the events that constituted an important part of the long-term trend toward larger, more complex and more hierarchical human social institutions.[5]

World-systems are interacting sets of polities[6] and settlements. Many, but not all, world-systems have been organized as core/periphery hierarchies in which some polities exploited and dominated the populations of other polities. Semiperipherality is an intermediate position within such a core/periphery hierarchy. When we study whole interstate systems we see that they all oscillate in what we call **a normal cycle of growth and decline** (see Figure 1). The largest settlement or polity in each region reaches a peak size and then declines and then this, or another, settlement or polity returns to the peak size again. These cycles are usually not observed by looking at single settlements or polities in isolation, but rather by looking at the **largest settlement or polity** within each region of interaction.[7]

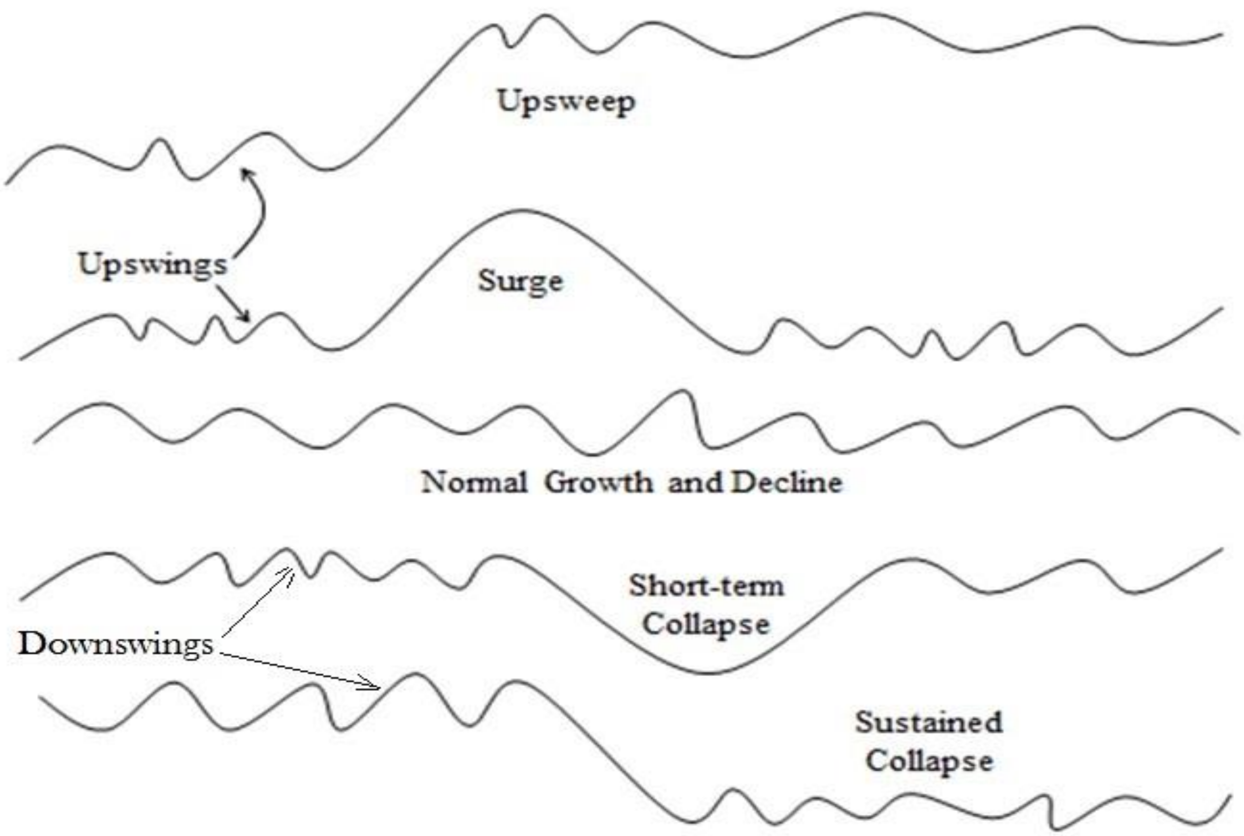


Fig. 1. Types of Medium-term Scale Change in the Largest Settlements or Polities

[5] This article reports results from a research project on the growth of settlements and polities in regional world-systems since the Stone Age. The project is the *Settlements and Polities (SetPol) Research Working Group* at the Institute for Research on World-Systems at the University of California-Riverside. The project uses both quantitative estimates of the population sizes of the largest settlements in world regions as well as estimates of the territorial sizes of largest polities to study the location and timing of changes in the scale of human institutions. The project web site is at http://irows.ucr.edu/research/citemp/citemp.html. IROWS collaborates with SESHAT: The Global History Data Bank and with the Big Data in Human History initiative (https://github.com/IISH/human-history).

[6] We use the term "polity" to generally denote a spatially-bounded realm of sovereign authority such as a band, tribe, chiefdom, state or empire (see also Cioffi-Revilla 2001: 4). Our study of polity size upsweeps is presented in Inoue *et al* (2012).

[7] The normal cycle roughly approximates a sine wave, although few cycles that involve the behavior of humans actually display the perfect regularity of amplitude and period found in the pure sine wave.

In Figure 1 the normal cycle of growth and decline is half way down the figure and is labeled "normal growth and decline." At the top of Figure 1 is a depiction of an upward sweep (upsweep) in which the size of the largest settlement or polity increases significantly. When an upward movement is sustained, and a higher level of scale becomes the new normal, we call this an "upward sweep" or an "**upsweep**." We define an upsweep as a peak that is **more than 1/3 higher than the average of the three immediately earlier peaks**.[8] We distinguish between an "**upswing**," which is any upturn in a growth/decline sequence, and an upsweep, which goes to a level that is more than 1/3 higher than the average of three prior peaks.

We want to explain the emergence and expansion of complexity and hierarchy in social change. We note that there is a rough association between the scale of settlements and polities and the degree of complexity and hierarchy. They are not the same thing, but they tend to be associated over many different systems and periods of time. There can be big settlements without much complexity or hierarchy. There can be small polities that have high levels of complexity and hierarchy. These are only rough proxies. We use them because there are available across time and space and make it possible to compare cultures that are rather different from one another.

Hierarchy and complexity tend to go together because an increase in complexity works better if some institutions of coordination emerge to regulate and integrate the more specialized parts. But there are non-hierarchical or less hierarchical ways to do this, like the emergence of larger identities that encourage people to cooperate with one another and the emergence of markets that motivate people to coordinate their activities with one another.

Units of Analysis

Our approach to the spatial bounding of the unit of analysis is very different from those who try to comprehend a single global system that has existed for thousands of years. Gerhard Lenski (2005); Andre Gunder Frank and Barry Gills (1994) and George Modelski (2002; Modelski, Devezas and Thompson 2008) and Sing Chew (2001;2007) all analyze the entire globe as a single system over the past several thousand years. We contend that this approach misses very important differences in the nature and timing of the development of complexity and hierarchy in different world regions that stem from the fact that they were unconnected or only very weakly connected, with one another. Combining apples and oranges into a single global bowl of fruit is a major mistake that makes it more difficult to both describe and explain social change. The claim that there has always been a single global world-system before the rise of an intercontinental network is profoundly misleading.

In this chapter we use Political-Military Networks (PMNs) as the unit of analysis (see also Chase-Dunn and Jorgenson 2003).[9] These are composed of polities that are making wars and military alliances with

---

[8] This cutting point specifies what we mean by "significant" in a way that can be used to systematically compare widely different times and places.

[9] The idea of the central Political/Military Network (PMN) is derived from David Wilkinson's (1987) definition of "Central Civilization." It spatially bounds systemic networks as sets of allying and fighting polities. The central Political-Military Network is the interstate system that was created when the Mesopotamian and Egyptian PMNs became directly connected with one another in about 1500 BCE. The central PMN expanded in waves until it came to encompass the whole Earth in the 19th century ce. Because it was an expanding system its spatial boundaries changed over time. We mainly follow Wilkinson's decisions about when and where the central System expanded, and the temporal bounding of the regions we are studying also follows Wilkinson's dating of when these regions became incorporated into the expanding central PMN. The contemporary global PMN is the international system of states. The merger of the Mesopotamian and Egyptian interstate systems began as a result of Eighteenth Dynasty Egypt's invasions, conquests, and diplomatic relations with states of the Southwest Asian (Mesopotamian) systems—first of all Mitanni, then the Hittites, Babylon, and Assyria. The signal event was Thutmosis I's invasion of Syria in about 1505 BCE. The fusion of the systems began then but enlarged and intensified until 1350 BCE. Thutmosis III's many campaigns in Syria and the establishment of tributary relations, wars and peace-making under Amenhotep II, as well as the peaceful relations and alliance with Mitanni by Thutmosis IV, eventually led to Egyptian hegemony under Amenhotep III (Wilkinson pers. comm. Friday, April 15, 2011). The final permanent linking of the South Asian PMN with the central PMN did not occur until the late 18th and early 19th centuries CE when the British and the French colonized parts of the South Asian subcontinent. Before that there had been several intermittent connections (Wilkinson 2017) that were not systemic or only temporarily systemic regarding geopolitical

one another. David Wilkinson has carefully studied the spatial boundaries of these interstate systems and we follow his lead in delineating them (Wilkinson 2017; Chase-Dunn, Inoue and Neal 2018). Following Wilkinson's (1987) specifications, the timings of the incorporation of smaller PMNs into the central PMN are as follows: Egyptian and Mesopotamian PMNs merged to form the central PMN in 1500 BCE; Europe was engulfed by the central PMN in 500 BCE[10]; South Asia was engulfed into the central PMN in 1750 ce[11]; and East Asia was engulfed into the central PMN in 1830 ce.[12]

Modeling the causes of polity and settlement scale changes

Our earlier research has shown that about half of the upsweeps of polity and settlement sizes were associated with the conquest actions of non-core (peripheral or semiperipheral) marcher states (Inoue, *et al* 2016). This partly confirms the hypothesis that core/periphery relations and uneven development are important for explaining the emergence of complexity and hierarchy in world-systems, but it also shows that a significant portion of the upsweeps were not associated with the actions of non-core marcher states. We are developing a multilevel model (Inoue and Chase-Dunn 2017) that combines interpolity dynamics with the "secular cycle" model developed by Turchin and Nefadov (2009). Our iteration model of the causes of the rise of complexity and hierarchy also hypothesizes that these are both more likely to increase in periods in which there has been greater interpolity conflict (warfare). Interpolity conflict is a selection mechanism. Polities that cannot mount a successful defense are likely to get selected out along with their institutions and their people. But high levels of conflict also reduce peoples' resistance to hierarchy-formation. They are more likely to assent to more centralized leadership and governmental institutions that provide order and peace after they have been exposed to a long period of high conflict. This works for both within-polity and between-polity conflict. We want to empirically test this hypothesis by using data on warfare intensity for the cases in which it is available.

This study of swings will help us determine the nature of the relationships across different political/military networks (PMNs). between urban and polity scale changes. To what extent is the timing of urban and polity swings correlated? Since both go up over the long run, we seek to determine their medium run relationship by calculating partial correlations that take out the long-term trend by controlling for year as an independent variable. We also examine graphs that show the track of largest city and polity sizes together for each PMN. In order to correlate urban and polity sizes we needed to produce time series of the two that have the same time points. We have done this by using the estimates we have to calculate linear interpolations for congruent years for each variable. For Mesopotamia and Egypt, we use 100-year intervals, while for South Asia, East Asia and the central PMN we use 50 year time steps. Using 50-year intervals for Egypt and Mesopotamia requires the use of too many interpolated data points because the original estimates are too spread out in time. We prefer to use the more cautious 100-year intervals for these PMNs.

Estimating the population sizes of cities

We use the compilations of estimates of the population sizes of cities published by Tertius Chandler (1987), George Modelski (2003), and Ian Morris (2010) as our main sources. Chandler's (1987) data compendium uses several proxies to estimate city populations: the number of households, the number of

---

interactions. Wilkinson sees the final incursion as beginning in the middle of the 18th century CE and becoming engulfment in 1857-8 CE.

.

[10] Europe was never a whole interstate system separate from the one in the Near East, though Wilkinson (1987) specifies a short-lived separate Aegean state system in the early Iron Age (1600 to 600 BCE). We wanted to use this Aegean PMN as one of our cases but we do not have enough data points to do this.

[11] David Wilkinson (2018) has reconsidered the extent to which earlier connections between the Indic and the central System constituted systemic political-military interaction. In earlier work he contended that the engulfment of the Indic PMN occurred with the incursion of Mahmud of Ghazni in the 11th century CE. Wilkinson now contends that the permanent systemic connection occurred in the period from 1750 to 1858 ce. We will use 1750 as the cutoff.

[12] In a later version of this research we will also use world regions as the unit of analysis (see Chase-Dunn *et al* 2017).

soldiers, estimates of spatial size of the built-up area and the estimated population density per unit of space. Sometimes he considers information about the number of houses of worship or the number of public baths (Chandler 1987:2-12). Chandler's definition of a city includes the resident population of the surrounding suburban areas – what is now called "urban agglomerations."

George Modelski (2003:4) regarded cities as "the central places of area-wide interactions; they facilitate the operation of the system, and in turn depend upon its support". He argued that cities (urban agglomerations) are "a manifestation of the growth of institutions capable of organizing vast regions into integrated systems" (Modelski 2003: 4).[13] Chandler's and Modelski's estimates of city population sizes have been criticized for being rough approximations based on several proxies that did not include archaeological evidence (Smith 2016a)

Ian Morris (2010: 107) reviews the debates among demographers and urbanists about the definitions of urban spatial boundaries and the reliability of census data. In his work, premodern settlement size estimates are based on archaeological evidence of their areal size and historical records (Morris 2010: 108). For modern cities Morris uses the definition and estimates from the *Economist Pocket World in Figures*, which bounds cities as urban agglomerations comprising a contiguous built-up area (Economist 2008: 23).

From the comparisons of these three data sources, we have found that Morris's estimates are most usually more conservative as to the sizes of cities compared with those of Modelski. Morris compiled his largest city size data using multiple data sources. He selected what he considered to be the best of the estimates among them, yet he was aware that the use of a single data source (e.g. only using Modelski's estimates) makes it easier to amend errors since it provides more consistent errors compared with using multiple sources (Morris 2010: 108).

We compiled our estimates in a similar manner as Morris and followed the comprehensive approach developed by Daniel Pasciuti (2002). In our data compendium of city population estimates archived at the IROWS,[14] we include all the estimates from all the sources, but in this research, we used what we have judged to be the best estimate from the three sources and supplemented with other sources from archaeology and history.

We define settlements as a **spatially contiguous built-up area**. This is the best definition for comparing the sizes of settlements across different polities and cultures because it ignores the complicated issue of governance boundaries (e.g. municipal districts, etc.). But it still has some problems. Most cultures have nucleated settlements in which residential areas surround a monumental, governmental or commercial center. In such cases it is fairly easy to spatially bound a contiguous built up area based on the declining spatial density of human constructions. But other cultures space residences out rather than concentrating them near a central place (e.g. many of the settlements in the preshistoric American Southwest such as Chaco Canyon). In these cases it is necessary to choose a standard radius from the center in order to make comparisons of population sizes over time or across cultures.

Estimating the territorial sizes of polities

What we want to know is the **size of the area over which a central power exercises a degree of control that allows it to appropriate important resources (taxes and tribute).** The ability to extract resources falls off with distance from the center in all polities and controlling larger and larger territories requires the invention of new transportation, communications and organizational technologies (what Michael Mann (1986) has called "techniques of power"). Military technologies and bureaucracies are important institutional inventions that make possible the extraction of resources over great distances, but so are new religious ideologies and new technologies of communication (Innis 1950).

---

[13] Modelski's city population size estimates have been geocoded by Reba *et al* 2016..

[14] When we find discrepancies in the city size compendia we read widely in order to produce better estimates (e.g. Chase-Dunn, Inoue and Anderson (2017). Our template for a comprehensive city size data compendium that will be contributed to SESHAT is at http://wsarch.ucr.edu/archive/data/setdataset.htm.

Of course, territorial size is only a rough indicator of the power of a polity because areas are not equally significant with regard to their ability to supply resources. A desert empire may be large but weak. But this rough indicator is quantitatively measurable in different world regions over long periods of time, so it is valuable for comparative historical research.

Estimating the territorial sizes of states and empires is usually based on the use of published historical atlases. For the ancient and classical worlds, these are based primarily on documentary evidence about who conquered which city, and whether and for how long tribute was paid to the conquering polity.[15] Sometimes it is difficult to tell whether or not tribute is asymmetrical or symmetrical exchange. Only asymmetrical (unequal) exchange signifies a tributary imperial relationship. Otherwise it is just trade and does not signify an extractive relationship.

Most of the large ancient and classical empires involved the conquest of territory that was contiguous with the home territory. But once naval power was taken up by tributary states an empire could conquer and dominate a client state that was far from its home territory, such as Rome's control of areas on the south shore of the Mediterranean Sea. If these distant non-contiguous tribute-payers were small in number and size, not including them in the estimates of the territorial sizes of empires would not constitute a large error. But, as capitalism moved from the semiperiphery to the core, capitalist nation-states increasingly adopted the thallasso cratic form of empire that had been pioneered by semiperipheral capitalist city-states[16]—control over distant overseas colonies. The modern colonial empires (British, French, etc.) require estimating the territorial sizes of colonies that are spread across the seas. The increasing institutionalization of the territorial boundaries of states makes this much easier than it was in the ancient and classical worlds in which polity boundaries were often quite fuzzy.

Not all maps in political atlases show the boundaries of territorial control. They may represent linguistic or religious groups or other distinctions that have little or nothing to do with state power. And maps may not have good time resolution. Our data on the territorial sizes of polities are mostly taken from the published articles of Rein Taagepera (1978a, 1978b, 1979, 1997), except that some estimates for South Asia have been added based on Schwartzberg (1992).

Power Configurations

David Wilkinson (1996, 1999a, 2001, 2004a, 2004b, 2006) has coded the power configurations of interstate systems by reading the histories of battles and diplomacy. His coding scheme is based on seven polarity categories: 0= Nonpolarity; 1= Multipolarity; 2= Tripolarity ;3= Bipolarity; 4= Unipolarity (Non-hegemonic); 5= Hegemony; 6= Empire. These vary in terms of how unequal is the distribution of power among states in an interacting network of warfare and diplomacy based on Wilkinson's judgments of the relative power of the states in each system. Wilkinson sees these categorical polarities as somewhat unique configurations, but it is also possible to use his categories as a rough continuum that varies from very decentralized nonpolarity to a very centralized situation of either hegemony or empire. It should be noted that Wilkinson's conception of hegemony (1994, 1999b, 2008) requires that the hegemon has the power to enforce its wishes upon the other states of the system.[17]

---

[15] The territorial sizes of polities are difficult to accurately estimate from archaeological evidence alone. Michael E. Smith (2016b) reviews the efforts that have been made to do this (see also Smith and Montiel 2001). It is usually not possible to obtain sufficient temporal resolution with archaeological data for the kind of study we are doing here. Carbon14 dates usually have a 200 year margin of error. When dendrochronology (tree ring) dating is available, as for much of the American Southwest, yearly accuracy makes the study of settlement sizes and polity sizes temporally feasible for a study such as ours.

[16] The comparative world-systems perspective developed by Chase-Dunn and Hall (1997) contends that semiperipheral capitalist city-states (specialized trading states in semiperipheral locations in the interstices between large tributary states and empires) were the main agents that encouraged commercialization and the production of commodities in the Bronze and Iron Ages.

[17] Claudio Cioffi-Revilla and David Lai have also produced estimates of power configuration (polarity) for ancient China from 2069 BCE to 729 BCE that correspond with the dates of the wars they have coded. These estimates

We should note here that there is a logical overlap between Wilkinson's power configuration variable and our measure of the territorial size of the largest state in an interstate system. The size of the largest state is an important component of power configuration, but it does not include any information about the sizes of the other states. We expect that power configuration and largest territorial state will be positively correlated, but our research will show how large the positive relationship is and will show when and where these two variables may diverge.

It should also be noted that Wilkinson coded power configuration every 10 or 25 years.[18] We used those of his codings that corresponded with the 50-year or 100-year time points at which we have estimates of largest city population sizes and the territorial sizes of largest empires.

Intensity of Interpolity Conflict

Warfare in interpolity systems and conflict within polities are both important causes of sociocultural evolution. Success or failure in warfare operates as a group selection mechanism in the competition among polities, and different levels of internal conflict and cooperation are also important conditions that have consequences for how well polities do in competition with one another. International relations political scientists hypothesize that the level of interpolity conflict (warfare) is related to the distribution of power among a set of interacting polities (less warfare in more centralized power configurations) and the iteration model developed by Chase-Dunn and Hall (1997: Chapter 6) suggests that upsweeps in complexity and hierarchy are more likely to emerge after periods in which within-polity and between-polity conflicts have been relatively high. We can test these hypotheses about the consequences of different levels of interpolity conflict in those of our cases in which warfare events have been coded over long periods of time. The most systematic efforts so far to develop datasets on premodern warfare using primary sources have been carried out by the Long-Range Analysis of War (LORANOW) project led by Claudio Cioffi-Revilla. We will also use the warfare events data coded by Peter Brecke (2001, nd) since 1400 CE for the central and East Asian PMNs.[19] And we will use the coding of East Asian battles assembled by David Kang and his associates (Kang *et al* 2016). Our level of interpolity conflict coding uses the number and length of wars and indicators of war extent (the number of autonomous polities involve in a war; Cioffi and Lai 2001) or severity (fatalities) to estimate the relative level of conflict for each time period. Our codings of interpolity conflict intensity are intended to be as comparable as possible across different war event data sets. We begin with the dataset on ancient China produced by the LORANOW project and then try to make other data sets

---

overlap with those of David Wilkinson for the period from 1025 BCE to 729 BCE. The Cioffi and Wilkinson polarity scales are not directly comparable. To make them comparable we propose the following:

Wilkinson/Cioffi
Non-polarity 0 =0
Multipolarity 1 =10-11 and 12
Tripolarity 2=7-8 and 9
Bipolarity 3= 4-5 and 6
Unipolarity 4= 1
Hegemony 5= 2
Empire 6= 3

With this conversion the Pearson's r correlation coefficient between the Cioffi and Wilkinson polarity scores in China from 1025 BCE to 725 BCE is .81.

18 Wilkinson codes the central, Mesopotamian and South Asia PMNs every 10 years. The East Asian and Egyptian systems are coded every 25 years.

19 In principle, we would like to estimate changes in the level of interpolity conflict by including all the wars among all the polities in each PMN. But some of the data sets include only wars among the Great Powers (core powers). Brecke (2001:5) says "Assembly of the Conflict Catalog began in 1996 by combining the conflicts from existing computerized war datasets such as Correlates of War (Small and Singer, 1982), Militarized Interstate Disputes (Jones, Bremer, and Singer, 1996), Great Power Wars (Levy, 1983) and Major-Minor Power Wars (Midlarsky, 1988). From there I added additional conflicts from Richardson (1960), Wright (1965), Sorokin (1937) Luard (1987), and Holsti (1991).

comparable. Ideally each decade would receive an interpolity conflict score that is the sum of the number of wars during that decade, the sum of the number of years (durations) that wars occurred within the decade, and the sum of the extents (the number of autonomous polities involved in each war. Once severity estimates are available we will also add these to produce our estimates of the relative intensity of interpolity conflict for each period. Because our other variables have very low temporal resolution during early time periods (100-year or 50-year intervals) we will also calculate war intensity for these long intervals.

Claudio Cioffi-Revilla and David Lai's (2001) data for Chinese warfare from 2700 BCE to 722 BCE estimates the onset and termination years for each war and a variable they call "extent" which is an estimate of the total number of autonomous polities involved in each war. Their indicator of extent varies from 2 to 9 in the ancient China data set. For later periods when we have severity measures we will scale the relative sizes of wars. [20] *For each time period the warfare intensity score equals the sum of the number of wars that occur, the sum of the durations of those wars that happened within the time period and the sum of the extents of those wars.* Figure A1 in the Appendix plots the components of our Chinese interpolity warfare intensity estimates from 1900 BCE to 700 BCE with 50-year intervals. In Cioffi-Revilla and Lai's China data set there are some years that have more than one war (e.g. 987 BCE). In this case we add the two wars together to produce our period estimate of warfare intensity. Figure A2 in the Appendix plots the relationships between the war intensity variable, power concentration, largest city sizes and the territorial sizes of the largest state or empire in China from 1900 BCE to 700 BCE.

A Qing dynasty illustration of Sun Jian's forces (right) attacking Liu Biao's forces (left)

[20] We revise the relative levels by century once we have better estimates of war size (battle deaths, total fatalities) because the whole distribution shifts because the total population goes up a lot, especially in the last 200 years. A small war in the 20th century is much bigger than a big war in the 15th century so we increase the values of the 3 categories as we move forward in time. using the total human population of the Earth as a guide in doing this.

Testing Causal Hypotheses with Time Series Data

We present descriptive statistics and we test for causality in the relationships among the variables we are studying using Granger time-series tests of antecedence. The Granger test uses the assumption that a cause must precede its consequence to estimate the likelihood of causation among time series variables. Most of our variables are measured at simultaneous time points (years), and the gaps between time points are large (50 or 100 years). But for some of our variables we have better temporal resolution. Some of Wilkinson's power configuration estimates are for decades, and for the war intensity variables we are able to construct decadal estimates because we know the years of onset and conclusion of war events. For these decadal variables, we can use precedence or antecedence to test for causation and we can look at different time lags. So, for example, to test whether high interpolity conflict is a cause of upsweeps we can see if the decade before an upsweep is unusually high with regard to the level of conflict. Or we can look at the previous two decades. If we think upsweeps in the territorial sizes of largest polities should suppress interpolity conflict we can see if the decades following a polity upsweep are unusually low with regard to the level of interpolity conflict.

Bivariate Correlations: Cities, States and Power Configuration

PMN	Time period	State/city	Powcon/city	Powcon/state	Year/city	Year/state	N
Mesopotamia	2700 -1500 BCE	-.09	.25	.14	-.66*	.48	13
Egypt	2600 -1500 BCE	.39	-.62*	-.01	.48	.45	12
South Asia	400 BCE – 1750 ce	.50	.09	.30	-22	.07	44
East Asia	1900 BCE - 1800 CE	.58**	-.18	.20	.85**	.63**	75
Central	1500 BCE – 700 ce	-.19	-.25	.28	.48	-.42	17
Central	1500 BCE – 1900 ce	.63**	--	--	.67**	.72**	69

Table 1: Bivariate correlation coefficients [21]

Added 1000-1750 CE to south asia; take south asia out of central from 1000cd to 1750ce. Use Cioffi polarity to extend east asia back to -1900 when taagepera starts

Produce another descriptive table that also includes the warfare variable for the cases for which we have it.

[21] The estimates for the tables and figures are contained in http://irows.ucr.edu/cd/appendices/powsize/powsize.xlsx
The Mesopotamia and Egypt results are using 100-year time intervals. The others are using 50 year time intervals.
Level of statistical significance: *=P = 0.05; **=P = 0.01; ***=P = 0.001; ****=P = 0.000. 2-tailed. The Pearson's correlation coefficient and significant tests require the assumption that the variables are: (1) interval or ratio level (2) linearly relate, and (3) bivariate normally distributed. For the variables which do not meet the assumption of bivariate normal distribution, we used Spearman's rank correlation. The variables that used Pearson's r are: Egypt year, Egypt State, South Asia Year, South Asia City, East Asia Year, East Asia power, central PMN year (1500-700BCE), central PMN city (1500-700BCE), central PMN state (1500-700BCE). The rest of the variables used Spearman's rank correlation.

REVISED

Did:
1. Added 1000-1750 CE to south asia;
2. take south asia out of central from 1000cd to 1750ce
   Cent city: 1400, 1450 , 1500 are south Asian city → used second largest, Paris for the years
   Cent state: no south Asian state
3. War data is still under progress

PMN	Time period	State/city	Powcon/city	Powcon/state	Year/city	Year/state	N
Mesopotamia	2700 -1500 BCE	-.09	.25	.14	-.66*	.48	13
Egypt	2600 -1500 BCE	.39	-.62*	-.01	.48	.45	12
South Asia	400 BCE – 1750 ce	.50	.09	.30	-22	.07	44
South Asia	400 BCE- 1000ce	.28	.16	.27	-55**	-.37	29
South Asia	1000 – 1750ce	78**	.098	.43	.64**	94**	16
East Asia	1900 BCE - 1800 CE	.58**	-.18	.20	.85**	.63**	75
Central	1500 BCE – 700 ce	-.19	-.25	.28	.48	-.42	17
Central	1500 BCE – 1900 ce	.63**	--	--	.43**	.64**	69

(** correlation is significant at the 0.001 level (2-tailed))
Pearson's correlation coefficient

Table 1 shows the bivariate Pearson's or Spearman's correlation coefficients (r) between power configuration (powcon), largest city size, and largest polity size for each of the PMNs we are studying. For Egypt and Mesopotamia, we use 100-year intervals, but for the others we use 50 year intervals. David Wilkinson has not yet finished coding power configuration for the central PMN, so the correlations between powcon, cities and states are only for the period from 1500 BCE to 700 BCE. Table 1 also shows the time periods and the number of time points (N) used to calculate the Pearson's rs. And we also show the correlations between cities and states with year to see how important the long-term trend may be and how it may influence the other correlations. There is no usual long-term trend for power configuration, so we do not show its correlations with year.

Table 1 reveals somewhat different patterns across the five PMNs. The state/city bivariate correlation is generally positive, but slightly negative for Mesopotamia during this time. There is a positive and significantly high correlation in the state/city bivariate correlation for East Asia.

The power configuration/city correlation is highly negative and significant for the Egyptian PMN, and it is negative for the central PMN during the period for which we have powcon estimates. It is positive for Mesopotamia (.25) but nearly null for East Asia and South Asia (check the latter after adding 1000-1858 ce)

The power configuration correlation with the size of the largest state is slightly negative for Egypt, but positive for the other PMNs. The powcon/state bivariate correlation is positive and significant for East Asia.

The correlation between year and city is positive for the central, East Asian, and Egyptian PMNs, and it is significant for East Asian PMN. The correlation between year and city is highly negative and significant for South Asia (check) and Mesopotamian PMN. The correlation between year and state is highly positive and significant for East Asia, positive for Mesopotamian and Egyptian PMN. It is negative and significant for South Asia (check), and negative for central PMN. More light can be shed on these correlations by examination of the charts that plot the changes for each PMN (see below) but first let us see what difference it makes if we take out the upsweeps and just look at the city and polity upswings. Probably take out the following section. The method of taking sweeps out is too messy. Devise a better more formal method of separating swings from sweeps.

Swing Bivariate Correlations: Cities, States and Power Configuration

PMN	Time period	State/city	Powcon/city	Powcon/state	Year/city	Year/state	N
Mesopotamia	2700-2400/2100 - 1500 BCE	-.09	.07	-.31	-.75	.80	11
Egypt	2600-2200/1800 - 1700 BCE	.23	1	.23	-.66	-.06	7
South Asia	400 BCE/50 BCE – 1000 ce	-.26	-.30	.18	-.08	-.30	23
East Asia	1900 BCE - 650 BCE/ 550 to 450 BCE/ 250bce-550 ce/750 ce-1800 CE	.48	.05	.41**	.80	.58	47
Central	1500 BCE – 1300 BCE/1150-650bce/ 450-400bce/ 50bce-50ce/150-1200ce/1350-1650 ce	.51	--	--	.58	.65	48

Table 1.5: Swings without upsweeps Bivariate correlation coefficients [22] (see powsize1) add 1000ce-1858 CE to indic; take south asia out of central from 1000cd to 1858cd

Discuss results of taking out upsweeps

[22] The Mesopotamia and Egypt results are using 100-year time intervals. The others are using 50 year time intervals.

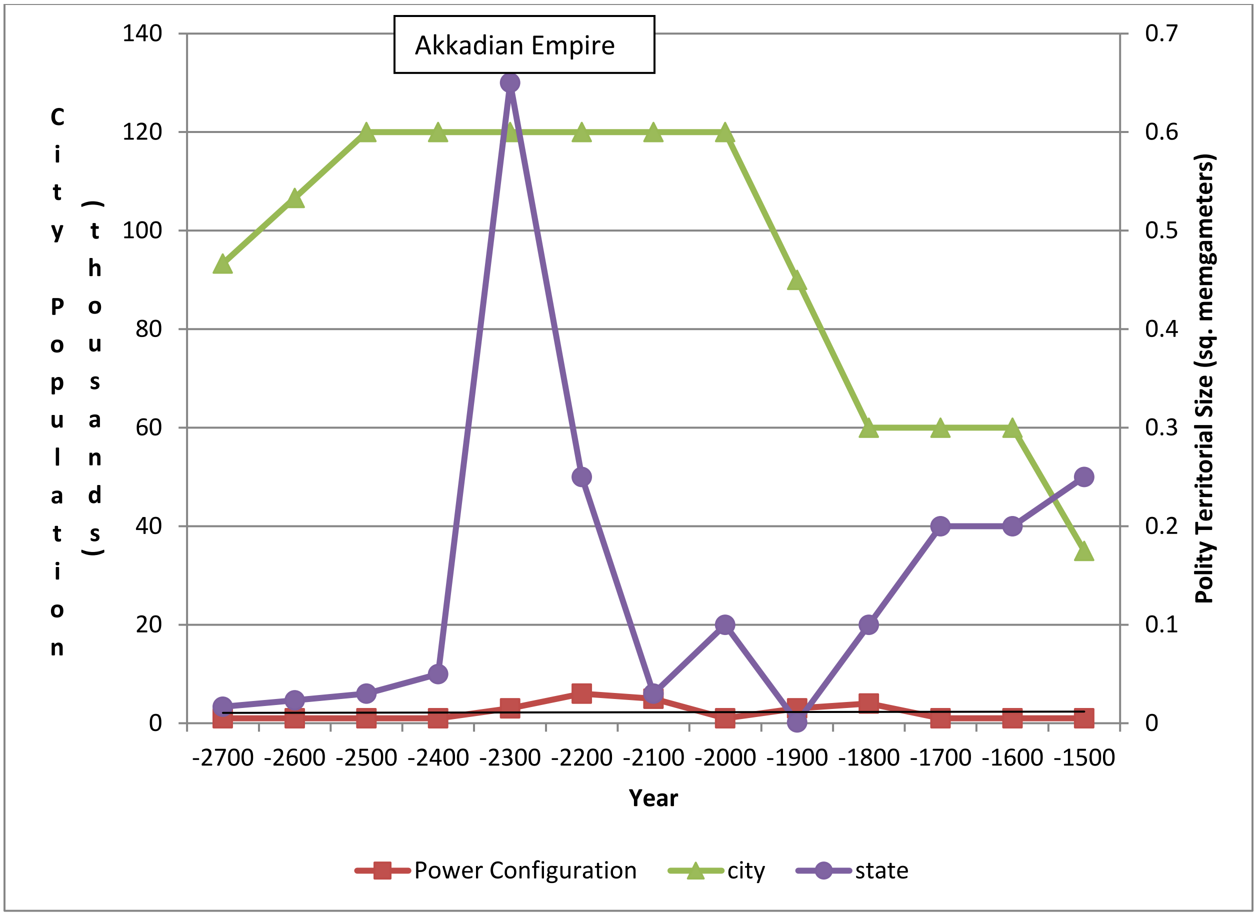


Figure 2: Mesopotamia, 2700- (start earlier)1500 BCE (rescale powcon so it is more visible)

ORIGINAL

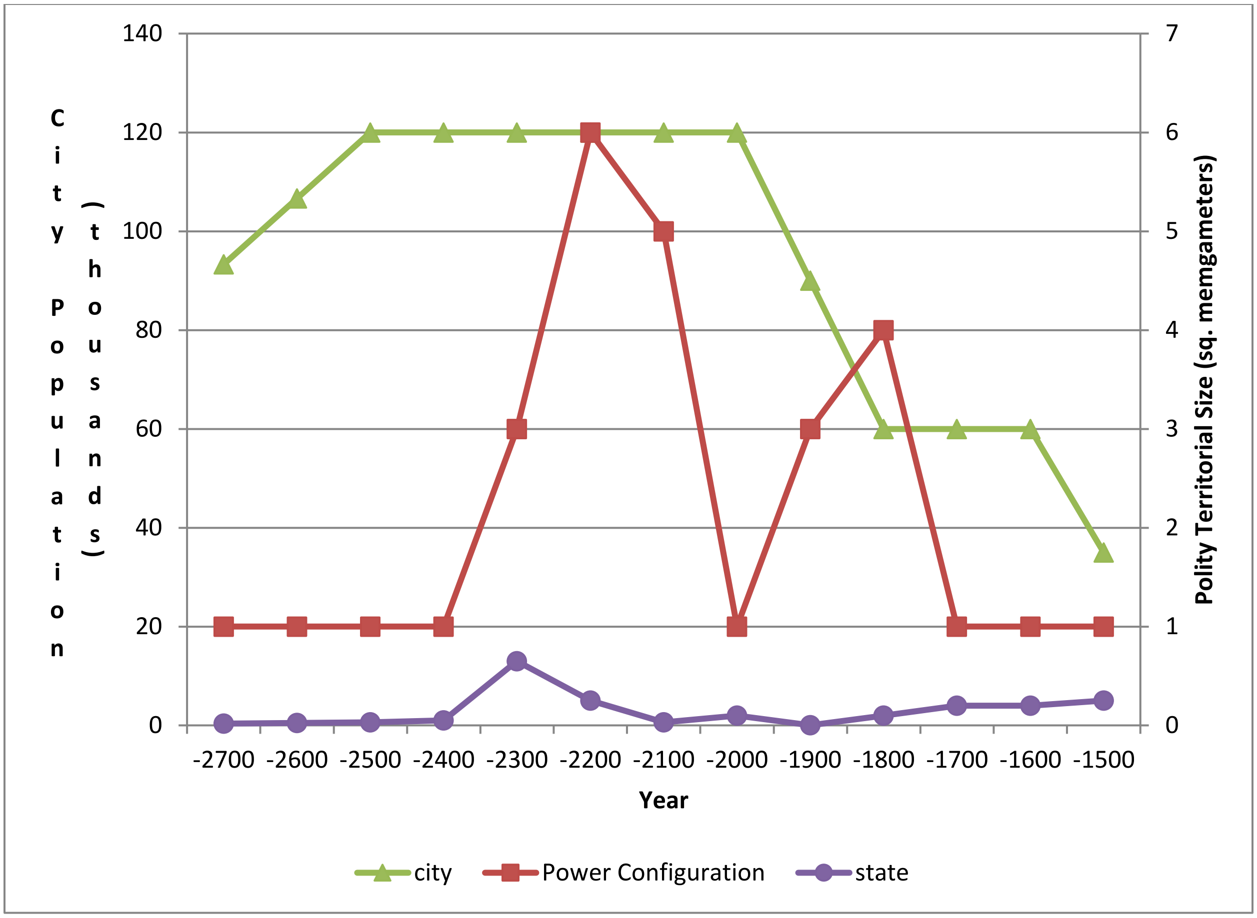


Figure 2: Mesopotamia, 2700- (start earlier)1500 BCE (rescale powcon so it is more visible)

VER 1. Power and State are both using the secondary Axis.

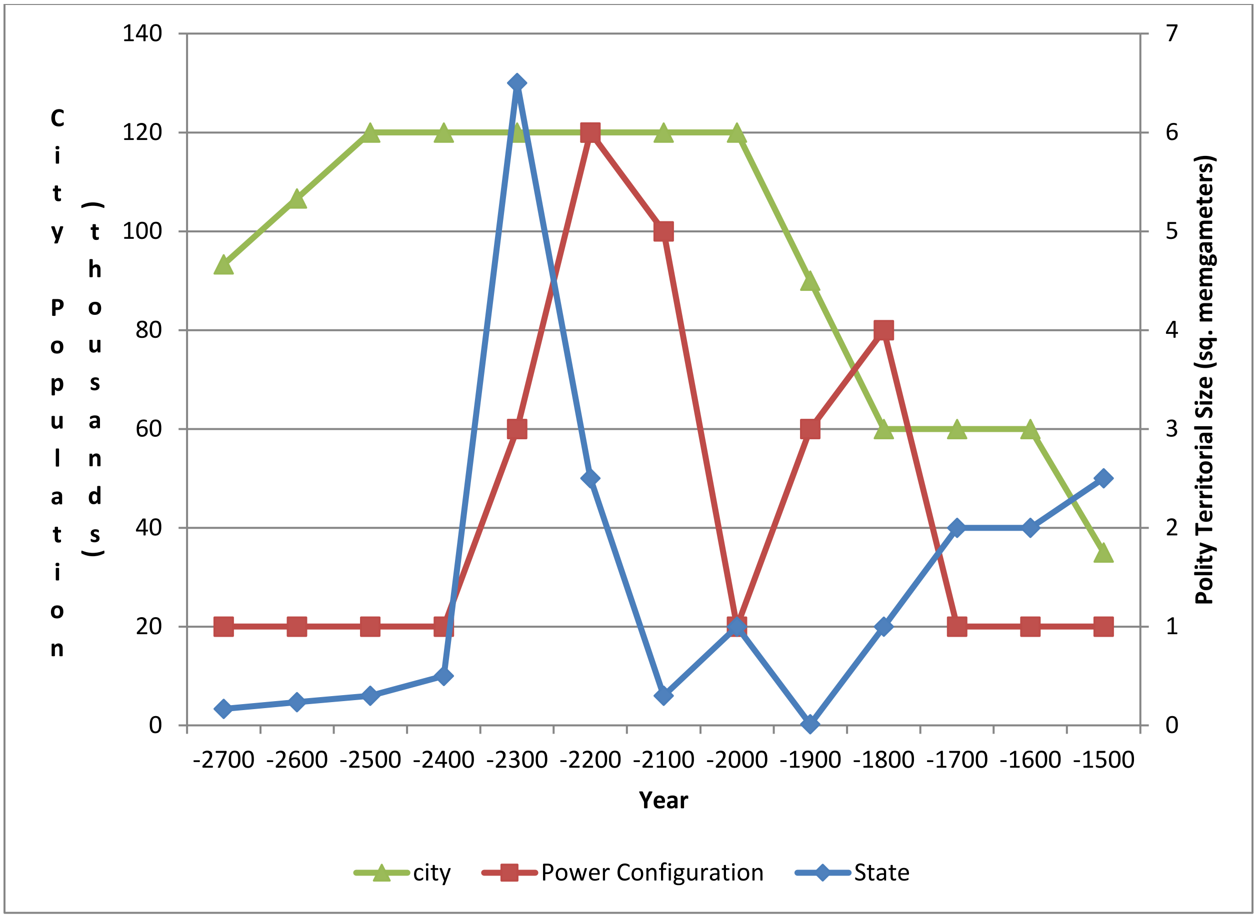


Figure 2: Mesopotamia, 2700- (start earlier)1500 BCE (rescale powcon so it is more visible)

Cioffi-Revilla (2001) has identified the polities that were in interaction with one another in the Mesopotamian/West Asian international system from 6000 BCE to 1500 BCE, including the chiefdoms as well as the states and the empires. Figure 2 shows the trajectories of our three variables for Mesopotamia during the period in the late Bronze and early Iron ages for which we have David Wilkinson's powcon estimates. Cities grew and then got smaller during this period. The correlation between year and city size in Table 1 is negative and statistically significant. The polity size story is rather different. Polities grew slowly until the dramatic rise and fall of the huge, but short-lived, Akkadian Empire. But then their upward trajectory resumed, unlike that of cities in this time period. The Power Configuration polarity sequence, which Wilkinson started coding in 2700 BCE, shows oscillations that sometimes, but not always, follow the trajectory of the territorial size of the largest polity. The Akkadian empire corresponds with a rise in the centrality of the power configuration coding, but later territorial size rises do not seem to track it. This results in the small positive bivariate correlation between powcon and the size of the largest state (.14) shown in Table 1.

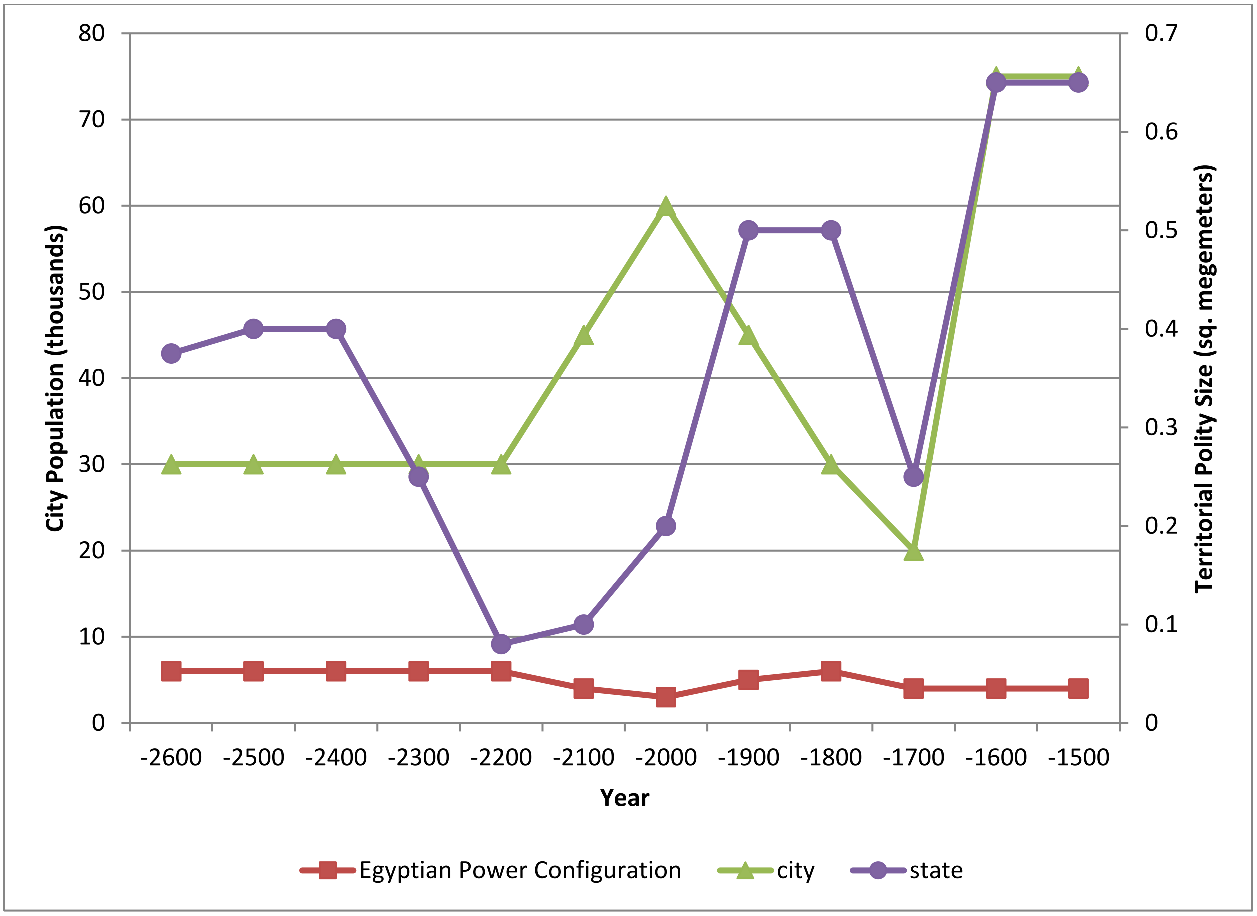


Figure 3: Egyptian PMN, 2600 start earlier-1500 BCE rescale powcon

The story of the Egyptian PMN is different. Cities generally got bigger, though with some downswings. This confirms the .48 correlation between year and city size in Table 1. The trajectories of city and state sizes shows a positive relationship (r= .39) but there are also some important divergences. City size seems to lead and state size to follow in the period from 2200 to 1800 BCE. Power configuration drops to non-polarity during what appears to be a recovery of the size of the largest Egyptian polity. The dips in polarity seem to follow declines in the size of the largest polity. Both the city and the polity correlations with year are positive, indicating the usual pattern of a long term upward trend.

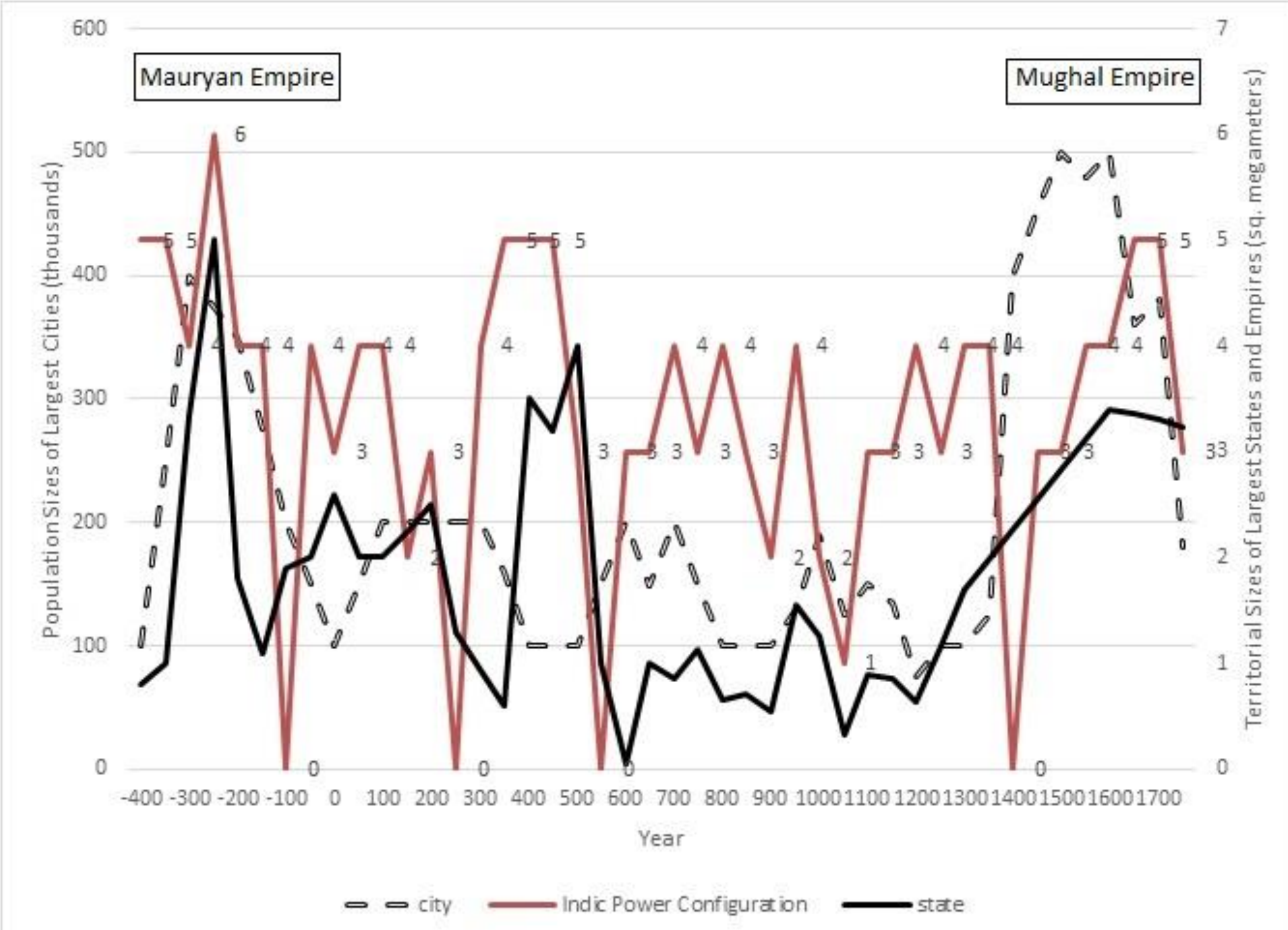


Figure 4: South Asia PMN, 400 BCE-1750 CE

The South Asia PMN displays some peculiarities noted elsewhere (Chase-Dunn, Manning and Hall 2000). The huge size of the Mauryan Empire was not repeated in later polity size upswings. Both the Delhi and the Mughal Empires were smaller. Indeed, the correlation between polity and year in Table 1 is -.39 and [recalculate the correlatons] statistically significant, and the story is the same for city sizes (-.55). Nevertheless, the relationship between city and polity sizes in positive (.12) which is obviously not due to a long-term upward trend. They both go down and the swings are somewhat contemporaneous. The power configuration variable swings the gamut from non-polar to empire and is correlated .13 with the size of the largest polity. The Mauryan Empire was a peak for both power configuration and polity size and just follows the largest peak of city sizes in the South Asia PMN. (Check)

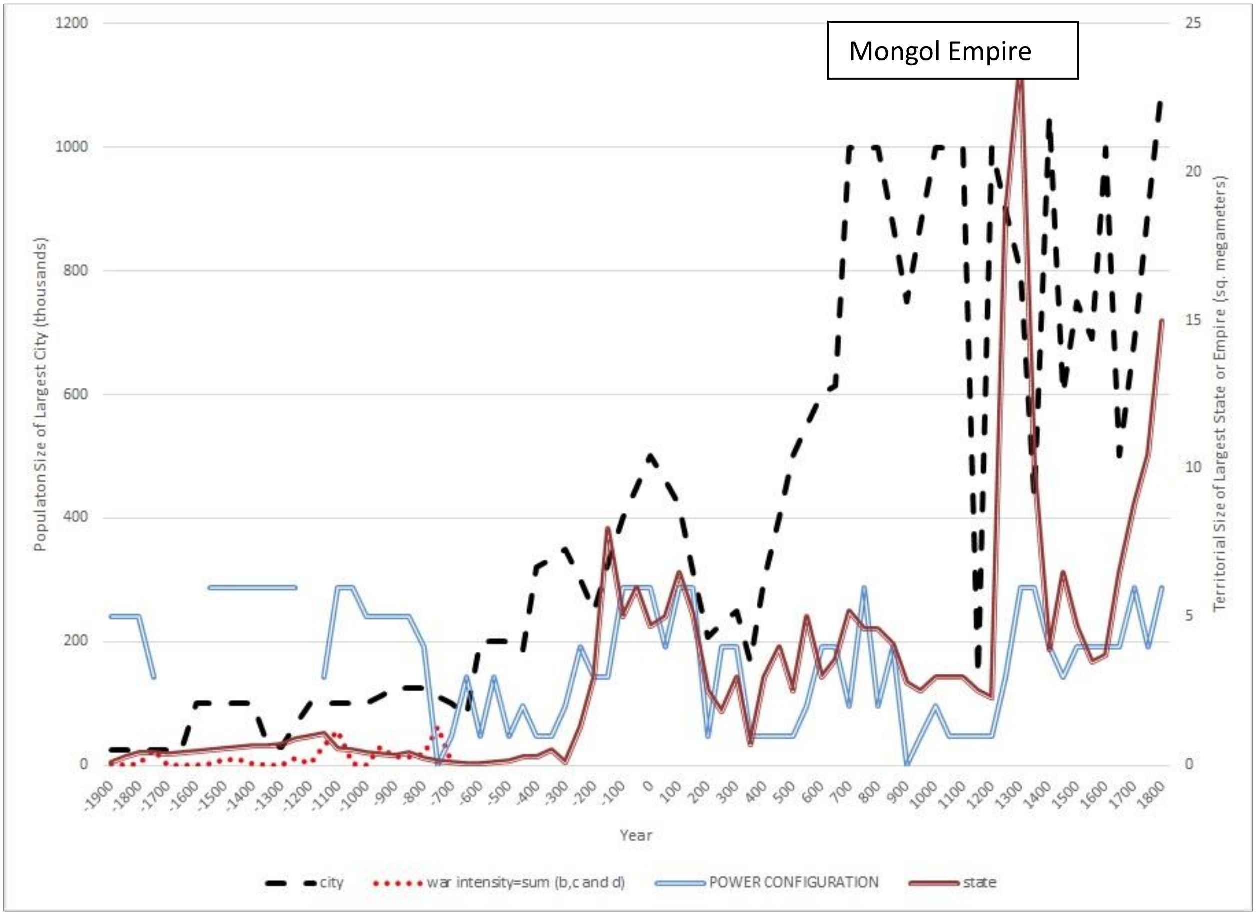


Figure 5: East Asian PMN, 1900 BCE to 1850 CE

The East Asian PMN graph contains 57 time points to display change in our three variables from 1000 BCE until 1800 ce. All of the correlations in Table 1 are positive and statistically significant. The only one that is not very positive and statistically no-significant is that between power configuration and city size (1.0). The bivariate correlation between city and polity size is .64 and statistically significant. The Mongol Empire, which was an important player in both the East Asian and the central PMNs, shows a peak for both powcon and the size of the largest polity in Figure 5.[23] The correlation between power configuration and the size of the largest polity in Table 1 is .50 and statistically significant. Both the trend correlations are high (city/year .82 with statistical significance and state/year .69 with statistical significance) so detrending is needed to see what happens with the state/city correlation.

[23] Our original version of this graph also showed a peak city size in 1300 CE because we were using Modelski's (2003: 63, 65) estimate that Hangzhou had a population of one million five hundred thousand residents in that year. This caused us to scrutinize Modelski's apparent claim more closely. We found that the high estimate for 1300 was a typographical error in Table 12 (Modelski 2003:63). On p. 65 he makes it clear that the estimate of 1.5 million is for 1250, before the Mongol conquest of Hangchou, not 1300. We decided to stick with Ian Morris's estimate of 800,000 for 1300 ce. Our discussion of the difficulties of estimating the size of Hangzhou and the role that East Asian geopolitics played in its growth during the 13th century is at http://irows.ucr.edu/papers/irows111/irows111.htm

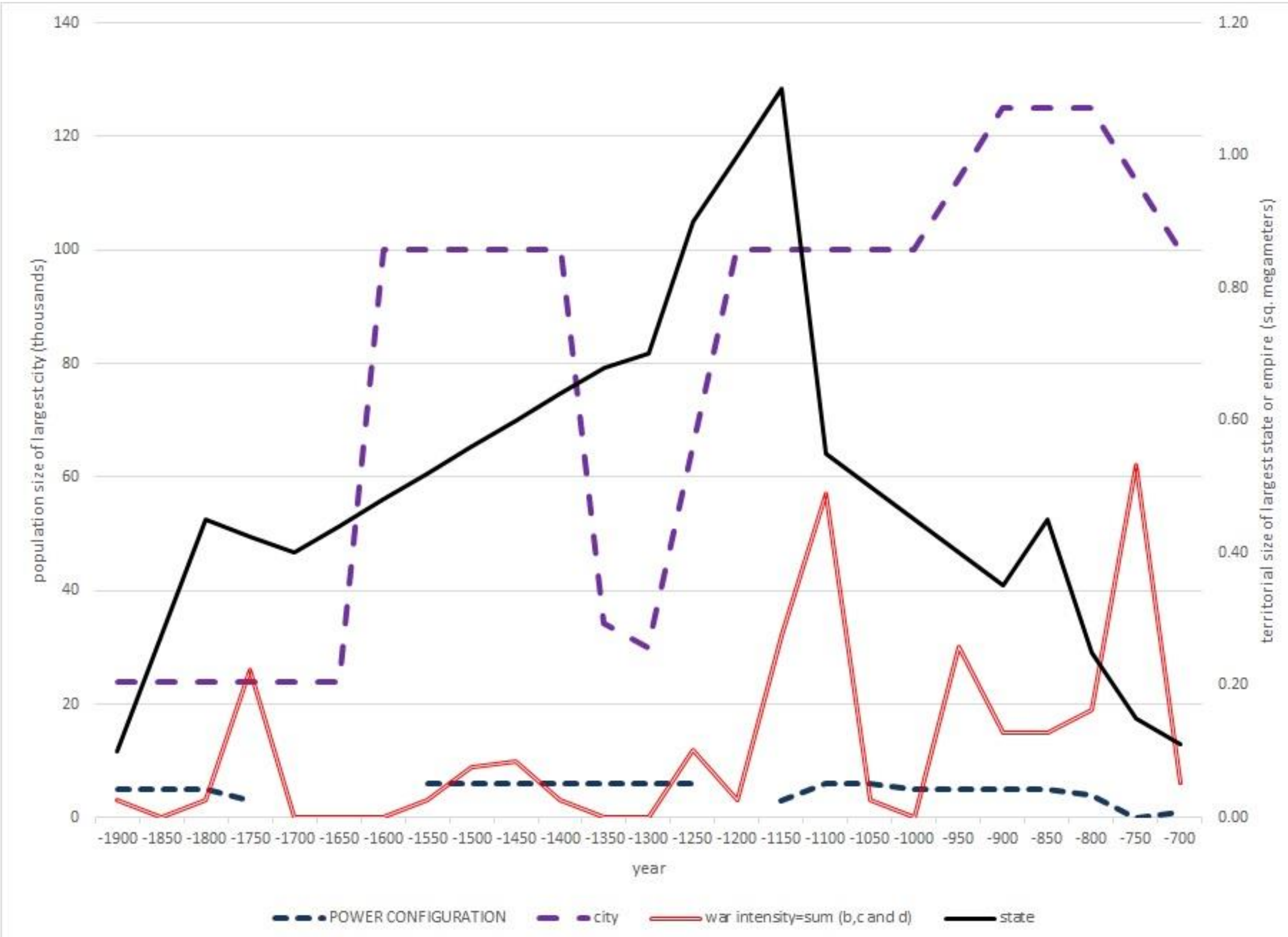


Figure 5a: Early China: conflict, power configuration and the territorial size of the largest state.

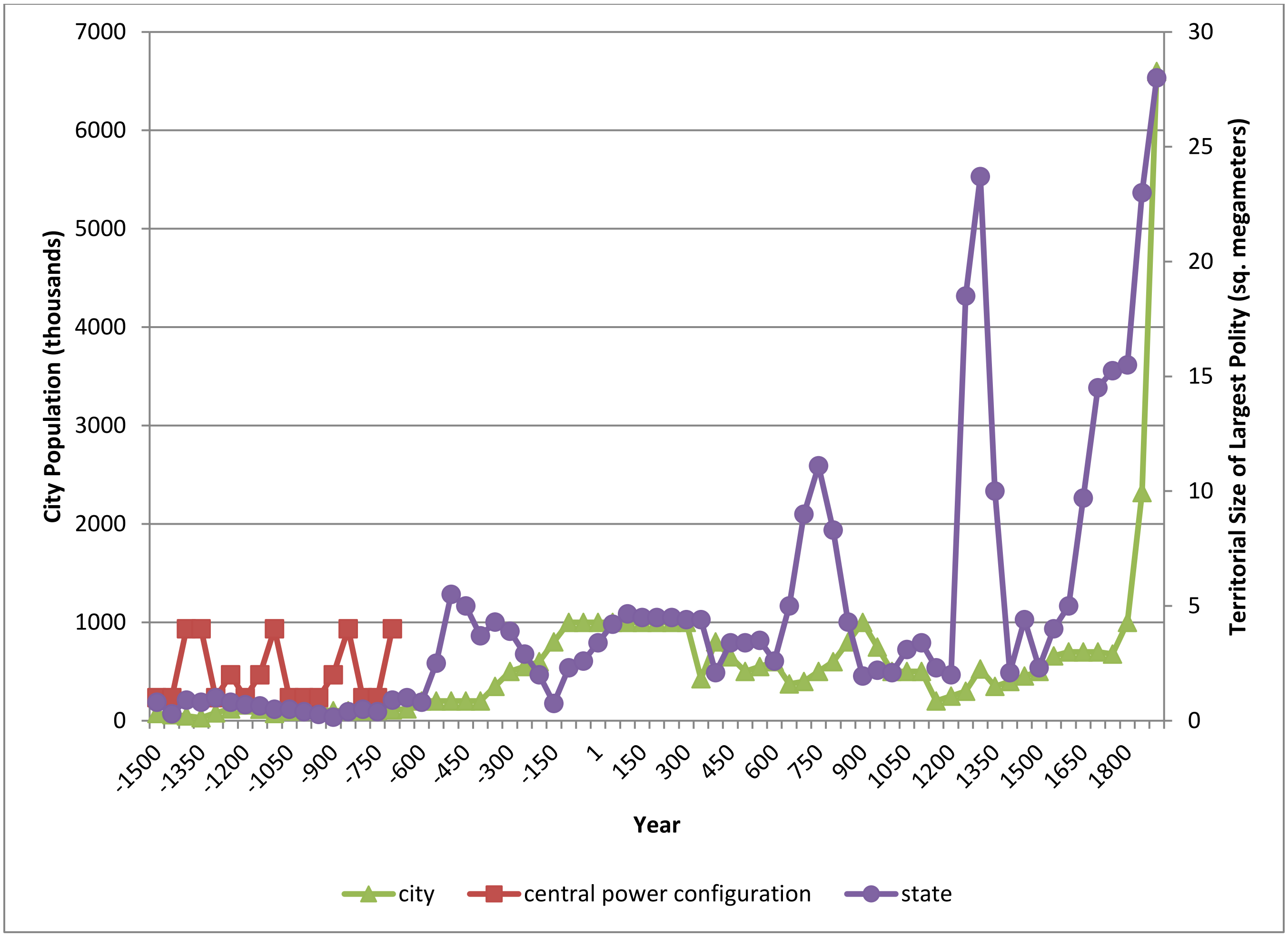


Figure 6: central PMN, 1500 BCE-1800 CE

Figure 6 shows the power configuration variable from 1500 BCE to 700 BCE, the time period that David Wilkinson (2004b) has coded. The scale in Figure 6 makes it difficult to see what is happening with the size of the largest polity in this period, but the Pearson's r correlation between polity size and power configuration for the seventeen time points in this period is .28. The correlation between power configuration and city size for this same period is -.25 (see Table 1 above). A graph for just this time period (1500 BCE to 700 BCE is in the appendix as Figure A1. It shows that there is a lot of variation in power configuration during this period, and that some of its relationship with changes in the largest polity size is positive, but in other instances it is not. The bivariate correlation between city and state size for the sixty-nine time points between 1500 BCE and 1900 CE is .63 and it is statistically significant[24] This supports our notion that cities and states cause each other. Both of the trend correlations are large, positive, and statistically significant for the central PMN (city/year = .67; state/year = .72) so the city/state correlation should be detrended to see whether or not the medium term variations are correlated when the long-term trend is removed.

[24] We do not include 1950 and 2000 CE in Figure 6 because the cities get so large that the scale makes it impossible to see earlier variations.

Partial correlations between cities and states controlling for year

The following tables report the partial correlation coefficients between largest cities and states when year is held constant in order to remove the long-term trends to see if medium term swings are correlated. We also report the partial correlations between city, state and power configuration for the periods in which the latter estimates are available. The first set of tables looks only at cities and states because we have longer time periods for just these two. The second set of table looks at these plus the power configuration variable but for generally shorter periods of time.

PMN / level	Partial Correlation	Mesopotamia (-4500- to -1500) n=31[25]		Mesopotamia (-2700 to -1500)n=13
		city	**state**	**state**
Mesopotamia (-4500 to -1500)	**city** Sig.(2-tailed)	-	0.58 (.763)	.16 (.62)
	state Sig.(2-tailed)	0.58 (.763)	-	

Table 2: Mesopotamian PMN (-4500 to -1500) (100 year intervals)

Table 2 shows that controlling for year changes the Mesopotamian correlation between city and state from the -.09 shown in Table 1 to .16 for the period from 2700 BCE to 1500 BCE. Controlling for year removes the negative bivariate correlation between year and city size (-66 in Table 1) which allows the positive relationship between city size and polity size to become visible. The longer term partial correlation between city and state sizes (4500 BCE to 1500 BCE is also positive (.58).

PMN / level	Partial Correlation	Egyptian PMN (-3200 to -1500) n=18		Egyptian PMN -2600 to -1500 n=12
		city	**state**	**state**
Egyptian PMN (-3200 to -1500)	**city** Sig.(2-tailed)	-	.25 (.323)	.34 (.312)
	state Sig.(2-tailed)	.25 (.323)	-	

Table 3: Egyptian PMN (-3200 to -1500) (100 year intervals)

Table 3 shows that the Egyptian correlation between city and state for the period between 2600 BCE and 1500 BCE changes from .39 (Table 1) to .34 when year is controlled. The positive bivariate correlations of both city and polity sizes with year were accounting for part of the positive correlation between city and polity sizes. The longer term partial correlation (3200 BCE to 1500 BCE) is also positive (.25).

Add 1000-1858ce

PMN / level	Partial Correlation	South Asian PMN (-600 and 1000)n=33	
		city	**state**
South Asian PMN (-600 and 1000)	**city** Sig.(2-tailed)	-	.38* (.032)
	state Sig.(2-tailed)	.38* (.032)	-

[25] Level of statistical significance: *=P = 0.05; **=P = 0.01; ***=P = 0.001; ****=P = 0.000

Table 4: South Asian PMN (-600 and 1000) (50 year intervals, N=29)

Table 4 shows that the city and state correlation for the South Asian PMN changes from .12 to .38 when year is controlled and this correlation is statistically significant at the .05 level. Again the higher correlation arises when year is controlled because the bivariate correlations with year are both negative (see Table 1).

(check)

PMN / level	Partial Correlation	East Asian PMN (-1900 to 1800)n=75 city	East Asian PMN (-1900 to 1800)n=75 state
East Asian PMN (-1900 to 1800)	**city** Sig.(2-tailed)	-	.03 (.835)
	state Sig.(2-tailed)	.03 (.835)	-

Table 5: East Asian PMN (-1900 to 1800) (50 year interval; N=57)

Table 5 shows that the East Asian correlation is reduced from .64 to .03 when year is controlled. This indicates that the very high long-term correlation of city size with year (.82 in Table 1) was the main reason behind the positive bivariate correlation between city and state in East Asia over the whole time period between 1900 BCE and 1800 ce.

PMN / level	Partial Correlation	East Asian PMN (-1900 to 1)n=39 city	East Asian PMN (-1900 to 1)n=39 state
East Asian PMN (-1900 to 1)	**city** Sig.(2-tailed)	-	.49** (.002)
	state Sig.(2-tailed)	.49** (.002)	-

Table 6: East Asian PMN (-1900 to 1)

But when we separate the East Asian data into two subperiods we find something interesting. The partial correlation between city and state is positive and statistically significant for the period before the Common Era (BCE) (.49** in Table 6) but slightly negative for the period of the Common Era (CE) (-.06 in Table 7).

PMN / level	Partial Correlation	East Asian PMN (1 to 1800) n=37 city	East Asian PMN (1 to 1800) n=37 state
East Asian PMN (1 to 1800)	**city** Sig.(2-tailed)	-	-.06 (.720)
	state Sig.(2-tailed)	-.06 (.720)	-

Table 7: East Asian PMN (1 to 1800)

We do not know why the relationship between city and year would be different in the two time periods.

PMN / level	Partial Correlation	Central PMN (-1500 and 1900)n=69	
		city	state
Central PMN (-1500 and 1900)	city Sig.(2-tailed)	- -	.51*** (.000)
	state Sig.(2-tailed)	.51*** (.000)	- -

Table 8: central PMN (-1500 and 1900) take south asia out of central from 1000cd to 1858cd

Table 8 shows that that state/city correlation for the central PMN declines from .63 (Table 1) to .51 when year is controlled, but that the partial correlation is still rather statistically significant for the whole period from 1500 BCE to 1900 ce. This indicates that the long term trend accounted for some of the positive bivariate correlation, but that there is an important medium-term positive relationship between cities and states for the central PMN.

PMN / level	Partial Correlation	Central PMN (-1500 and 1) n=31	
		city	state
Central PMN (-1500 and 1)	city Sig.(2-tailed)	- -	-.21 (.264)
	state Sig.(2-tailed)	-.21 (.264)	- -

Table 9: central PMN (-1500 and 1)

Table 9 looks at the subperiod before the advent of the Common Era (BCE) for the central PMN and shows a negative relationship during this period, just the opposite of what we found for the East Asian PMN.

PMN / level	Partial Correlation	Central PMN (1 and 1900) n=39	
		city	state
Central PMN (1 and 1900)	city Sig.(2-tailed)	- -	.54*** (.000)
	state Sig.(2-tailed)	.54*** (.000)	- -

Table 10: central PMN (1 and 1900) take south asia out of central from 1000cd to 1858cd

The Common Era for the central PMN shows as large and statistically significant positive partial correlation between city and state sizes. Again this is quite different from what we found for the Common Era period of the East Asian PMN.

PMN / level	Partial Correlation	Mesopotamia (-2700 to -1500) n=13 powcon	state	city
Mesopotamia (-2700 to -1500)	**powcon** Sig.(2-tailed)	-	.16 (.618)	.45 (.144)
	state Sig.(2-tailed)	.16 (.618)	-	.16 (.624)
	city Sig.(2-tailed)	.45 (.144)	.16 (.624)	-

Table 11: Mesopotamian PMN (2700 to 1500 BCE) (N=13)

Table 11 shows that the partial correlation between Mesopotamian power configuration and city size for the period between 2700 BCE and 1500 BCE is .45. This is more positive than the bivariate correlation (.25), so controlling for year increases this correlation. The partial correlation between power configuration and the size of the largest polity is .16, which is nearly the same as the bivariate correlation shown in Table 1 (.14). The logical overlap between these two variables is not large enough to produce a very high positive correlation over time in Mesopotamia.

PMN / level	Partial Correlation	Egyptian PMN (-2600 to -1500) n=12 powcon	state	city
Egyptian PMN (-2600 to -1500)	**powcon** Sig.(2-tailed)	-	.40 (.224)	-.46 (.158)
	state Sig.(2-tailed)	.40 (.224)	-	.34 (.312)
	city Sig.(2-tailed)	-.46 (.158)	.34 (.312)	-

Table 12: Egyptian PMN 2600 BCE to 1500 BCE

Table 12 shows that the Egyptian partial correlation between city and power configuration is negative -.46, but it is somewhat less negative than the bivariate correlation shown in Table 1 (-.62). This is because the bivariate correlation between year and city is positive (.48) so controlling year lowers the negative partial correlation. Also recall that the partial correlation between powcon and city was positive .45 for the Mesopotamian PMN. The partial correlation between state and power configuration is.40 whereas the bivariate correlation in Table 1 was -.01. Again this is because the bivariate correlation between state size and year is .45 so controlling the long-term trend allows the positive short term relationship to be visible. The partial correlation between powcon and state size for Mesopotamia was .16.

PMN / level	Partial Correlation	South Asia PMN (-400 to 1000) n=29 powcon	state	city
South Asia PMN (-400 to 1000)	**powcon** Sig.(2-tailed)	-	.19 (.333)	.00 (.998)
	state Sig.(2-tailed)	.19 (.333)	-	.10 (.620)
	city Sig.(2-tailed)	.00 (.998)	.10 (.620)	-

Table 13: South Asia PMN add 1000-1858ce

Table 13 shows that the South Asian partial correlation between city and state is .10, whereas the bivariate correlation in Table 1 is .12 (see also Figure 4). Recall that both city and state are negatively correlated with year during this period in South Asia. The partial correlation between city and power configuration is effectively zero, whereas the bivariate correlation reported in Table 1 was .07 . The partial correlation between state and power configuration is .19 whereas the bivariate correlation in Table 1 was .13 Controlling for the long-term downward trends of city and state sizes increases the partial correlations. (check)

PMN / level	Partial Correlation	East Asian PMN (-1000 to 1800) n=57		
		powcon	state	city
East Asian PMN (-1000 to 1800)	powcon Sig.(2-tailed)	-	.47** (.000)	-.01 (.918)
	state Sig.(2-tailed)	.47** (.000)	-	.04 (.786)
	city Sig.(2-tailed)	-.01 (.918)	.04 (.786)	-

Table 14: East Asian PMN

Table 14 is for a somewhat shorter and more recent period than Table 5 but the partial correlations between city and state are similar (.02 and .04). The partial correlation between power configuration and city is -.01 and that between power configuration and state is .47 and is statistically significant (see also Figure 5). This must be due to the logical overlap between the power configuration and the size of the largest state.

PMN / level	Partial Correlation	Central PMN (-1500 to -700) n=17		
		powcon	state	city
Central PMN (-1500 to -700)	powcon Sig.(2-tailed)	-	.34 (.199)	-.51* (.04g5)
	state Sig.(2-tailed)	.34 (.199)	-	.01 (.959)
	city Sig.(2-tailed)	-.51* (.045)	.01 (.959)	-

Table 15: central PMN

Table 15 is for a much shorter and earlier time period than is used for Table 8. For this early time period the state/city partial correlation is -.01 whereas for the whole time period for which we have estimates shown in Table 8 the correlation .51 and is statistically significant. This means that there are either important period differences, or that the estimates for the earlier time periods are unreliable or some combination of the two. The partial correlation between power configuration and city in Table 15 is -.51, whereas the partial correlation between power configuration and state is .34.

The partial time series correlation results generally confirm the hypothesis that changes in the sizes of cities and states are contiguous in time (see Table 16). Both the Egyptian and Mesopotamian PMNs are during the Bronze and Early Iron ages, when estimates of the sizes of both cities and polities are less reliable.[26] We have already remarked that we had to rely on more interpolations for both of these cases. We reduced the number of interpolations by using 100 year intervals rather than 50 year intervals which should have reduced the errors. The state/city partial correlations are positive for all of our cases, but barely so for the East Asian PMN. This partly confirms our hypothesis that these two aspects of size cause each other but it does not tell us which of these causes is larger. For that we will turn to tests of Granger causality. We also do not know why the interaction between city and state sizes is so weak in East Asia. One possibility is the somewhat greater role of non-core marcher states in the process of empire formation in East Asia. It is well-known that horse nomads and forest peoples despised cities and could only reinvent themselves to become an urban ruling class with great effort.

PMN	Time period	State/city (whole period)	Powcon/city (shorter period)	Powcon/state (shorter period)
Mesopotamia	2700-1500 BCE	.16	.16	.45
Egypt	2600-1500 BCE	.41	-.46	.40
South Asia	600 BCE- 1000 ce	.38*	.00	.19
East Asia	1900 BCE- 1800 ce	.02	-.01	.47**
Central	1500 BCE- 1900 ce	.51***	-.51*	.34

Table 16: Summary of Partial Correlations (add 1000=-1858ce to south asia) take south asia out of central from 1000cd to 1858cd

Table 16 also shows big differences across the PMNs in the partial correlations between city sizes and power configuration. There is a positive relationship in Mesopotamia, but zero or negative relationships in the other PMNs. We would generally suppose a positive relationship because of the expected positive connection of both of these variables with the sizes of the largest polities. This idea finds support in the case of Mesopotamia, but South Asia and East Asia have nearly null partial correlations and Egypt and the central PMN have rather substantial negative partial correlations. These results are confusing. The negative partial correlation between city size and power configuration for the central system may be due to the temporally truncated time period for which estimates of power configuration are available (see Figure 6 above).

The findings regarding the partial correlations between power configuration and the sizes of largest states are more consistent. All of the PMNs show positive partial correlations. This is reassuring because of the noted logical connection between these two variables. Perhaps it is the rather small positive partial correlations in South Asia (check)and Mesopotamia that are the most noteworthy. In these cases, a substantial amount of the variation in power configuration is not captured by the size of the largest polity.

[26] As estimates of polity and settlement sizes for the Bronze and Early Iron Ages improve we should be able to be more certain about what accounts for the lack of positive cross-temporal correlations between city and state sizes in Mesopotamia and Egypt – poor data or a truly different relationship during this early time period.

We also found curious subperiod differences in the city/state relationships for both the East Asian and the central PMNs (Tables 6,7,9 and 10 above). For the period from 1900 BCE to the beginning of the Common Era (CE) the East Asian PMN had a significant positive relationship between the size of the largest city and that of the largest polity (.49** in Table 6). Whereas for the period from the beginning of the Common Era until 1800 CE the same correlation is null (-.06 in Table 7). We noted above that non-core marcher states, more important in East Asia than in the central PMN, were somewhat anti-urban. But this may not explain the subperiod findings for East Asia because non-core marchers were already playing an important part in the BCE period (the Xiongnu). And the central PMN also displays a curious subperiod difference. Table 9 shows that the city/state relationship for the central PMN from 1500 BCE to the beginning of the Common Era is .21 whereas for the period from the beginning of the Common Era until 1900 CE it is .54*** (Table 10). So these two PMNs display rather different subperiod results. Why?

East Asian Power Configuration and Battles

East Asian Battles data:

East Asian Power Configuration data:
Integrated measure of power configuration between Wilkinson (1999) and Cioffi ().
[NOTE]
Cioffi's data is converted to Wilkinson's measure:
(To make these unique and to correspond with a non-hierarchical to hierarchical continuum we propose:
Wilkinson/Cioffi
Non-polarity 0 =0
Multipolarity 1 =10-11 and 12
Tripolarity 2=7-8 and 9
Bipolarity 3= 4-5 and 6
Unipolarity 4= 1
Hegemony 5= 2
Empire 6= 3)
For the overlapped years, between -1025 and 1850, we used Wilkinson's data, rather than Cioffi's data.

Granger Causality Tests

Granger causality tests identify lagged correlations between two time-series variables. They examine temporal precedence of one variable relative to another, and if it is proven, it indicates a possible causality. In the test, panel vector autoregression analysis assesses Granger causality among multiple time-series variables. The test allows us to determine whether the sum of lagged values of variable A explains more of the variance in variable B than lagged values of variable B itself. When the test shows the evidence that lagged variable A values significantly predict changes in variable B, there is Granger causality in the relationship between variable A and B. The current study uses either chi-squared tests or F-statistics depending on the sample size to test whether or not we can reject the null hypothesis. [27]

We test the Granger causality of the three variables—polity size upswings/upsweeps, city size upswings/upsweeps, and the level of polarity—of each PMNs.

H1: lagged values of independent variable X provide more information on the respective dependent variable than lagged variable of dependent variable Y alone.

H0: lagged values of dependent variable Y explain more information than the lagged values of independent variable X explain about the variable of dependent variable Y.

Granger causality tests assume that the data are covariance stationary. The raw data of the three variables in our study are not stationary. [28] Therefore, we logged and first differenced the raw data to make the values stationary. After these transformations of the raw data Granger causality inferences should be valid (Freeman 1983; Goldstein 1988).

We tested the Granger causality of the three variables: polity size, city size and polarity level.

Polity size is the largest territorial size of a polity within a PMN at 100-year intervals or 50-year intervals. When the 50-year interval data are not available, we interpolated the 100-year interval data points to obtain the 50-year data estimates. For Mesopotamia and Egypt, we used the 100-year intervals since even the 100-year interval data points are not all available. We interpolated the missing data points to have the 100-year interval data points for these two PMNs.

City size is the largest population size of a city within in a PMN at 100-year intervals or 50-year intervals. The interpolation was conducted in the same manner with the polity size data. City data also has the 100-year interval data points for Egypt and Mesopotamia for the same reason with the polity data.

Polarity is measured using Wilkinson's scale. David Wilkinson's coding scheme for polarity is: 0. Nonpolarity, 1. Multipolarity, 2. Tripolarity, 3. Bipolarity, 4. Unipolarity (Non-hegemonic), 5. Hegemony, 6. Empire. We test the hypotheses that these three variables may be causes of one another.

"Polity up" in the following tables means the upsweeps or upswing of polity territorial size. "City up" means the upsweeps or upswing of city population size. "Polity up" in the following tables indicates the unification toward the rule by a single Empire over an extended territory.

Mesopotamia (Lag time 2, N=10)

The year period is 2700BCE to 1500BCE. The data points: 100-year interval.

---

[27] Granger causality is based on linear regression modeling of stochastic processes (Granger 1969). The Granger causality is difficult to be applied to nonlinear data. This is the limitation of the application of Granger causality since many historical dynamics are non-linear.

[28] The assumptions of Granger Causality test are that: (1) the data are described as a linear model (?); (2) the data are stationary. To examine stationarity of the data, the augmented Dickey-Fuller (ADF) test was conducted. The test did not reject null-hypothesis that the variables are not a unit root and stationary. A stationary process is a stochastic process whose joint probability distribution does not change when shifted in time. Parameters such as the mean and the variance do not change over time.

Equation (Dependent Variable)		Excluded (Independent Variable)	F	p-value
Polarity	←	Polity up	18.532	0.0205
Polarity	←	City up	34.251	0.0086
Polity up	←	Polarity	.14663	0.8694
Polity	←	City ups	.19633	0.8315
City upsweep	←	Polarity	6.1177	0.0874
City upsweep	←	Polity upsweep	.37433	0.7459

Table 17: Panel Vector Autoregression Tests for Granger Causality, Mesopotamia

The raw data was transformed using log and first difference to ensure stationarity. F-test is used due to small sample size. The results show that the city size upsweep (upswing) Granger cause the level of polarity, or level toward the unification by a single polity (empire). The results also reveal that the polity size upsweep (upswing) Granger cause the polarity (the level toward the unification by a single polity (empire)). There is no significant Granger causality between city size and polity size increase.

Egypt (Lag time 2, N=9)

The year period is 2600BCE to 1500BCE. The data points: 100-year interval

Equation (Dependent Variable)		Excluded (Independent Variable)	F	p-value
Polarity	←	Polity up	5.3034	0.1586
Polarity	←	City up	.18385	0.8447
Polity up	←	Polarity	1.2081	0.4529
Polity up	←	City up	.18385	0.8447
City up	←	Polarity	88.514	0.0112
City up	←	Polity up	44.008	0.0222

Table 18: Panel Vector Autoregression Tests for Granger Causality, Egypt

The raw data was transformed using log and first difference to ensure stationarity. F-test is used due to small sample size. The results show that the polarity, or level toward the unification by a single polity (empire) Granger cause city upsweep (upswing). The results also reveal that the polity size upsweep (upswing) Granger causes city size upsweep (upswing) in Egypt.

East Asia (lag time 2, N=54)

The data range is 1000BCE to 1800AD. The data points: 50-year interval

Equation (Dependent Variable)		*Excluded (Independent Variable)*	χ^2	*p-value*
Polarity	←	Polity up	.43105	0.806
Polarity	←	City up	.12579	0.939
Polity up	←	Polarity	.04458	0.978
Polity up	←	City up	7.0693	0.029
City up	←	Polarity	1.7393	0.419
City up	←	Polity up	.03599	0.982

Table 19: Panel Vector Autoregression Tests for Granger Causality, East Asia

The raw data was transformed using log and first difference to ensure stationarity. The results also reveal that the city size upsweep (upswing) Granger cause polity size upsweep (upswing).

South Asia (Lag time 2, N=26)

The data range is:400BCE to 1000AD. The data points: 50-year interval

Equation (Dependent Variable)		*Excluded (Independent Variable)*	χ^2	*p-value*
Polarity	←	Polity size	.24277	0.886
Polarity	←	City size	.00593	0.992
Polity size	←	Polarity	8.8052	0.012
Polity size	←	City size	.22504	0.894
City up	←	Polarity	3.7068	0.157
City up	←	Polity up	6.1279	0.047

Table 20: Panel Vector Autoregression Tests for Granger Causality, South Asia (add 1000-1858ce)

The raw data was transformed using log and first difference to ensure stationarity. F-test is used due to small sample size. The results show that the level of polarity (the level of unification toward a single polity/empire) Granger cause polity up sweep (swing). The results also reveal that the polity size upsweep (upswing) Granger cause city size upsweep (upswing).

Central PMN (Lag time 2, N=14)

The year period is 1500BCE to 700BCE. The data points: 50-year interval

Equation (Dependent Variable)		*Excluded (Independent Variable)*	*F*	*p-value*
Polarity	←	Polity up	1.6446	0.2597
Polarity	←	City up	.52839	0.6113
Polity up	←	Polarity	.98727	0.4191
Polity up	←	City up	.8995	0.4489
City up	←	Polarity	5.3985	0.0382
City up	←	Polity up	14.057	0.0035

Table 21: Panel Vector Autoregression Tests for Granger Causality, central PMN take south asia out of central from 1000cd to 1858cd

The raw data was transformed using log and first difference to ensure stationarity. F-statistics is used for central PMN because of the small sample size (14). The results show that the level of polarity (the level of unification by a single polity/empire) Granger cause city up sweep (swing). The results also reveal that the polity size upsweep (upswing) Granger cause city size upsweep (upswing). Further, the polity size upsweep (upswing) Granger cause the level of polarity.

Discussion and Conclusions

An earlier study (Chase-Dunn, Alvarez and Pasciuti 2005) found positive cross-temporal correlations in several world regions in the relationship between the territorial sizes of the largest and the second largest states (Taagepera 1978a: 116). This was surprising because of the hypotheses that territorial sizes of states is somewhat of a zero-sum game. If one state has a lot of territory there is less available for other states. This finding was interpreted to mean that world regions experience periods of growth in which states are generally getting larger and periods of decline in which states are getting smaller, thus producing the positive cross-temporal correlations between largest and second largest states. If this is true it has implications for our study of the relationships between cities and states. The positive correlations, when they exist, may be due to these regional growth/decline phases. Add discussion of granger results From Granger causality tests of the five regions, we found that in Egyptian, South Asia, central PMN, Polity upsweep/upswing Granger cause City upsweep/upswing. In East Asian PMN, City upsweep/upswing Granger cause Polity upsweep/upswing. Further, we found that in Mesopotamian and East Asian PMN, city upsweep/upswing Granger cause polarity, but in Egyptian, central PMN polarity Granger cause city upsweep/upswing. In South Asian PMN, polarity Granger cause polity upsweep/upswing. (check)

Bibliography

6000 Years of Urban Growth http://www.citylab.com/housing/2016/06/watch-6000-years-of-urbanization-in-3-minutes-max-galka-metrocosm/487142/

Abu-Lughod, Janet Lippman 1989. *Before European Hegemony The World System A.D. 1250-1350* New York: Oxford University Press.

Adams, Robert McCormick 1981 *The Heartland of Cities: Surveys of Ancient Settlement and Land Use on the central Floodplain of the Euphrates*. Chicago: University of Chicago Press.

Algaze, Guillermo 1993. *The Uruk World System: The Dynamics of Expansion of Early Mesopotamian Civilization* Chicago: University of Chicago Press.

______. 2000. "The prehistory of imperialism: the case of Uruk period Mesopotamia" in M. Rothman (ed.) *Uruk Mesopotamia and its Neighbors: Cross-cultural Interactions and their Consequences in the Era of State Formation.* Santa Fe: School of the Americas

Anderson, E. N. and Christopher Chase-Dunn 2005. "The Rise and Fall of Great Powers" in Christopher Chase-Dunn and E.N. Anderson (eds.) *The Historical Evolution of World-Systems*. London: Palgrave.

Álvarez, Alexis. E.N. Anderson, Elisse Basmajian, Hiroko Inoue, Christian Jaworski, Alina Khan, Kirk Lawrence, Andrew Owen, Anthony Roberts, Panu Suppatkul and Christopher Chase-Dunn 2013 Comparing World-Systems: Empire Upsweeps and Non-core marcher states Since the Bronze Age" Presented at the annual meeting of the American Sociological Association, New York, August http://irows.ucr.edu/papers/irows56/irows56.htm

Amin, Samir 1980. *Class and Nation, Historically and in the Current Crisis*. New York: Monthly Review Press.

Anderson, E. N. and Christopher Chase-Dunn "The Rise and Fall of Great Powers" in Christopher Chase-Dunn and E.N. Anderson (eds.) 2005. *The Historical Evolution of World-Systems*. London: Palgrave.

Arrighi, Giovanni 1994. *The Long Twentieth century*. London: Verso.

______ . 2008 *Adam Smith in Beijing*. London: Verso.

Arrighi, Giovanni, Takeshi Hamashita, and Mark Selden 2003 *The Resurgence of East Asia: 500, 150 and 50 Year Perspectives*. London: Routledge

ARVE Population World Atlas http://arve.unil.ch/popmap

Bairoch, Paul 1988 *Cities and economic development: from the dawn of history to the present* Chicago: University of Chicago Press

Bairoch, Paul, Jean Batou and Pierre Chevre 1988 *The Population of European Cities, 800 to 1850: Data Bank and Short Summary of Results*. Geneva: Librairie Droz, 11 rue Massot.

. 1988 The population of European cities. Data bank and short summary of results: 800-1850, La population des villes europeennes. Banque de donnees et analyse sommaire des resultats: 800-1850. Geneva, Switzerland, Librairie Droz. http://www.popline.org/node/366534

Barfield, Thomas J. 1989 *The Perilous Frontier: Nomadic Empires and China*. Cambridge, MA.: Blackwell

Beaujard, Philippe. 2005 "The Indian Ocean in Eurasian and African World-Systems Before the Sixteenth century." *Journal of World History* 16,4:411-465.

______ . 2012a *Les mondes de l'océan Indien* Tome I: De la formation de l'État au premier système-monde Afro-Eurasien (4e millénaire av. J.-C. – 6e siècle apr. J.-C.). Paris: Armand Colin.

______ . 2010. "From Three possible Iron-Age World-Systems to a Single Afro-Eurasian World-System." *Journal of World History* 21:1(March):1-43.

______ . 2112b *Les mondes de l'océan Indien* Tome II: L'océan Indien, au coeur des globalisations de l'ancien Monde du 7e au 15e siècle. Paris: Armand Colin Beckwith, I. Christopher. 1991. "The Impact of the Horse and Silk Trade on the Economies of T'ang China and the Uighur Empire." *Journal of the Economic and Social History of the Orient* 34:2:183-198.

Bentley, Jerry H. 1993. *Old World Encounters: Cross-Cultural Contacts and Exchanges in Pre-Modern Times*. Oxford: Oxford University Press.

Blanton, Richard E., Stephen A. Kowalewski, and Gary Feinman. 1992. "The Mesoamerican World-System." *Review* 15:3(Summer):418-426.

Bosworth, Andrew 1995 "World cities and world economic cycles" Pp. 206-228 in Stephen Sanderson (ed.) *Civilizations and World Systems*. Walnut Creek,CA.: Altamira.

Braudel, Fernand 1972 *The Mediterranean and the Mediterranean World in the Age of Philip II*. New York: Harper and Row, 2 vol.

______ . 1984. *The Perspective of the World*, Volume 3 of *Civilization and Capitalism*. Berkeley: University of California Press.

Brecke, Peter 2001 "The Long-Term Patterns of Violent Conflict in Different Regions of the World" http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.15.9141&rep=rep1&type=pdf

__________ nd Conflict Catalogue http://www.cgeh.nl/data#conflict

Brown, Barton M. 1987 "Population estimation from floor area," *Behavior Science Research* 21:1-49.

Chandler, Tertius and Gerald Fox 1974 *Three Thousand Years of Urban Growth*. New York: Academic Press

Chandler, Tertius 1987 *Four Thousand Years of Urban Growth: An Historical census*. Lewiston, N.Y.: Edwin Mellon Press

Chase-Dunn, Christopher 1985 "The system of world cities: A.D. 800-1975." Pp. 269-292 in Michael Timberlake (ed.) *Urbanization in the World-Economy*, New York: Academic Press.

Chase-Dunn, C. 1988. "Comparing world-systems: Toward a theory of semiperipheral development," *Comparative Civilizations Review*, 19:29-66, Fall.

Chase-Dunn, C and Thomas D. Hall 1993"Comparing World-Systems: Concepts and Working Hypotheses" *Social Forces* 71:4(June):851-886.

______ . 1997 *Rise and Demise: Comparing World-Systems* Boulder, CO.: Westview Press.

Chase-Dunn, Christopher, Thomas D. Hall, & Peter Turchin. 2007 "World-Systems in the Biogeosphere: Urbanization, State Formation, and Climate Change Since the Iron Age." Pp.132-148 in *The World System and the Earth System: Global Socioenvironmental Change and Sustainability Since the Neolithic*, edited by Alf Hornborg and Carole L. Crumley. Walnut Creek, CA: Left Coast Books.

Chase-Dunn, C. and Susan Manning, 2002 "City systems and world-systems: four millennia of city growth and decline," *Cross-Cultural Research* 36, 4: 379-398 (November

Chase-Dunn, C. , Susan Manning and Thomas D. Hall 2000 "Rise and fall: East-West synchronicity and South Asia exceptionalism reexamined," *Social Science History*. 24,4:727-754.

Chase-Dunn C. and Alice Willard 1994 "Cities in the central Political-Military Network since CE 1200" *Comparative Civilizations Review,* 30:104-32 (Spring).

Chase-Dunn,C. Alexis Alvarez, and Daniel Pasciuti 2005 "Power and Size; urbanization and empire formation in world-systems" Pp. 92-112 in C. Chase-Dunn and E.N. Anderson (eds.) *The Historical Evolution of World-Systems*. New York: Palgrave.

Chase-Dunn, C. Daniel Pasciuti, Alexis Alvarez and Thomas D. Hall. 2006 "Waves of Globalization and Semiperipheral Development in the Ancient Mesopotamian and Egyptian World-Systems" Pp. 114-138 in Barry Gills and William R. Thompson (eds.), *Globalization and Global History* London: Routledge.

Chase-Dunn, C. and Andrew K. Jorgenson 2003 "Regions and Interaction Networks: an institutional materialist perspective," *International Journal of Comparative Sociology*44,1:433-450.
Chase-Dunn, C. Eugene N. Anderson, Hiroko Inoue, Alexis Álvarez, Lulin Bao, Rebecca Álvarez, Alina Khan and Christian Jaworski 2013 "Semiperipheral Capitalist City-States and the Commodification of Wealth, Land, and Labor Since the Bronze Age" IROWS Working Paper #79 available at http://irows.ucr.edu/papers/irows79/irows79.htm
Chase-Dunn, C and Bruce Lerro 2014 *Social Change: Globalization from the Stone Age to the Present*. Boulder, CO: Paradigm.
Chase-Dunn, Christopher and Daniel Pasciuti 2004. "Review of George Modelski's (2003) World Cities, -3000 to 2000," Washington, DC: FAROS 2000. http://www.irows.ucr.edu/cd/reviews/modrev.htm
Chase-Dunn,C. David Wilkinson, E.N. Anderson, Hiroko Inoue and Robert Denemark Time Mapping Globalization since the Bronze Age IROWS Working Paper # 100.
Chase-Dunn, C. Hiroko Inoue, Teresa Neal, and Evan Heimlich "The Development of World-Systems" *Sociology of Development* 1,1: xx-xx,
Chase-Dunn, C. and Marilyn Grell-Brisk 2016 "Uneven and Combined Development in the Sociocultural Evolution of World-Systems" Pp. 205-218 in Alexander Anievas and Kamran Matin (eds.) *Historical Sociology and World History: Uneven and Combined Development over the Longue Durée* New York: Rowman and Littlefield.
Chase-Dunn, C and Hiroki Inoue 2017 "Spirals of sociocultural evolution within polities and in interpolity systems" To be presented at the annual meeting of the International Studies Association, Baltimore, MD, February 22-25. 2017
Chase-Dunn, C., Hiroko Inoue and E.N. Anderson 2017 "The Growth of Hangzhou and the Geopolitical Context in East Asia" IROWS Working Paper # 111. http://irows.ucr.edu/papers/irows111/irows111.htm
Chase-Dunn, C., Hiroko Inoue and Teresa Neal. Forthcoming "High Bar Rules of Thumb for Time-Mapping Systemic Human Interaction Networks. Pp. xxxx in C. Chase-Dunn and Hiroko Inoue (eds.) ***Systemic Boundaries:*** *Time Mapping Globalization since the BronzeAge* Vienna: Springer-Verlag GmbH
Chase-Dunn, C., Hiroko Inoue, Eugene Anderson and David Wilkinson 2017 The SETPOL Framework: Settlements and polities in World-Systems" IROWS Working Paper #116 available at http://irows.ucr.edu/papers/irows116/irows116.htm

Chew, Sing C. 2001 *World ecological degradation: accumulation, urbanization, and deforestation, 3000 B.C.-A.D.* Walnut Creek, CA: Altamira Press
______ . 2007 *The Recurring Dark Ages: ecological stress, climate changes, and system transformation* Walnut Creek, CA: Altamira Press.
Cioffi-Revilla, Claudio 2001 "Origins of the international system: Mesopotamian and West Asian Polities, 6000 BC to 1500 BC" Annual Meeting of the ASOR, November http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.189.2373&rep=rep1&type=pdf
Cioffi-Revilla, Claudio and David Lai 1995 War and Politics in Ancient China, 2700 to 722 B.C.: Measurement and Comparative Analysis, *Journal of Conflict Resolution* 39(3) 467–494.
__________________________________ 2001 Chinese Warfare and Politics in the Ancient East Asian International System, ca. 2700 B.C. to 722 B.C., *International Interactions* 26(4) 2: 347–378.
____________________ and Todd Landman 1999 Evolution of Maya Polities in the Ancient Mesoamerican System, *International Studies Quarterly* 43(4) 1999: 559–98.
Davis, Kingsley 1969. *World Urbanization 1950-1970*, Volume 1. Institute of International Studies, University of California, Berkeley.
DeWinter, Walter 2016 "Globalization in Nubia during the Middle Kingdom and the Second Intermediate Period (2000- 1500 B.C.) http://irows.ucr.edu/papers/irows99/irows99.htm

Dupuy, Trevor N. 1980 *The Evolution of Weapons and War*. New York: Bobbs-Merrill
Economist. 2008. *The Economist Pocket World in Figures,* 2008 Edition. London: Profile.
Ekholm, Kasja and Jonathan Friedman 1982 "'Capital' imperialism and exploitation in the ancient world-systems" *Review* 6:1 (summer): 87-110.
Elvin, Mark. 1973. *The Pattern of the Chinese Past*. Stanford: Stanford University Press.
Fitzpatrick, John. 1992. "The Middle Kingdom, the Middle Sea, and the Geographical Pivot of History." *Review* XV, 3 (Summer): 477-521.
De Vries, Jan 1984 *European Urbanization, 1500-1800* Cambridge, MA: Harvard University Press.
Fletcher, Roland 1995 *The Limits of Settlement Growth*. Cambridge: Cambridge University Press.
______ . n.d. City and Polity Data Files, Personal communication
Flynn, Dennis O. 1996 *World Silver and Monetary History in the 16th and 17th centuries*. Brookfield, VT: Variorum.
Frank, A. G., B.K. Gills, B. K. 1993 "The Cumulation of Accumulation" Pp. 81-114 in A.G. Frank and B.K. Gills, (eds.) *The World System: Five Hundred Years or Five Thousand?* London: Routledge.
Frank, Andre Gunder 1998 *Reorient: Global Economy in the Asian Age*. Berkeley: University of California Press.
______ . 2014 *Reorienting the 19th century: Global Economy in the Continuing Asian Age*. Boulder, CO: Paradigm Publishers.
Frank, Andre Gunder and Barry Gills 1994 *The World System: 500 or 5000 Years*? London: Routledge.
Freeman, John R. 1983. "Granger Causality and the Times Series Analysis of Political Relationships" *American Journal of Political Science*. 27(2): 327-358.

GeaCron *World History Atlas & Timelines since 3000 BC*. Luis Músquiz http://geacron.com
Goldstein, Joshua. 1988. *Long Cycles: Prosperity and War in the Modern Age*. New Haven: Yale University Press.
Granger, C. W. J. 1969. "Investigating causal relations by econometric models and cross-spectral methods." *Econometrica*. 37: 424-438.
______________ 1988 "Some Recent Development in a Concept of Causality." *Journal of Econometrics*, *39*, 1: 199-211.
_______________ & Newbold, P. 1974 "Spurious Regressions in Econometrics". *Journal of Econometrics*, *2*, 111–120.
Hall, Thomas D., Christopher Chase-Dunn and Richard Niemeyer. 2009 "The Roles of central Asian Middlemen and Marcher States in Afro-Eurasian World-System Synchrony." Pp. 69-82 in *The Rise of Asia and the Transformation of the World-System*, Political Economy of the World-System Annuals. Vol XXX, edited by Ganesh K. Trichur. Boulder, CO: Paradigm Press.
"History of the World: Every Year" territorial polities since 3150 BC with nice music https://www.youtube.com/watch?v=ymI5Uv5cGU4&feature=em-share_video_user
Honeychurch, William 2013 "The Nomad as State Builder: Historical Theory and Material Evidence from Mongolia" *Journal of World Prehistory* 26:283–321.
Hui, Victoria Tin-Bor 2005 *War and state Formation in Ancient China and Early Modern Europe*. Cambridge: Cambridge University Press.
______ . 2008 "How China was ruled" *China Futures*, Spring, 53-65
Innis, Harold 1972 [1950] *Empire and Communications*. Toronto: University of Toronto Press.
Inoue, Hiroko 2014 "Settlement dynamics and empire dynamics: a comparative and evolutionary world-systems perspective" Paper presented at the annual meeting of the American Sociological Association, San Francisco, August 17.
Inoue, Hiroko, Alexis Álvarez, Kirk Lawrence, Anthony Roberts, Eugene N Anderson and Christopher Chase-Dunn 2012 "Polity scale shifts in world-systems since the Bronze Age: A comparative

inventory of upsweeps and collapses" *International Journal of Comparative Sociology* http://cos.sagepub.com/content/53/3/210.full.pdf+html
Inoue, Hiroko, Alexis Álvarez, Eugene N. Anderson, Andrew Owen, Rebecca Álvarez, Kirk Lawrence and Christopher Chase-Dunn. 2015 "Urban scale shifts since the Bronze Age: upsweeps, collapses and semiperipheral development" *Social Science History*. Volume 39 number 2, Summer http://irows.ucr.edu/papers/irows89/irows89.htm
____________ , Alexis Álvarez, E.N. Anderson, Kirk Lawrence, Teresa Neal, Dmytro Khutkyy, Sandor Nagy, Walter De Winter and Christopher Chase-Dunn 2016 "Comparing World-Systems: Empire Upsweeps and Non-core marcher states Since the Bronze Age' IROWS Working Paper #56
Inoue, Hiroko and C. Chase-Dunn 2017 Spirals of Sociocultural Evolution: Polities and Interpolity Systems" To be r presented at the annual meeting of the International Studies Association, San Francisco, April 4-7, 2018.
Kang, David C. Meredith Shaw, and Ronan Tse-min Fu. 2016. "Measuring War in Early Modern East Asia, 1368–1841: Introducing Chinese and Korean Language Sources." Int Stud Q. 60 (4): 766-777. https://academic.oup.com/isq/article-abstract/60/4/766/2918876/Measuring-War-in-Early-Modern-East-Asia-1368-1841?redirectedFrom=fulltext
Korotayev, Andrey, Goldstone, Jack A., Zinkina, Julia, 2015. "Phases of global demographic transition correlate with phases of the Great Divergence and Great Convergence' *Technological Forecasting & Social Change* Retrieved March 20, 2015 from http://www.sciencedirect.com/science/article/pii/S0040162515000244
Kowalewski, Stephen A. 1982 "The evolution of primate regional systems" *Comparative Urban Research* 9,1:60-78.
Lattimore, Owen 1940 *Inner Asian Frontiers of China*. New York: American Geographical Society.
Lassner, Jacob 1970 *The Topography of Baghdad* Detroit: Wayne State University Press.
Lenski, Gerhard 2005 *Ecological-Evolutionary Theory*. Boulder, CO: Paradigm Publishers
Lieberman, Victor. 2003. *Strange Parallels: Southeast Asia in Global Context, c. 800-1830*. Vol. 1: Integration on the Mainland. Cambridge: Cambridge University Press.
______ . 2009. *Strange Parallels: Southeast Asia in Global Context, c. 800-1830*. Vol 2: Mainland Mirrors: Europe, Japan, China, South Asia, and the Islands. Cambridge: Cambridge University Press.
Liu, Xinru and Lynda Norene Shaffer. 2007. *Connections across Eurasia: Transportation, Communication, and Cultural Exchange on the Silk Roads*. New York: McGraw-Hill.
Mann, Michael. 1986. *The Sources of Social Power, Volume 1: A history of power from the beginning to A.D. 1760*. Cambridge: Cambridge University Press.
McNeill, W H. 1982. *The Pursuit of Power: Technology, Armed Force, and Society since A.D. 1000*. Chicago, IL: The University of Chicago Press.
McNeill, John R. and William H. McNeill 2003 *The Human Web*. New York: Norton.
Modelski, George 2003 *World Cities: –3000 to 2000*. Washington, DC: Faros 2000
______ . Tessaleno Devezas and William R. Thompson (eds.) 2008 *Globalization as Ev. olutionary Process: Modeling Global Change*. London: Routledge
Morris, Ian. 2010 *Why the West Rules—For Now*. New York: Farrer, Straus and Giroux
______ . 2013 *The Measure of Civilization*. Princeton, NJ: Princeton University Press. http://ianmorris.org/docs/social-development.pdf
______ . and Walter Scheidel (eds.) *The Dynamics of Ancient Empires: State Power from Assyria to Byzantium*. New York: Oxford University Press.
Neal, Teresa 2013 "The Sasanian empire and world-systems research" Working Paper, Department of History, University of California-Irvine
Pasciuti, Daniel 2002" A measurement error model for Estimating the Population Sizes of Preindustrial Cities"

Pasciuti, Daniel and Christopher Chase-Dunn 2002 "Estimating the Population Sizes of Cities" http://irows.ucr.edu/research/citemp/estcit/estcit.htm
Pomeranz, Kenneth 2000 *The Great Divergence: Europe, China and the Making of the Modern World Economy*. Princeton: Princeton University Press.
Reba, Meredith, Femke Reitsma and Karen C.Seto 2016 "Spatializing 6,000 years of global urbanization from 3700 BC to AD 2000" *Scientific Data* 3 Macmillan Publishers Limited http://dx.doi.org/10.1038/sdata.2016.34 http://www.nature.com/articles/sdata201634#supplementary-information http://www.nature.com/articles/sdata201634 http://www.citylab.com/housing/2016/06/watch-6000-years-of-urbanization-in-3-minutes-max-galka-metrocosm/487142/
Rozman, Gilbert 1973 *Urban Networks in Ching China and Tokogawa Japan*. Princeton, NJ: Princeton University Press.
Sanders, William T., Jeffrey R. Parsons, and Robert S. Santley 1979 *The Basin of Mexico: Ecological Processes in the Evolution of a Civilization*. New York: Academic Press,
Scheidel, Walter. 2009 "From the "great convergence" to the "first great divergence": Roman and Qin-Han state formation" Pp. 11-23 in Walter Scheidel (ed.) *Rome and China: Comparative Perspectives on Ancient World Empires*. New York: Oxford University Press.
______ . and Sitta Von Reden (eds.) *The Ancient Economy*. New York: Routledge.
SESHAT: The Global History Data Bank. The Evolution Institute http://evolution-institute.org/seshat
SetPol Project. The Research Working Group on Settlements and Polities, Institute for Research on World-Systems, University of California-Riverside http://irows.ucr.edu/research/citemp/citemp.html
Sherratt, Andrew G. 1993a. "What Would a Bronze-Age World System Look Like? Relations Between Temperate Europe and the Mediterranean in Later Prehistory." *Journal of European Archaeology* 1:2:1-57.
_____. 1993b. "Core, Periphery and Margin: Perspectives on the Bronze Age." Pp. 335-345 in *Development and Decline in the Mediterranean Bronze Age*, edited by C. Mathers and S. Stoddart. Sheffield: Sheffield Academic Press.
_____. 1993c. "Who are You Calling Peripheral? Dependence and Independence in European Prehistory." Pp. 245-255 in *Trade and Exchange in Prehistoric Europe*, edited by C. Scarre and F. Healy. Oxford: Oxbow (Prehistoric Society Monograph).
_____. 1993d. "The Growth of the Mediterranean Economy in the Early First Millennium BC." *World Archaeology* 24:3:361-78.
Schwartzberg, Joseph E. 1992 *A Historical Atlas of South Asia* New York: Oxford University Press. eMap: Atlas: Document: English : 2nd impression. Chicago, Ill.: Digital South Asia Library, center for Research Libraries http://dsal.uchicago.edu/reference/schwartzberg/
Taagepera, Rein 1978a "Size and duration of empires: systematics of size" *Social ScienceResearch 7:108-27.*
______ . 1978b "Size and duration of empires: growth-decline curves, 3000 to 600 B.C." *Social Science Research*, 7 :180-96.
______ . 1979 "Size and duration of empires: growth-decline curves, 600 B.C. to 600 A.D." *Social Science History* 3,3-4:115-38.
______ . 1997 "Expansion and contraction patterns of large polities: context for Russia." *International Studies Quarterly* 41,3:475-504.
Smith, Michael E. 2016a "Why would a journal called "Scientific Data" publish bad data? The Chandler/Modelski city-size problem" http://publishingarchaeology.blogspot.jp/2016/06/why-would-journal-called-scientific.html
____________ 2016b "Bounding Empires and Political/Military Networks with Archaeological Data"

Paper presented at the workshop on Systemic Boundaries, March 4, 2016 University of California-Riverside. http://wsarch.ucr.edu/archive/conferences/confname/papmike.pdf
Smith, Michael E. and Lisa Montiel 2001 "The Archaeological Study of Empires and Imperialism in Prehispanic central Mexico" *Journal of Anthropological Archaeology* 20: 245-284.
Taagepera, Rein. 1978a. "Size and Duration of Empires: systematics of size." *Social Science Research* 7:108-27. http://www.sciencedirect.com/science/article/pii/0049089X78900078
Taagepera, Rein. 1978b. "Size and duration of empires: growth-decline curves, 3000 to 600 B.C." *Social Science Research* 7: 180-96. http://www.sciencedirect.com/science/article/pii/0049089X78900108
Taagepera, Rein. 1979. "Size and duration of empires: growth-decline curves, 600 B.C. to 600 A.D." *Social Science History* 3(3-4): 115-38. http://www.jstor.org/pss/1170959
Taagepera, Rein. 1997. "Expansion and contraction patterns of large polities: context for Russia." *International Studies Quarterly* 41(3): 475-504. http://onlinelibrary.wiley.com/doi/10.1111/0020-8833.00053/abstract
Tainter, Joseph. 1988. *The Collapse of Complex Societies*. Cambridge: Cambridge University Press.
Teggart, Frederick J. 1939 *Rome and China: A Study of Correlations in Historical Events* Berkeley: University of California Press.
Territory of polities since 3150 BCE https://www.youtube.com/watch?v=ymI5Uv5cGU4&feature=em-share_video_user
Tilly, Charles. 1990. *Coercion, Capital, and European States, AD 990-1990*. Cambridge, MA: Basil Blackwell.
Turchin,Peter 2011 . Strange Parallels: Patterns in Eurasian Social Evolution . *Journal of World Systems Research* 17(2):538-552.
Turchin, Peter, Jonathan M. Adams, and Thomas D. Hall 2006. "East-West Orientation of Historical Empires and Modern States." *Journal of World-Systems Research.* 12:2(December):218-229.
______ . and Sergey Gavrilets 2009 "The evolution of complex hierarchical societies" *Social Evolution & History*, Vol. 8 No. 2, September: 167–198.
______ . Thomas E.Currie, Edward A.L. Turner and Sergey Gavrilets 2013 "War, space, and the evolution of Old World complex societies" *PNAS* October vol. 110 no. 41: 16384–16389 Appendix: http://www.pnas.org/content/suppl/2013/09/20/1308825110.DCSupplemental/sapp.pdf
Turchin, Peter and Sergey Nefadov 2009 *Secular Cycles* Princeton, NJ: Princeton University Press.
United Nations 2011a Data on Cities and Urban Agglomerations http://esa.un.org/unpd/wup/CD-ROM/
United Nations 2011b World Urbanization Prospects: The 2011 Revision: Methodology http://esa.un.org/unpd/wup/pdf/WUP2011_Methodology.pdf
United Nations: Department of Economic and Social Affairs, "Annual Population of Urban Agglomerations with 300,000 in habitants or more" http://esa.un.org/unpd/wup/DataQuery/
Wallerstein, Immanuel 2011 [1974] *The Modern World-System*, Volume 1. Berkeley: University of California Press.
Walters, Pamela Barnhouse 1985 "Systems of cities and urban primacy: problems of definition and measurement." Pp.63-86 in Michael Timberlake (ed.) *Urbanization in the World-Economy*, New York: Academic Press.
Wheatley, Paul 1983 *Nagara and Commandery: Origins of the Southeast Asian Urban Traditions*. Chicago: University of Chicago Department of Geography. Research Paper #s 207-208.
White, D. R., Natasa Kejzar and Laurent Tambayong 2006 "Oscillatory dynamics of city-size distributions in world historical systems". Pp. 190-225 in G. Modelski, T. Devezas and W. Thompson, (eds.) *Globalization as Evolutionary Process: Modeling, Simulating, and Forecasting Global Change*.. London: Routledge.
Wilkinson, David 1987 "Central Civilization." *Comparative Civilizations Review* 17:31-59.

______ 1991 "Core, peripheries and civilizations." Pp. 113-166 in Christopher Chase-Dunn and Thomas D. Hall (eds.) *Core/Periphery Relations in Precapitalist Worlds*, Boulder, CO.: Westview.
______ 1992a "Decline phases in civilizations, regions and oikumenes." A paper presented at the annual meetings of the International Studies Association, Atlanta, GA. April 1-4.
______ 1992b "Cities, civilizations and oikumenes:I." *Comparative Civilizations Review* 27:51-87 (Fall).
______ 1993 "Cities, civilizations and oikumenes:II" *Comparative Civilizations Review* 28: 41-72.
__________ 1994. "Hegemony and Social Change." 38 Mershon International Studies Review, 374-376.
______ 1996 "Configurations of the South Asia States System" 34 *Comparative Civilizations Review*, Spring pp. 63-119.
______ 1999a "Power Polarity in the Far Eastern World System, 1025 BC--AD 1850: Narrative and 25-Year Interval Data." Journal of World-Systems Research 5(3): 501-617.
_________ 1999b "Unipolarity without Hegemony." 1 International Studies Review no. 2 (Summer) 141-172.
______ 2001 "Problems in Power Configuration Sequences: The Southwest Asian Macrosystem to 1500 BC." 17 *Comparative Civilization* pp. 1-13.
______ 2004a "Power Configuration Sequences in the Northeast African World System to 1500 BC." *Comparative Civilizations Review* (Spring), 82-104.
______ 2004b "The Power Configuration Sequence of the central World System, 1500-700 BC" *Journal of World-Systems Research* Vol. 10, 3. http://jwsr.pitt.edu/ojs/index.php/jwsr/article/view/279
______ . 2006 "Analysis of Power-Structure Fluctuations in the 'Longue Durée of the South Asian World System." 1 *Structure and Dynamics*: eJournal of Anthropological and Related Sciences No. 2 (2006), Article 2. (With Sergei V. Tsirel.) http://repositories.cdlib.org/imbs/socdyn/sdeas/vol1/iss2/art2
______ 2008 "Hêgemonía: Classical and Modern Hegemony." 14 Journal of World Systems Research no. 3, 119-141.
______ 2017 "When states-systems unite: Spatio-temporal boundary and transition issues in the unification of the central, Far Eastern and South Asia states-systems" Pp. xxxx in C. Chase-Dunn and Hiroko Inoue (eds.) ***Systemic Boundaries:*** *Time Mapping Globalization since the BronzeAge* Vienna: Springer-Verlag GmbH
Wilkinson's Maps: http://irows.ucr.edu/research/citemp/asa01/wilkinson.htm
Wilkinson, Toby C., Susan Sherratt and John Bennet 2011 *Interweaving Worlds: Systemic Interactions in Eurasia, 7th to 1st Millennia BC*. Oxford: Oxbow Books.
Wohlforth, William C., Richard Little, Stuart J. Kaufman, David Kang, Charles A Jones, Victoria Tin-Bor Hui, Arther Eckstein, Daniel Deudney and William L Brenner 2007 "Testing balance of power theory in world history" *European Journal of International Relations* 13,2: 155-185.
Wolf, Eric 1997 *Europe and the People Without History*, Berkeley: University of California Press.
Wong, R. Bin 1997 *China Transformed: Historical Change and the Limits of European Experience*. Ithaca: Cornell University Press.
Yoffee, Norman 2006. *Myths of the Archaic State: Evolution of the Earliest Cities, States, and Civilizations*. New York: Cambridge University Press.
____________ 2015 *The Cambridge World History, Volume 3 Early Cities in Comparative Perspective, 4000 BCE- 12 ce*. Cambridge; Cambridge University Press
http://metrocosm.com/history-of-cities/