Power and Size:

Urban and Polity Size Swings and changes in the distribution of power among states in interstate systems since the bronze Age

Map of Hangzhou



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For presentation at the meeting of the American Sociological Association, Seattle, August 23, 2016, PEWS Roundtable.

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Draft 8-17-16; 10102 words



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 states and changes in the distribution of power among states 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 both increased over time and went through cyclical growth and decline phases. 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. More numerous are the smaller **upswings** in which the sizes of the largest city or polity increase but do not become significantly larger than earlier increases. Sweeps are large changes and swings are smaller changes. In this paper we will study these more numerous urban and polity swings in 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 compare swings with sweeps to see if there are patterned differences 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 PMN. Thus, the main unit of analysis in this paper is the political/military interaction network – a whole system of interacting polities that are making war and military alliances with one another. We study the relationships across time between the growth and decline of the largest cities and the largest polities we will examine the relationships between these 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 discuss such potential causes of upswings and upsweeps as demographic change, warfare and trade. And we consider whether or not the causes of downswings are different from the causes of upswings.

In earlier work (Inoue *et al* 2012, 2015) we have identified big changes in the sizes of the largest settlements and polities in PMNs 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 studied (Inoue 2015: Table 7) while there were thirty-six upswings. And we found only five urban downsweeps[[1]](#footnote-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). The questions we are asking in this paper, which uses whole interpolity systemic networks as the unit of analysis, are: 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 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 compare them with sweeps.

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]](#footnote-2) with larger continental and global systems in order to study sociocultural evolution. 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**.[[3]](#footnote-3)

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.[[4]](#footnote-4)

World-systems are interacting sets of polities[[5]](#footnote-5) and settlements. Many, but not all, world-systems are organized as core/periphery hierarchies in which some polities exploit and dominate 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.[[6]](#footnote-6)

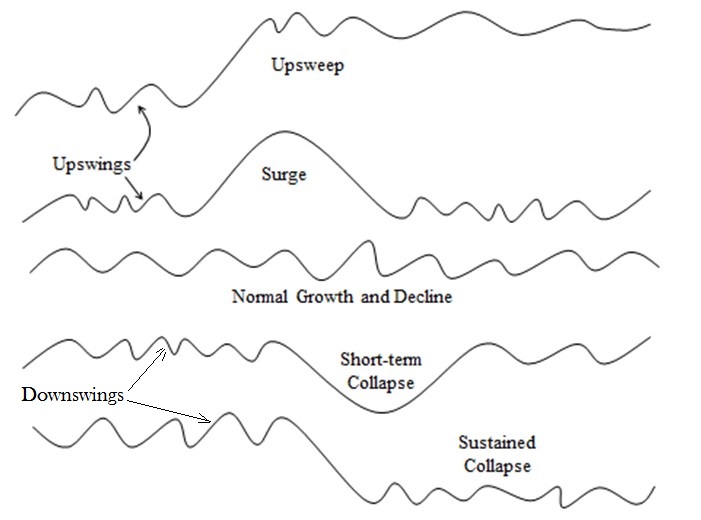


Fig. 1. Types of Medium-term Scale Change in the Largest Settlements or Polities

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**.[[7]](#footnote-7) 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.

**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 actions of non-core (peripheral or semiperipheral) marcher states (Inoue, *et al* 2016). This confirms our 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 upsweeps were not associated with the actions of non-core marcher states. We are developing a multilevel model (Chase-Dunn and Inoue 2017) that combines interpolity dynamics with the “secular cycle” model developed by Turchin and Nefadov (2009). This study of swings will help us determine the nature of the relationships across different 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 fifty year time points. Using fifty-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. So we prefer to use the more cautious 100 year intervals for these PMNs.

**Unit 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 is profoundly misleading.

In this paper we use Political-Military Networks( PMNs) as the unit of analysis.[[8]](#footnote-8) These are composed of polities that are making wars and military alliances with one another. David Wilkinson has carefully studied the spatial boundaries of these interstate systems and we follow his lead in delineating them (Wilkinson 2017). 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[[9]](#footnote-9); South Asia was engulfed into the Central PMN in 1000 CE and East Asia was engulfed into the Central PMN in 1830 CE.[[10]](#footnote-10)

**Estimating the population sizes of cities**

What are the important differences in the methods of chandler, morris and modelski?

We use the compilations published by Tertius Chandler (1987), George Modelski (2003), and Ian Morris (2010) as our main sources for city population size estimates. Chandler’s (1987) data compendium uses various proxies to estimate city populations such as the number of households, the number of solders, estimates of areal population density, and etc. Chandler ‘s definition includes the resident population of the city and surrounding suburban or urbanized areas. His estimates of city population sizes have been criticized due to his rough approximations using the several proxies without rigorously relying on archaeological evidence (Smith 2016a).

Modelski regards cities as "the central places of area-wide interactions; they facilitate the operation of the system, and in turn depend upon its support" (Modelski 2003: 4). He argues that cities are "a manifestation of the growth of institutions capable of organizing vast regions into integrated systems" (he uses Richard Blanton's definition, which is the urban agglomeration) (Modelski 2003: 4).[[11]](#footnote-11)

Morris reviews the debates among demographers and urbanists about the definitions of urban spatial boundaries and the reliability of census data (Morris 2010: 107). 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 selects what he considers to be the best of the estimates among them, yet he is aware of the fact that the use of a single data source (e.g. only using Modelski’s data) 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,[[12]](#footnote-12) 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 such 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 for the appropriation of 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 ideologies and new technologies of communication (Innis 1950).

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 measureable 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 or not and for how long tribute was paid to the conquering polity.[[13]](#footnote-13) 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 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 thallassocratic form of empire that had been pioneered by semiperipheral capitalist city-states[[14]](#footnote-14)—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 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.  
        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 related, but our research will show how large the positive relationship is and will show when and where these two variables diverge.  
        It should also be noted that Wilkinson coded power configuration every 10 or 25 years. [[15]](#footnote-15) We used those of his codings that corresponded with the fifty-year or 100-year time points at which we have estimates of largest city population sizes and the territorial sizes of largest empires.

**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 | -.05 | .26 | | .17 | | -.74\*\* | | .20 | | 13 |
| Egypt | 2600 -1500 bce | .51 | -.67\* | | -.02 | | .60\* | | .45 | | 12 |
| South Asia | 400 bce – 1000 ce | .28 | .16 | | .27 | | -.55 | | -.36 | | 29 |
| East Asia | 1000 bce - 1800 ce | .49 | .07 | | .43 | | .80 | | .59 | | 57 |
| Central | 1500 bce - 1900 ce | .63 | -.42# | | .28# | | .45 | | .64 | | 69 |

Table 1: Pearson’s r bivariate correlation coefficients [[16]](#footnote-16)

Note: the Mesopotamia and Egypt results are using 100-year time intervals. The others are usiing 50 year time intervals. # = For the period from 1500 BCE to 700 BCE

Table 1 shows the bivariate Pearson’s correlation coefficients (r) between power configuration, 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, cites 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 period.[[17]](#footnote-17) The power configuration/city correlation is negative for the Egyptian PMN and for the Central PMN during the period for which we have powcon estimates. It is positive for Mesopotamia (.26) but less positive for South Asia and nearly null for East Asia. The power configuration correlation with the size of the largest state is slightly negative for Egypt, but positive for the other PMNs. The correlation between year and city is positive for the Central and East Asian PMNs and for Egypt, but negative for South Asia and Mesopotamia.

More light can be shed on these correlations by examination of the charts that plot the changes for each PMN.

Akkadian Empire

Figure 2: Mesopotamia, 2700-1500 BCE

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 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 (.17) shown in Table 1.

Figure 3: Egyptian PMN, 3300-1500 BCE

The story of the Egyptian PMN is different. Cities generally got bigger, though with some downswings. This confirms the .60 correlation between year and city size in Table 1. The trajectories of city and state sizes shows a positive relationship (r= ..51) 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.

Mauryan Empire

Figure 4: South Asia PMN, 400 BCE-1000 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. Indeed, the correlation between polity and year in Table 1 is -.36, and the story is the same for city sizes (-.55). Nevertheless, the relationship between city and polity sizes in positive (.28) 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 .27 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.

Mongol Empire

Figure 5: East Asian PMN, 1000 BCE-1800

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. The only one that is not very positive is that between power configuration and city size (.07). The bivariate correlation between city and polity size is .49. 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.[[18]](#footnote-18) The correlation between power configuration and the size of the largest polity in Table 1 is .43. Both the trend correlations are high (city/year .80 and state/year .59) so detrending is needed to see what happens with the state/city correlation.

Abbasid Empire

British Empire

Mongol Empire

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 -.42 (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.[[19]](#footnote-19) This supports our notion that cities and states cause each other. Both of the trend correlations are large and positive for the Central PMN (city/year = .45; state/year = .64) 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.

**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)** [[20]](#footnote-20) | | **Mesopotamia**  **(-2700 to -1500)** |
| **city** | **state** | **state** |
| **Mesopotamia (-4500 to -1500)** | **city** | - | 0.58  (.763) | .16  (.62) |
| **state** | 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 -.05 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 (-.74 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)** | | **Egyptian PMN**  **-2600 to -1500** |
| **city** | **state** | **state** |
| **Egyptian PMN (-3200 to -1500)** | **city** | - | .25  (.323) | .34  (.31) |
| **state** | .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 .51 (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).

|  |  |  |  |
| --- | --- | --- | --- |
| **PMN / level**  **Partial Correlation** | | **South Asian PMN (-600 and 1000)** | |
| **city** | **state** |
| **South Asian PMN (-600 and 1000)** | **city** | - | . 38\*  (.032) |
| **state** | . 38\*  (.032) | - |

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 .28 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).

|  |  |  |  |
| --- | --- | --- | --- |
| **PMN / level Partial Correlation** | | **East Asian PMN (-1900 to 1800)** | |
| **city** | **state** |
| **East Asian PMN (-1900 to 1800)** | **city** | - | .02  (.835) |
| **state** | .02  (.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 .49 to .02 when year is controlled. This indicates that the very high long-term correlation of city size with year (.80 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)** | |
| **city** | **state** |
| **East Asian PMN (-1900 to 1)** | **city** | - | .49\*\*  (.002) |
| **state** | .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)** | |
| **city** | **state** |
| **East Asian PMN (1 to 1800)** | **city** | - | -.06  (.720) |
| **state** | -.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)** | |
| **city** | **state** |
| **Central PMN (-1500 and 1900)** | **city** | - | .51\*\*\*  (.000) |
| **state** | .51\*\*\*  (.000) | - |

Table 8: Central PMN (-1500 and 1900)

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)** | |
| **city** | **state** |
| **Central PMN (-1500 and 1)** | **city** | - | -21  (.264) |
| **state** | -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)** | |
| **city** | **state** |
| **Central PMN (1 and 1900)** | **city** | - | .54\*\*\*  (.000) |
| **state** | .54\*\*\*  (.000) | - |

Table 10: Central PMN (1 and 1900)

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)** | | |
| **powcon** | **state** | **city** |
| **Mesopotamia (-2700 to -1500)** | **powcon** | - | .16  (.618) | .45  (.144) |
| **state** | .16  (.618) | - | .16  (.624) |
| **city** | .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 (.26), 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 (.17). 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)** | | |
| **powcon** | **state** | **city** |
| **Egyptian PMN (-2600 to -1500)** | **powcon** | - | .40  (.224) | -.46  (.158) |
| **state** | .40  (.224) | - | .34  (.312) |
| **city** | -.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 (-.67). This is because the bivariate correlation between year and city is positive (.60) 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 -.02. 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)** | | |
| **powcon** | **state** | **city** |
| **South Asia PMN (-400 to 1000)** | **powcon** | - | .19  (.333) | .00  (.998) |
| **state** | .19  (.333) | - | .10  (.620) |
| **city** | .00  (.998) | .10  (.620) | - |

Table 13: South Asia PMN

Table 13 shows that the South Asian partial correlation between city and state is .10, whereas the bivariate correlation in Table 1 is .28 (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 .16.. The partial correlation between state and power configuration is .19 whereas the bivariate correlation in Table 1 was .27. Controlling for the long-term downward trends of city and state sizes reduces the partial correlations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PMN / level Partial Correlation** | | **East Asian PMN**  **(-1000 to 1800)** | | |
| **powcon** | **state** | **city** |
| **East Asian PMN (-1000 to 1800)** | **powcon** | - | .47\*\*  (.000) | -.01  (.918) |
| **state** | .47\*\*  (.000) | - | .04  (.786) |
| **city** | -.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)** | | |
| **powcon** | **state** | **city** |
| **Central PMN (-1500 to -700)** | **powcon** | - | .34  (.199) | -.51\*  (.045) |
| **state** | .34  (.199) | - | .01  (.959) |
| **city** | -.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.[[21]](#footnote-21) 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 | 4500-1500 bce | 0.58 | .45 | .16 |
| 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

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 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.

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?

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.

To do: look at graphs for leads and lags and comment upon these. Figure out why the subperiods for the East Asian and Central PMNs are different.

* Count the swings and sweeps. Compare these with counts and tables in earlier studies. Compare the figs. How often is the largest city in the largest polity? Identify the sweeps in the graphs.
* Do time series test of antecedence (Granger causality). Pick a sample of swings and figure out what caused them by reading the histories.
* Do the Aegean pmn. Also study the city size distribution by adding the 2nd largest city in each system at each time point.

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1. A downsweep is a low point (trough) that is at least 1/3 lower than the average of the three previous troughs. [↑](#footnote-ref-1)
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. [↑](#footnote-ref-2)
3. 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. [↑](#footnote-ref-3)
4. 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. [↑](#footnote-ref-4)
5. We use the term “polity” to generally denote a spatially-bounded realm of sovereign authority such as a band, tribe, chiefdom, state or empire. Our study of polity size upsweeps is presented in Inoue *et al* (2012). [↑](#footnote-ref-5)
6. 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. [↑](#footnote-ref-6)
7. This cutting point specifies what we mean by “significant” in a way that can be used to systematically compare widely different times and places. [↑](#footnote-ref-7)
8. 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 linking of the South Asian PMN with the Central PMN was begun by the incursion of Mahmud of Ghazni in 1008 CE. Alexander of Macedon’s earlier incursion into South Asia in the 4th century BCE had been a temporary connection between the Central and the South Asian PMNs that ceased after the Greek conquest states in South Asia had been expelled. The connection was made permanent by Mahmud of Ghazni. After 1850 CE the East Asian PMN was engulfed by the Central PMN. [↑](#footnote-ref-8)
9. 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). [↑](#footnote-ref-9)
10. In a later version of this research we shall also use world regions as the unit of analysis. [↑](#footnote-ref-10)
11. Modelski’s city population size estimates have been geocoded by Reba *et al* 2016. For a critique of Chandler’s and Modelski’s estimates see Smith (2016a). [↑](#footnote-ref-11)
12. Our template for a comprehensive city size data compendium is at <http://wsarch.ucr.edu/archive/data/setdataset.htm> [↑](#footnote-ref-12)
13. 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. [↑](#footnote-ref-13)
14. 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. [↑](#footnote-ref-14)
15. Wilkinson codes the Central, Mesopotamian and South Asia PMNs every 10 years. The East Asian and Egyptian systems are coded every 25 years. [↑](#footnote-ref-15)
16. The estimates for the tables and figures are contained in <http://irows.ucr.edu/cd/appendices/powsize/powsize.xlsx> [↑](#footnote-ref-16)
17. The bivariate Pearson’s r between largest city and largest state in Mesopotamia from 4500 BCE to 1500 BCE is .42. So the result in Table 1 is a function of the fact that cities had peaked and were declining in size during this time period (see also Figure 2 below). [↑](#footnote-ref-17)
18. 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> [↑](#footnote-ref-18)
19. 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. [↑](#footnote-ref-19)
20. Level of statistical significance: **\*=**P = 0.05; **\*\*=**P = 0.01; **\*\*\***=P = 0.001; **\*\*\*\*=**P = 0.000 [↑](#footnote-ref-20)
21. 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 a 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. [↑](#footnote-ref-21)