Millet, Rice, and Isolation: Origins and Persistence of the World's Most Enduring Mega-State*

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Abstract

We propose and test empirically a theory describing the endogenous formation and persistence of mega-states, using China as an example. We suggest that the relative timing of the emergence of agricultural societies, and their distance from each other, set off a race between their autochthonous state-building projects, which determines their extent and persistence. Using a novel dataset describing the historical presence of Chinese states, prehistoric development, the diffusion of agriculture, and migratory distance across $1° \times 1°$ grid cells in eastern Asia, we find that cells that adopted agriculture earlier and were close to *Erlitou* – the earliest political center in eastern Asia – remained under Chinese control for longer and continue to be a part of China today. By contrast, cells that adopted agriculture early and were located further from *Erlitou* developed into independent states, as agriculture provided the fertile ground for state-formation, while isolation provided time for them to develop and confront the expanding Chinese empire. Our study sheds important light on why eastern Asia kept reproducing a mega-state in the area that became China and on the determinants of its borders with other states.

Keywords: State, Agriculture, Isolation, Social Complexity, Stickiness to China, Erlitou, East Asia

JEL Classification: F50, F59, H70, H79, N90, O10, R10, Z10, Z13

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1 Introduction

Since their emergence some 6,000 years ago, states have been the main societal actors affecting social relations, development, and conflict (Claessen, 1978; Fukuyama, 2011; Boix, 2015). Understanding the emergence, evolution, and persistence of states is thus key to our understanding of human organization. Of particular interest are large persistent states, which have left lasting impacts on the contemporary institutional, cultural, ethno-linguistic, and religious landscape. For example, as the only historical case with a nearly uninterrupted existence of more than 2,000 years, the Chinese state has unified a region almost the size of Europe, but under one government (see Figure B.1).[1] During the same period, the lands that hosted Sumer, Akkad, Babylonia, and Assyria transitioned through Persian, Hellenic, Roman, Byzantine, Arab, Ottoman, and British rule, coming to be populated mainly by speakers of languages imported from Arabia and Central Asia, with most of their contemporary populations holding religious beliefs also imported from outside their immediate region, and with little continuous thread of culture, language, or religion connecting them to the world of the third millennium BCE.

Why did a large core state emerge and persist in eastern Asia? How did its current national borders form? Why did some polities, which were historically independent, gradually become part of an enormous empire while others became separate modern states? To address these questions, we propose and test empirically a theory of the endogenous formation and persistence of mega-states, using China, the largest core state that emerged and persisted in eastern Asia, as an example.[2] We hypothesize that the relative timing of the emergence of agricultural societies and their distance from each other set off a race between competing autochthonous state-building projects, which determined their extent and persistence. Specifically, following a long tradition, we posit that the adoption of agriculture in a given location gave rise to larger populations, the emergence of stratified societies, and eventually the formation of autochthonous states (Boix, 2015; Diamond, 1997; Fukuyama, 2011; Carneiro, 1970; Galor, 2022). Thus, the differential timing of the adoption of agriculture across regions resulted in a multiplicity of chiefdoms clustered in agricultural pockets distant from each other.[3] As these complex societies evolved, they competed with each other as they expanded into nearby locations. These evolutionary forces aggregated clusters of chiefdoms into larger isolated state-level societies. When these early agricultural states expanded into suitable nearby locations, they encountered resistance from other hierarchical societies at different stages of development. In particular, our hypothesis implies that *ceteris paribus*, the earlier these processes started, i.e., the earlier agriculture arrived and became

[1] A few neighboring countries including Korea, Vietnam and Japan can be seen as "off-shoots" of China in the same way that Egypt, Persia, Arabia, Greece and the Mediterranean settlements can be considered off-shoots of Mesopotamia. However, the process of developing agrarian civilizational offshoots was already in play in the west by the Persian conquest of Assyria, Greek conquest of Persia etc. way back in the 1st millennium BCE, about 1,500 years ahead of the corresponding process in eastern Asia (more below on this).

[2] We use "China" as a general term here, in order to refer to the state and cultures that can be traced back in a continuous historical thread over the last two millennia from the early "Sinitic states" to the contemporary People's Republic of China. These states shared a common geographic core, and a continuously evolving set of cultural features, including concepts of statehood itself. Eastern Asia includes what is now China plus Mongolia, Korea, Japan, and the northeastern portion of Southeast Asia.

[3] Our approach does not try to resuscitate the view that agricultural productivity is sufficient for the emergence of states(productivity and surplus theory), a view that has been amply criticized. However, we view agriculture as providing the fertile ground for the emergence of hierarchical complexity and population density.

established, and the more distant a society was from others, the more time it would have to consolidate its autochthonous state-building project and the longer it could survive as an independent state.

Our theory implies that in the context of eastern Asia, after the domestication of millet and rice, complex societies and early chiefdoms would emerge in clusters of land highly productive for their cultivation. Moreover, it is in these clusters where competition and conflicts between various chiefdoms – the earliest manifestation of states – tended to be more intense, leading to their agglomeration into larger states. Indeed, the earliest full-fledged state in eastern Asia emerged at *Erlitou* in the heart of what would become China,[4] close to the earliest locations where millet and rice were domesticated and adopted. These circumstances gave this region a head start in the process of autochthonous state-building, out of which the Sinitic states, i.e., the precursors of China, rose from earlier proto-states that had Erlitou as their political center. As these Sinitic states expanded, they encountered other autochthonous state-building projects; while some were incorporated permanently into the growing empire (e.g., the states that later became Guangdong and Yunnan provinces), others were not (e.g., the states that later became Korea and Vietnam). Based on our hypothesis, we predict that a polity's ability to fend off the expansion of and persistent control by Sinitic states depended on its degree of autochthonous state-building as determined by i) the timing of its adoption of agriculture, and ii) its distance from Erlitou. Our main prediction is that these two forces interact with each another and generate heterogeneous effects on the ability of China to control a region. Specifically, we predict that early adoption of agriculture should benefit autochthonous state-building projects located sufficiently far from Erlitou but be detrimental to those close to it.

To test this hypothesis, we constructed a novel dataset documenting the historical presence of the Chinese state, social complexity (including urbanization, population density, state hierarchy, etc.), the location and size of early chiefdoms and proto-states, timing of the adoption of agriculture, climate, and geography across $1^\circ \times 1^\circ$ degree grid cells in eastern Asia. In the light of this millennia-long evolutionary process, we trace the historical expansion of China between 221 BCE and 1911 CE for a total of 2,132 years to document the shifts in the boundaries and the corresponding location of bureaucratic and tax collection centers over time. Based on these we constructed three indicators of a cell's "stickiness to China", i.e., the degree to which it was incorporated in and controlled by the Chinese state in the last 2,000 years. The first, "territorial China", is an indicator showing the length of time when the Chinese state exercised *military* control and had the apparent power to repel invaders. Since territorial China does not imply the day-to-day presence and thus administrative capacity of the Sinitic state, we enumerate the county seats in each cell in each period as a proxy for its presence and tax collection effort and refer to it as "cadastral China". The third, "hybrid China", combines both territorial and cadastral China into a single measure. The three indicators together measure the duration and intensity of a cell's incorporation into the Sinitic states over time. We employ "stickiness to China", social complexity, and the location and size of early chiefdoms and proto-states as our key dependent variables in the empirical analysis. Our key independent variables are, respectively, a newly constructed variable for the years since a cell first adopted agriculture (YSA),[5] its distance from

[4] Erlitou is located in western Henan Province along the middle Yellow River in today's North China (Figure 6). It is also considered the precursor of the Qin dynasty and China's original political center.

[5] Previously, data for the adoption of agriculture at the grid cell level was available only for Europe (Pinhasi et al.,

Erlitou, and whether it is located in a cluster of areas highly productive of millet or rice ("hotspots") – essentially locations where agriculture had the potential to generate the evolutionary processes that allowed the emergence of complex societies and states.[6]

Our empirical analysis yields two main findings. First, using an event study design, we provide evidence that the evolutionary processes that generated higher levels of social complexity started as early as 6,000 BCE in the hotspots for millet and rice after the domestication of these crops.[7] Therefore, the regions that would become China led the process of social complexification and state-building in eastern Asia for millennia before the emergence of the first state. However, these processes were concentrated in locations dominated by millet, in the Chinese heartland, where complex societies appeared earlier and were more common. It is in this millet heartland, close to the centroids of the earliest domestication centers and stratified societies, that Erlitou – the first state-level society in eastern Asia – emerged (Section 4). Second, as predicted by our theory, we find a significant negative interaction between the timing of adoption of agriculture and the distance from Erlitou on the ability of Sinitic states to control a cell (Section 5). So, while early adoption of agriculture in locations close to Erlitou facilitated their incorporation into Sinitic states, it hindered it for more isolated locations further than 2.2 weeks of travel from Erlitou. Moreover, while increasing distance from Erlitou always hindered incorporation into Sinitic states, earlier adoption of agriculture reinforced this negative effect. This finding implies that the early adoption of agriculture was only a necessary but not a sufficient condition for autochthonous state building. The early adoption of agriculture promoted the emergence of lasting autonomous states only for those regions located far enough away from the earliest political center in eastern Asia - the region that would become China's initial and permanent heartland.

Our study contributes to unlocking the puzzle of why eastern Asia kept reproducing a mega-state in the area that became China and what determined its borders with other states. While our theory is quite general, there are various particularities in our empirical setting that help us in the analysis. Chief among them is eastern Asia's relative isolation from the rest of the land mass, which allows us to treat the emergence and diffusion of agriculture and states independently from events elsewhere.

In terms of contributions to the existing literature, our paper is clearly relevant to the literature on the "deep roots" of comparative development – a perspective that sees variations in contemporary income, cultural traits, and institutions across space and time as rooted in a gamut of historical factors such as geography, human characteristics, and historical events (e.g., Acemoglu et al., 2005; Ashraf et al., 2010; Ashraf and Galor, 2013; Michalopoulos, 2012; Nunn, 2012; Spolaore and Wacziarg, 2013; Dell et al., 2018; Özak, 2018).

Second, by attempting to understand how large states emerged and expanded, our work also contributes to the literature on state formation (Wittfogel, 1957; Carneiro, 1970; Tilly, 1992; Olson,

2005).

[6] As will be detailed in Section 3, YSA across eastern Asia is measured using the most complete set of archaeobotanical, archaeological, and geographical data available, while the distance from Erlitou is measured by migratory distances constructed based on the Human Mobility Index (HMI) (Özak, 2018). Additionally, we identify clusters of cells with high potential for the production of calories by farming millet or rice based on climatically based potential productivities (Galor and Özak, 2016).

[7] The pre-historic dataset that we constructed to measure social complexity includes: reliance on agriculture, population density, political integration above the band or small settlement, social stratification, fixity of settlements, writing system, use of money, technology level, urbanization, and transportation (for details please refer to Section 3.3.2).

1993; Diamond, 1997; Boix, 2015; Scott, 2017). In particular, our study is closely related to Carneiro's "circumscription theory" that views the interaction between concentrations of agricultural land and conflict as the driving forces behind the emergence of complex society and states. It is also related to the literature that views the emergence of agriculture as fundamental to the rise in population density and social complexity in fostering state formation (Diamond, 1997; Borcan et al., 2021), as well as with the literature that connects social conflict with state formation (Turchin, 2009; Gennaioli and Voth, 2015). A nuance that distinguishes our contribution from this literature is that, while their focus is on the initial stage of state formation, we emphasize the evolution and persistence of mega-states. In so doing our study is thus closely related to Alesina and Spolaore (2005), who endogenize the size and borders of nations.

Third, our work also contributes to a fast-growing literature comparing a unified China with a fragmented Europe – a body of work that focuses on the role of external military threats or conflict in shaping Chinese history (Lattimore, 1940; Barfield, 1992, 2001; Turchin, 2009; Bai and Kung, 2011; Graff and Higham, 2012; Ko et al., 2018; Chen and Ma, 2020). A paper that is very closely related to ours is Fernández-Villaverde et al. (2020), which explores Diamond's "fractured-land" hypothesis using simulations to test the role played by topography in accounting for a unified China and a fractured Europe. While there are certainly overlaps and complements between our studies, both the hypothesized underlying forces and analytical methods differ fundamentally. In particular, we place our emphasis on the *timing* of the emergence of agriculture and state-building, and its interaction with geographic isolation as key determinants of the emergence, extent, and persistence of a mega-state.

The remainder of our paper is organized as follows. In Section 2, we provide both a historical background and a conceptual framework for our analysis. In Section 3, we introduce our data sources and explain the construction of variables to be used in the empirical analysis. Sections 4 and 5 present our main empirical analyses. Section 6 concludes.

2 Historical Background and Conceptual Framework

Like Childe (1951), Diamond (1997), Asouti et al. (2013), and Dow and Reed (2021), we view the transition from foraging to settled agriculture (including animal husbandry) as one of the most important factors contributing to increases in technological and social complexity. In the context of eastern Asia, we focus on three fundamental sources of variation in the level of development of societies through history. They are: i) the independent emergence and diffusion of agriculture within eastern Asia,[8] ii) the tendency towards the endogenous emergence of social stratification and increasingly large-scale polities following the adoption and intensification of agriculture, and iii) the emergence of the first state-level society, and the geographic obstacles between regions (especially between early starters and late adopters, whose interaction was constrained by prevailing modes of travel and communications).

[8]Different groups of domesticates in different parts of the world emerged independently and at different times over the past eleven or twelve millennia.

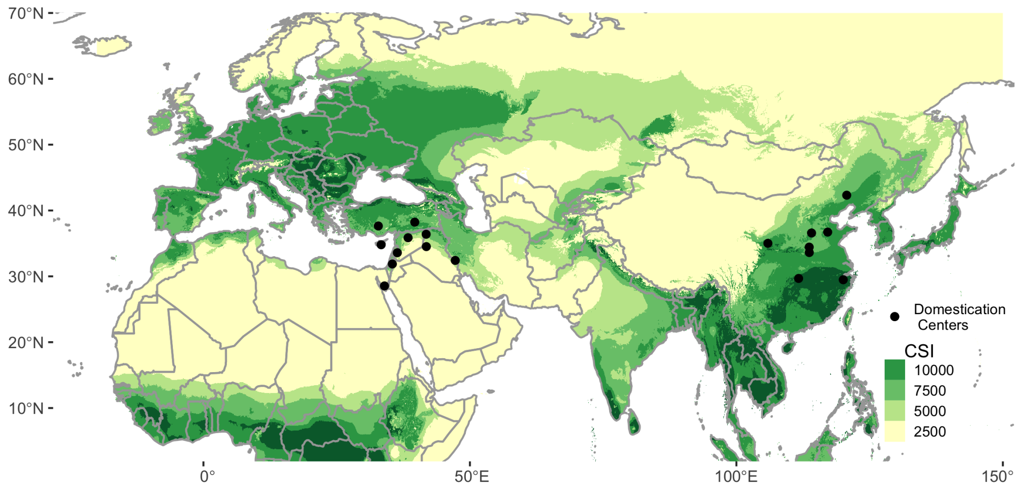


Figure 1: Pre-1,500 Calories and Agriculture Domestication Centers

2.1 The Independent Origins of Agriculture

An important initial condition of our story is that the major origins of cereal cultivation that occurred in separate pockets of eastern and western Asia were separated by a large expanse of difficult-to-traverse and agriculturally inhospitable terrain. For instance, in eastern Eurasia, the middle and lower portions of the Yangtze and Yellow river systems, including their numerous tributaries and smaller counterparts such as the Huai and Liao rivers, saw the adoption of broomcorn and foxtail millet (Panicum miliaceum and Setaria italica) and wetland rice (Oryza sativa Japonica).[9] In Asia's west, separated by thousands of miles from those river systems draining to the Pacific, agricultural societies emerged near and around rivers draining into the Persian Gulf, with primary roles played by a varied suite of grains including wheat, oats, barley, and rye.[10] This pattern is clearly shown in Figure 1, which depicts the earliest locations of domestication and the suitability of land for agriculture as measured by its caloric potential (Galor and Özak, 2015).[11,12] It is important to note that the two fertile regions in the west and east were separated by a large, isolated area with very low caloric potential.

[9] Note that the word "Japonica" entered the standard scientific terminology before the current archaeobotanical consensus that the crop was first cultivated in what are currently sites in China near the Yangtze River and tributaries; "Japonica" is thus understood to be a misnomer but under taxonomic naming rules, the first given name has priority.

[10] Not only grains, major legume crops and animal domesticates also differed, with only the pig being an important source of meat, hides, and fertilizer in the east before the late arrival of western and steppe domesticates in the third millennium BCE, whereas pigs, goats, sheep, and cattle all played important early roles in the west. Goats, sheep and cattle did figure importantly on China's western and northern margins by 3,000 BCE, so they could have influenced the dynamics of large state-building somewhat, given the role of societies on that margin, but they appear to have played no part in central and eastern China in the early millennia of its agrarian development, and remained unimportant in those regions thereafter.

[11] Detailed definition of Caloric Suitability Indices (CSI) in Section 3.2.3.

[12] The West Asian agricultural package, including contributions from nearby Mediterranean and Black Sea regions, diffused outwards to southern Europe, North Africa, the region of present-day Iran, and the western Indian subcontinent before reaching the western outskirts of the millet and rice-growing east on the eve of the Erligang civilization (Stevens et al., 2016). Wheat was still a delicacy for elites rather than a staple in China as late as the 7th century CE, though it displaced millet as China's second major cereal centuries later. East Asian agriculture, for its part, diffused to the south, east, and west of its points of origin, spawning agrarian societies in not only what is now China but also Korea, Japan, and Vietnam by the time that elements of the west Asian agricultural package had reached this zone.

One testament to the extent of their isolation (caused by the lack of continuous farmland) is that the main crops of eastern and western Asia did not diffuse substantially between these regions during the first few thousand years of cultivation, periods that saw the gradual growth of settled populations and the emergence of complex societies independently in each region. States that formed in eastern Asia interacted together as a region much more than they did with the rest of Eurasia until at least the Mongol Empire (the *Yuan* dynasty). One example (and consequence) of the separation of eastern and western agrarian societies that lasts to this day is the high prevalence of lactose intolerance in eastern Asia populations (Sahi, 1994).[13]

2.2 The First Political Center in Eastern Asia

Every known early civilization that subsequently gave rise to cities, large empires, and a highly specialized occupational division of labor (as in soldiers, tax collectors, administrators, artisans, etc.), was preceded by a growing population that increasingly required a fixed abode, which in turn resulted from having adopted a suite of domesticated crops and animals and gradually improved agricultural techniques (Diamond, 1997).[14] But it was only after a protracted period that the archaeological record of each region begins to show appreciable changes in social complexity as marked by walled fortifications, elaborate elite burials, and sites of religious rituals.[15] Unlike western Eurasia, which has had shifting heartlands in Mesopotamia, Egypt, Persia, and Europe, the later blossoming and more geographically isolated civilizations of eastern Asia remained centered until recently on a fixed core area – an area that began to assume a leading position in eastern Asia in terms of level of social complexity from around 6,000 BCE.

The political center of this core area was Erlitou – considered to be the earliest state-level civilization in eastern Asia (c. 1,700 BCE). Politically, Erlitou was the first in eastern Asia to have established a multiple level administrative hierarchy consisting of a single ruler who controlled a large territory through a hierarchy of local administrators, and a large group of commoners. By comparison with the numerous chiefdoms that preceded it, Erlitou had the largest urban center with a population of around 30,000 at its peak.[16] As expected, its economy was also highly developed, with many regional centers

[13]Isolation alone cannot explain China's failure to take up dairying during the past two millennia; the land for grazing cattle and a different lifeway are less attractive and more difficult to incorporate for most Han ethnic dynasties.

[14]The Mesopotamian civilizations of Sumer, Akkad, Babylon and Assyria, the Mesoamerican civilizations of the Olmec, Maya, Toltec, and Aztec, and the first eastern Asian civilization in China, were each preceded by intensifying cultivation of cereals and pulses and domestication or management of animals (Boix, 2015). The Egyptian and Indus Valley civilizations mainly relied on crops and animals from the Fertile Crescent package that reached them by the early fourth millennium BCE (Allen, 1997; Murphy and Fuller, 2017).

[15]Typically, it took thousands of years from early experimentation with the wild precursor plants to the gradual modification of crops by selective use of preferred grains as seed, the addition and improvements in methods of fertilization, weed control, and water management (Harris and Fuller, 2014). Evidence of sedentism and of large ritual centers prior to agriculture in a few instances has yet to reverse the conclusion that agriculture preceded large states in each region spawning them independently. Borcan et al. (2021) find that on average 3400 years separate the first emergence of societies relying mainly on domesticates and the first emergence of a full state in eight pristine sites that include the Fertile Crescent, China, Mesoamerica and the Andes.

[16]Erlitou had an urban center of three square kilometers (the palace area alone occupied 12,000 square meters) and a peripheral settlement that spread over 860 square kilometers (Liu et al., 2004). Through the diffusion of culture and technology, it had a profound impact on other civilizations that extended to as far as 1,500km (Xu, 2014). Some scholars even consider Erlitou the capital of the mythic Xia Dynasty, China's first, although there remains controversy around this (Xu, 2018).

specialized in manufacturing a variety of goods. Perhaps because of this highly specialized economy, Erlitou was already a highly stratified society as gauged by the sharp contrast in living standards between its elite and commoners (Liu and Xu, 2007). Erlitou is located very close to the centroid of all chiefdoms within what later became China (see Section 4 for further details) and the centroid of the eight earliest centers of millet and rice domestication (see Figure 1).[17] This early second millennium BCE state-building project at Erlitou presaged the much larger scale state-building projects that would retain roughly the same geographic core for over twenty-two hundred years. Moreover, it remained close to the capital of the Sinitic states over the next three millennia.[18]

2.3 The Expansion of Sinitic States

China's expansion has three features: i) it consolidated a core area which remained under Sinitic states' rule for most of the time, ii) its expansion in the buffer and peripheral areas waxed and waned, and iii) its final expansion to the frontier zone and stable control was achieved in the last dynasty – the Qing dynasty (see Figure B.21).

The earliest state in eastern Asia emerged in Erlitou, located in western Henan Province along the middle Yellow River in today's North China. The emergence of a state-level society at Erlitou was the culmination of an evolutionary process of competition between and unification of earlier chiefdoms in the region. Although large numbers of chiefdom-type polities were also emerging in the Yangtze River region, this region did not develop large-scale state-level societies as in the Yellow River region. The first unified empire in China, the Qin Empire, was formed by unifying the populations based around these two river systems. By this time, other autochthonous states were established that competed with the nascent Chinese state. The future Chinese provinces of Yunnan, Fujian, Guangxi, Guangdong, and northern Vietnam, in the south, were still home to independent states known as Ailao, Minyue, and Nanyue.[19] Likewise, the three contemporary northeastern provinces were the territory of the Sushen people and Buyeo state. Also, the Korean peninsula had the Old Gojoseon state. The Xiongnu tribal confederation inhabited the steppe. Current Xinjiang was composed of many city-states. Most parts of China's core were first unified by the Qin dynasty at its peak, covering about 30 percent of the current PRC. This core area remained under unified rule for 75 percent of the time during the subsequent 23 centuries. For another 12 percent of those years, this area was divided into two states – (typically one northern and one southern), making it the core of what the world of recent centuries has called China.

Historically, the relationship between China and surrounding states followed a cyclical pattern. Chinese dynasties always sought to expand and control the frontier regions; military campaigns gained China short-term but not long-term control.[20] The expansion encountered resistance from nomadic

[17]The eight centers of domestication and cultivation are: Peiligang, Cishan, Houli, Xinglongwa, Dadiwan, lower Yangtze, upper Huai/Han, middle Yangtze (Stevens and Fuller, 2017).

[18]Only with the shift of the capital to Beijing beginning in the late 1,200s CE did the capital move on a long-term basis in a more northeasterly direction.

[19]Minyue (Fujian) and Nanyue (Guangdong and Guangxi) were conquered during the Western Han dynasty (c. 202 BCE-8 CE), and Ailao (Yunnan) during the Eastern Han dynasty in 76 CE, respectively. Ailao however regained independence after some six hundred years as Nanzhao (c. 738-902 CE) and still later as Dali (c. 937-1253 CE). Yunnan became a part of China in 1253 CE and has remained a province of China ever since.

[20]Sometimes the neighboring states voluntarily became part of the empire for protection.

and agrarian societies, which had their own ethnic identities and had traveled sufficiently far down the road of autochthonous state-building to prevent long-term incorporation into the Chinese empire. In particular, even if temporarily incorporated into the empire, these non-Chinese ethnicities and their nascent states provided the ideology and means to seek independence. Isolated regions were better able to take advantage of these forces and the relative weakness of Chinese power in its periphery to create independent states. Figure B.2 shows the temporal change of China's territory (the green dashed line).[21] There is a long-term trend towards larger empires from Qin to PRC times with ups and downs between.

2.4 The Evolution of States – a Conceptual Framework

A central concept guiding our analysis is that the relative timing of the emergence of agricultural societies and their distance from each other set off a race between competing autochthonous state-building projects that determines their extent and persistence. Specifically, agrarian systems provided the underpinning for the emergence of state-level societies by increasing populations and promoting urbanization. Over time, rising populations spread farming practices to agriculturally suitable areas nearby. While agriculture diffused across space, locations that adopted it earlier benefited from a head start in autochthonous state-building. This allowed them to spread and reinforce ethnolinguistic identities at their margins. In other words, the differential timing of the adoption of an agricultural way of life created a gradient of social complexity across which states emerged, whereby the earliest state should emerge close to the original agricultural core of eastern Asia in central China. However, if this earliest core state did not expand fast enough relative to others, it created opportunities for these societies to build their own states and resist incorporation into the enlarging core state.

The historical stylized facts are consistent with this analytical framework. To begin with, agriculture was adopted in central China no later than 6,500 BCE. It then took four thousand years of the spread, intensification, and improvement of the eastern Asian agrarian system before the first state-level society emerged (Erlitou around 1,700 BCE), and another fifteen hundred years to form the first unified empire (the Qin Empire in 221 BCE). During the process, the eastern Asian agricultural package had spread from its initial zones of domestication into surrounding and distant areas such as Korea (3,500 BCE) and Vietnam (2,000 BCE), laying the foundations for populous agrarian societies in those regions where linguistic and cultural identities differed from that of China's heartland. Chiefdoms and early states started to appear in those same regions: in 850 BCE in Korea and 750 BCE in Vietnam (Borcan et al., 2018).

Given our framework, hypothesis, and stylized facts, our empirical strategies are as follows. First, we provide empirical evidence to bear on the claim that the earliest empire-building project that would later become China did indeed emerge from the clusters of millet and rice hotspots in northern China around Erlitou. Second, we then present evidence to show that locations relatively closer or farther from Erlitou should have a larger or smaller chance of becoming part of China, depending on when they adopted agriculture.

[21] China's territory is defined as areas in which China could exercise military control and had the apparent power to repel invaders, more discussion of this measurement is in Section 3.3.1.

3 Data

3.1 Geographic Coverage

We focus on that part of eastern Asia that includes today's China and neighboring states that, until recent centuries were influenced more by the spread of east Asian domesticates and culture rather than west Asian equivalents because of their relative isolation from other early developed zones in the same land mass (e.g., the band of agrarian societies running from west Asia to north Africa and southern Europe). Specifically, we mark off an area located between 70° and 150° east and 0° and 60° north, and split it into $1^\circ \times 1^\circ$ cells for our analysis.[22]

3.2 Key Independent Variables

3.2.1 Years Since the Adoption of Agriculture

To estimate the number of years since the adoption of agriculture (YSA), we used data on the spread of agriculture across Asia based on archaeobotanical evidence collected from 481 independent archaeological sites (Figure 2(a)). We constructed this measure following the methods employed by Pinhasi et al. (2005) and Silva et al. (2015). Specifically, we use the Inverse Distance Weighted (IDW) method to construct estimates of the timing of diffusion across our grid cells for each of the four original native grain crops – millet (foxtail, broomcorn) and rice (japonica and indica).[23] For cells lacking historical records, we interpolated the timing of the adoption of agriculture based on the sites and dates provided in the pertinent sources. Specifically, we predicted the date of the adoption of agriculture in a cell c as the weighted average of the date of cells that contain the relevant information located within a week of migratory distance from c, where the weights are a function of the inverse of the migratory distance to cell c. Doing so allows us to predict the date of the adoption of agriculture in a given cell for each crop. We select the earliest of the various crops and assign it to cell c.[24]

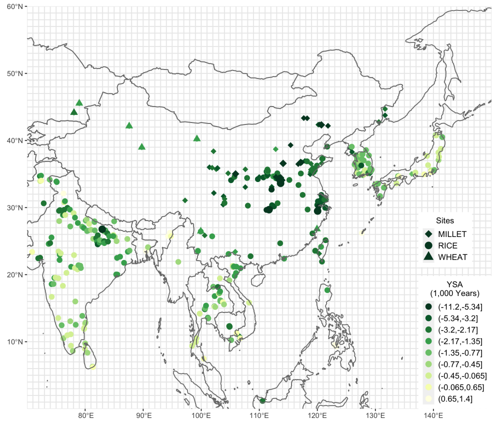
Since agriculture can only be adopted in regions habitable by humans, we restrict our predictions to areas where the geo-climatic conditions allow human existence and support agriculture (Burke et al., 2017; Wren and Burke, 2019; Xu et al., 2020), by assuming that geo-climatic conditions that support a population density of less than two people per square kilometer in the year 1 CE would preclude the adoption of agriculture. Our predictions are made on the basis of: latitude, elevation, ruggedness, mean temperature, mean precipitation, extreme temperatures, temperature volatility, precipitation volatility, optimal caloric suitability, and length of fallow season.[25] Figure 2(b) shows the predicted

[22]This region includes more than 40 percent of Eurasia's longitude or 48 percent of Asia's. Its northern margins extend beyond the scope of traditional temperate farming, and it extends far enough south to include all of mainland Asia.

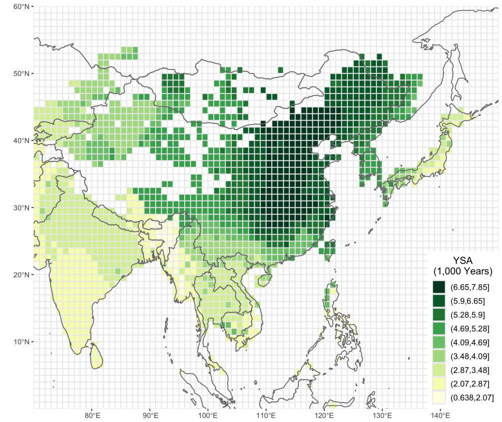
[23]We also included wheat, but it arrived too late to have any significant impact on YSA. Data on the diffusion of foxtail millet, broomcorn millet, and wheat are from Stevens and Fuller (2017), while those on the diffusion of rice is taken from the Rice Archaeological Database (Silva et al., 2015).

[24]By definition, IDW can only predict values for cells within the convex hull generated by the set of all locations that have data in the original source (Figure B.3). Thus, to extend the interpolation to the full range of cells we study, we use out-of-sample predictions based on an OLS regression between YSA and a set of geographic and climatic variables, including distance from the original locations, using the sample of the interpolated data (see Appendix F).

[25]We estimate the probability of adoption using a logistic regression, which includes the levels and squares of each geo-climatic characteristic, as well as an indicator that identifies the ventile of each characteristic in which population density was low (see Figure F.1). The results are similar between various alternative specifications.



(a) Adoption Sites



(b) Interpolation

Figure 2: Years Since the Adoption of Agriculture

spatial distribution of YSA.[26]

3.2.2 Migratory Distance from the Earliest State - Erlitou

The ability of states to expand geographically by projecting military power onto a region depends crucially on its relative isolation from other competing states. Thus, to estimate the distance from each cell to Erlitou we use the Human Mobility Index (HMI), which estimates the minimal travel time between two given cells based on human biological, geographical, and pre-modern technological constraints (i.e., before the availability of steam power), and allowing for a wide range of activities such as the sending of army troops, conducting trade, or establishing communications, etc. (Özak, 2010, 2018).[27] Figure 3 depicts the location of Erlitou and the iso-time curves of migratory distances to it.

Our other controls related to distance also use HMI for construction. The isolation between China and other powerful states in the western part of the land mass is of particular importance, especially if the two were expanding simultaneously (Ashraf et al., 2010). To account for the effect of isolation on state building, we construct the level of isolation from the rest of Eurasia for each cell, by taking the average of the pairwise HMI distance between cell c and all other cells in Eurasia. In addition, given the importance of river transport, we also measure a cell's HMI distance to major rivers in eastern Asia,[28] particularly the inland waterways, which were the most important transport network before the modern era (Elvin, 1973).

3.2.3 Millet and Rice Hotspots

On the assumption that concentrations of lands suitable for cultivating millet and rice are those where complex societies were more likely to emerge and spread, we must identify their spatial distribution.

[26] For example, a cell with a YSA of 3,000 means it adopted agriculture 3,000 years before 1912 CE.

[27] We use HMI with seafaring, because the pertinent historical data on sea routes are available to estimate travel time by sea. This is crucial as travel between Erlitou and Japan, Taiwan, and other locations all entail a sea route.

[28] HMI distance to rivers with stream order higher than 5.

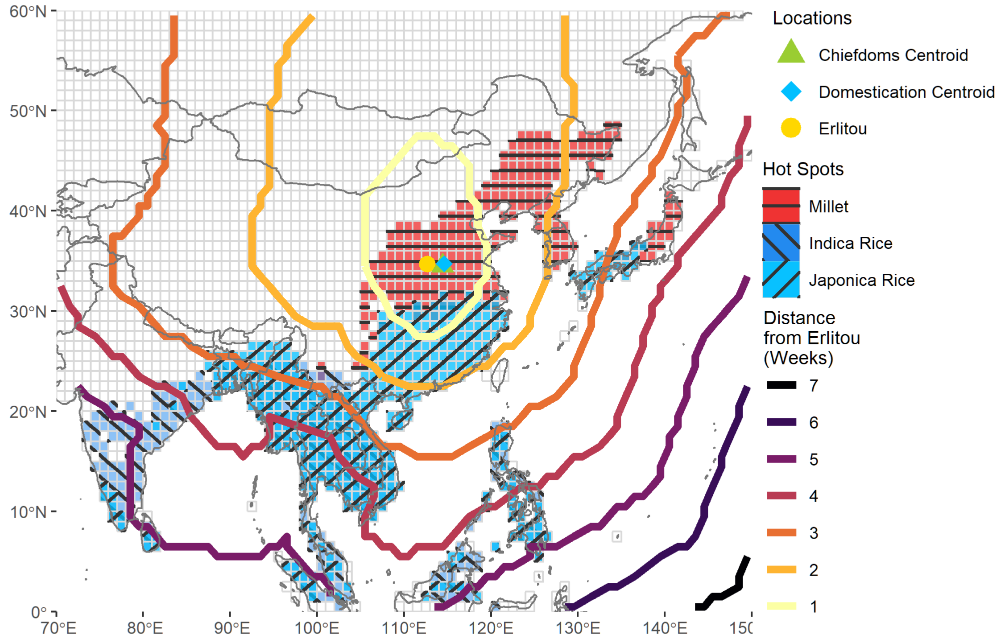


Figure 3: HMI Distance from Erlitou and Crop Hotspots

We identify these clusters of agriculturally suitable land using data on caloric (agricultural) suitability provided by Galor and Özak (2015, 2016), which captures the potential caloric output obtainable from each crop based on cultivation methods and agro-climatic conditions before 1,500 CE.

The ability to produce calories from agriculture was a necessary but not sufficient condition for the development of social complexity and state expansion, however. Only clusters of spatially concentrated agriculturally suitable land, so called suitability "hotspots" – i.e., groups of cells with above-average agricultural suitability – could generate "agglomeration" effects with greater potential to increase social complexity than did single suitable cells in isolation. In a nutshell, the economies of scale conferred by hotspots facilitated the diffusion of agricultural ways of life and the corresponding emergence of complex societies and expanding states. Using the local Moran-I statistic of each cell (Anselin, 1995, 2001), we identified the locations of millet and rice hotspots in eastern Asia, which are depicted in Figure 3.[29,30]

3.3 Dependent Variables

3.3.1 Stickiness to China

To construct a novel variable measuring the stickiness to China, we measured the number of years each cell has been a part of a Sinicized state. Specifically, we constructed three measures – territorial,

[29] Specifically, given a cell i and its neighboring cells N_i, its local Moran-I statistic can be obtained by $I_i = z_i \sum_{j \in N_i} w_{ij} z_j$, where $z_i = (x_i - \bar{x})$ measures the difference between the suitability of cell i, x_i, and the average suitability in the region, $\bar{x}$, w_{ij} denotes whether i and j are neighbors (Anselin, 1995, 2001). We include in the hotspots only those region for which we reject the hypothesis that $I_i = 0$ with a high level of confidence.

[30] For rice hotspots, we distinguish between japonica (mainly cultivated and domesticated in China) and indica rice (mainly cultivated and domesticated in India). In our main empirical analyses we will distinguish between rice and millet, while the appendix provides results distinguishing between millet and both types of rice.

cadastral, and hybrid.

A cell is judged to be included in "territorial China" if it is within lands over which a Chinese dynasty of the time asserted control. To construct this measure, we digitized a set of historical maps originally collected by Tan (1982) and augmented by Gu and Shi (1993) and Zhou (2017) for a period of two millennia. Altogether, there are 99 maps, each covering an average period of approximately 22 years (Figure B.4).[31] Based on these maps, we code territorial China based on whether or not the Sinitic states exercised military control and had the apparent power to repel invaders in cell c in year t (T_{ct}). However, the boundary shifts that occurred between dynasties are silent on both the type of rule (direct versus indirect) and the degree of Sinicization (i.e., how culturally and institutionally Chinese a dynasty was). To account for these effects, we weight the territorial control in each year by i) distinguishing regions according to whether they were under direct rule (R_{ct}=1) or not (R_{ct}=0.5) when T_{ct}=1,[32] and ii) the degree of Sinicization in cell c in year t (abbreviated as SI, ranging from 0 to 1). The detailed coding procedure is explained in Appendix E and the resulting Sinicization Index is shown in Figure B.5, respectively. For cell c in year t, territorial China is defined as

$$\bar{T}_{ct} = T_{ct} \cdot R_{ct} \cdot SI_{ct}. \tag{1}$$

By summing $\bar{T}_{ct}$ over 2132 years ($\bar{T}_c = \sum_t \bar{T}_{ct}$), we compute cell c's stickiness to China in "territorial" terms. We define $\bar{T}_c$ as the total number of years that cell c falls within China's border, taking into account both the "type of rule" (direct versus indirect) and level of Sinicization. Figure 4(a) depicts the spatial distribution of $\bar{T}_{ct}$. In our sample, 73 percent of the cells were conquered by China at least once (Table C.1, column(1)), 43 percent of the cells were ruled by Sinitic states for more than 500 years, and 54 percent of the cells are in the PRC today.

An obvious limitation of territorial China is that it may fail to capture fully the *presence* of the Sinitic state; e.g., after conquering a region a dynasty's army may have retreated and left it to be ruled indirectly, with no settled population and taxation resulting therefrom.[33] To reflect the presence of the Sinitic states with fiscal and other administrative functions, we construct an alternative measure called "cadastral China" to indicate how intensely a cell was governed by a Sinitic state, using county seats as a proxy. To construct this measure, we built upon CHGIS Version 6, augmenting it with data from Zhou (2017) to include i) counties located outside of the boundaries of today's PRC, and ii) counties established by non-Han dynasties (e.g., the Liao and the Jin).[34] Specifically, after confirming whether or not a cell contains a county seat, i.e., C_{ct}=1 if it does and 0 if it does not, we counted their

[31]Based on Tan (1982), the China Historical Geographic Information System (CHGIS) digitized the boundary information but only for the late Qing (c. 1820 and 1911). In addition to digitizing all the maps compiled by Tan, we further digitized those documented by Gu and Shi (1993) and Zhou (2017).

[32]Conceptually, the latter resembles the current autonomous regions of China, although the central government typically exerted less control over such areas before the advent of modern modes of communication and transportation. Indirectly ruled areas were recognized by different terminologies between dynasties. For example, Xinjiang was the "Xiyu Protectorate" in the Western Han dynasty and was a "Dependency" in the Qing dynasty before 1844.

[33]We also cannot rule out that the maps used reflect the perceptual and political biases of dynastic proclamations and historians, since the sources relied on are Chinese and not all boundaries are sure to have been mutually agreed, nor was there always an undisputed sovereign with whom to reach such an agreement.

[34]Figure B.6 shows the distribution of the counties contained in CHGIS (in yellow) and the counties missing in CHGIS we geocoded from Zhou (2017) (in green).

actual number in cell c in year t to account for the varying strength of the state presence (e.g., N_{ct}=5 if cell c has five counties in year t). Thus, Sinitic states presence in year t in cell c is

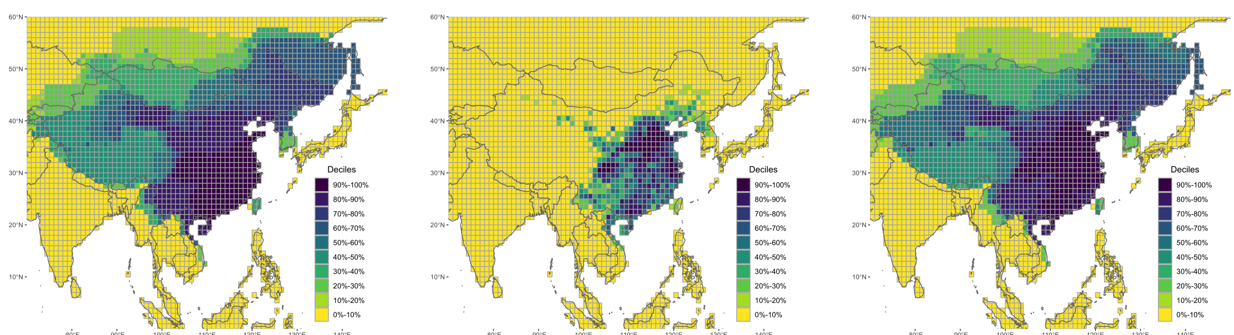
$$\bar{C}_{ct} = C_{ct} \cdot N_{ct}. \tag{2}$$

By summing $\bar{C}_{ct}$ over time ($\bar{C}_c = \sum_t \bar{C}_{ct}$), we obtain cell c's stickiness defined in terms of cadastral China. We define $\bar{C}_{ct}$ as the total number of years that cell c has a county present multiplied by the number of counties therein (as weight). Figure 4(b) depicts the spatial distribution of $\bar{C}_{ct}$, where about 17 percent of the cells had one or more county seats at least once (Table C.1, column(1)), about 15.7 percent of the cells in today's PRC.

Territorial and cadastral China capture two different aspects of state-building. Territorial China emphasizes the territory where China could project its military influence, while cadastral China reflects the actual presence of state bureaucracy (county seat) or the fiscal capacity of the Chinese state. For robustness, we combine the two in "hybrid China" by replacing the "type of rule" (R_{ct}) in territorial China with the existence of county seats (C_{ct}) in cadastral China.[35] Hence, in each period and for each cell,

$$\bar{H}_{ct} = T_{ct} \cdot C_{ct} \cdot SI_{ct}. \tag{3}$$

By summing $\bar{H}_{ct}$ over time ($\bar{H}_c = \sum_t \bar{H}_{ct}$), we can obtain cell c's stickiness defined in terms of hybrid China.[36] Figure 4(c) shows the spatial distribution of hybrid China.



(a) Territorial (b) Cadastral (c) Hybrid

Figure 4: Stickiness to China

3.3.2 Prehistoric Development

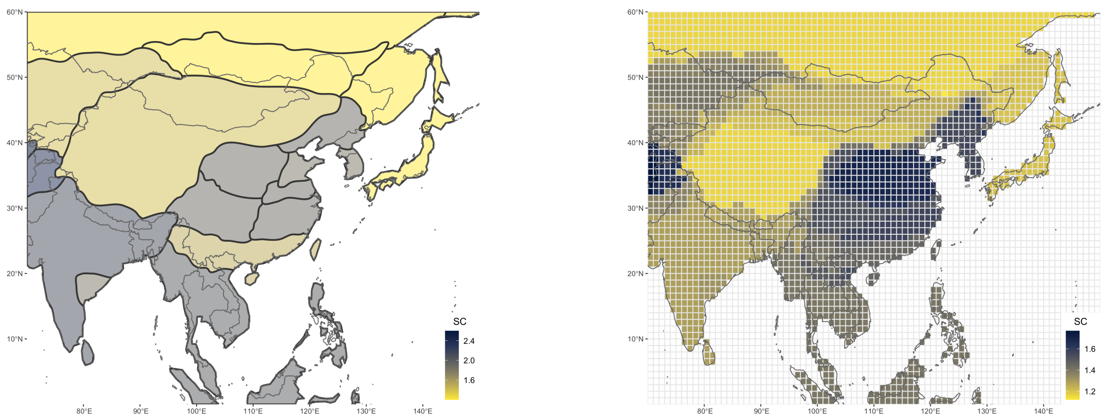
We use the level of social complexity as our first measure of prehistoric development. We do so by constructing a panel of the level of social complexity between 10,000 BCE and 1,000 BCE across eastern Asia based on *The Atlas of Cultural Evolution (ACE)*, which maps the borders of major civilizations around the world (Peregrine, 2003).[37] Using 3,000 BCE as an example, Figure 5(a) shows the distribution of civilizations in our area of analysis. For each civilization, we employ ten measures

[35] Unlike earlier, C_{ct} is set to 0.5 for a cell with no county seat.

[36] Figure B.7 shows the distribution of hybrid China stickiness at the regional level.

[37] During this period, the number of civilizations in eastern Asia averaged between nine and nineteen.

as proxies for its stage of development according to ACE; they include: reliance on agriculture, population density, political integration above the band or small settlement, social stratification, fixity of settlements, writing system, use of money, technology level, urbanization, and transportation. Each of these measures takes on a value between 1 and 3.[38] As a summary measure, we take the average of all ten characteristics to construct an index to reflect their average level of social complexity over time. Figure 5(a) depicts the level of social complexity across civilizations in 3,000 BCE and Figure 5(b) the mean level of social complexity between 10,000-1,000 BCE across cells.



(a) Social Complexity in 3,000 BCE

(b) Average Social Complexity (10,000-1,000 BCE)

Figure 5: Social Complexity (10,000-1,000 BCE)

Our second prehistoric measure identifies the location, size, duration, and cultural type of complex societies. According to Diamond (1997) and Johnson and Earle (2000), societies can be classified by their increasing level of complexity – band, tribe, chiefdom, and state.[39] Xu (2018) provides the most comprehensive archaeological data on the location, size, duration, and cultural zone (it belongs to) of over 1,000 wall- or trench-enclosed settlements (including bands, tribes, chiefdoms, and city states) dating to 7,000-221 BCE located within China.[40] We digitized this data and created a panel of the presence and number of complex societies and cultures in each cell across time (Figure 6).[41] Additionally, we complemented Xu (2018)'s data using locations of archaeological sites outside China from Whitehouse et al. (1975).[42] This way, we generated a cross-sectional dataset covering the full range of eastern Asia (Figure B.8).

4 The Emergence of the Earliest State

Before examining our proposed "race" between the early-starting and neighboring autochthonous states, we explore a fundamental pillar of our proposed hypothesis: Did the expansion of the agri-

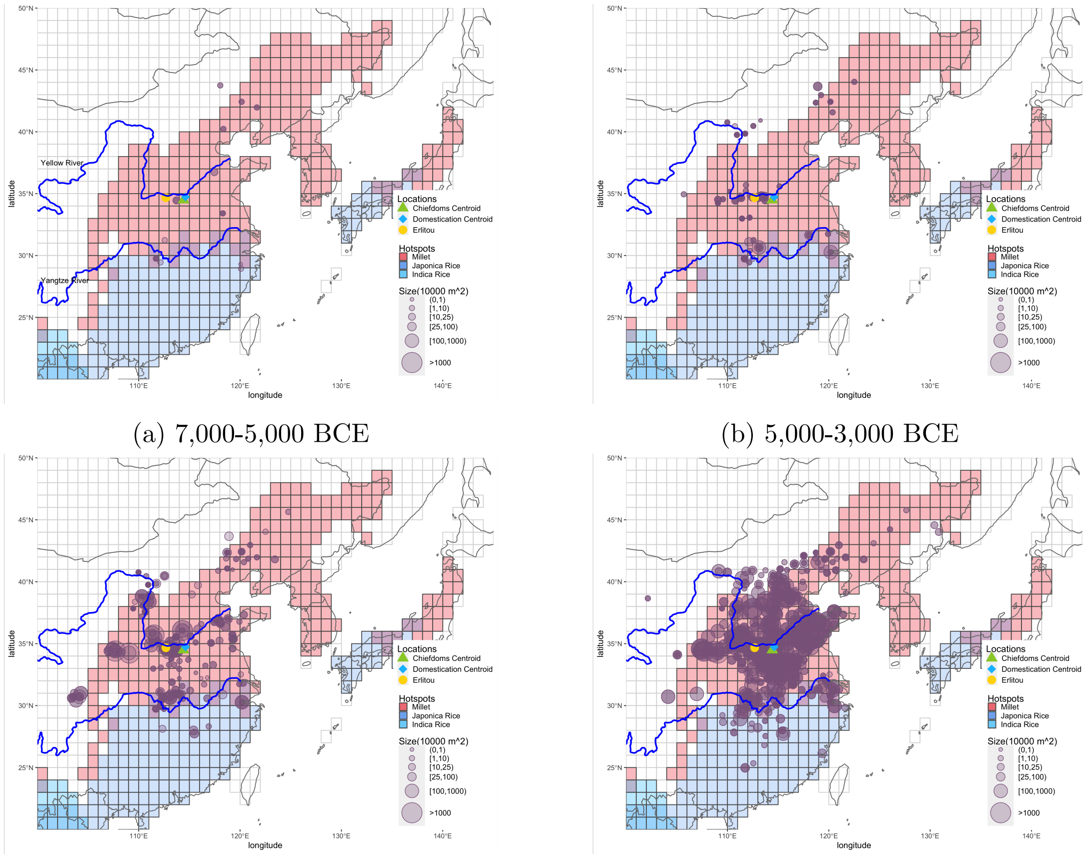
[38]Table D.2 in Appendix D shows the coding scheme in ACE.

[39]Bands and tribes are relatively egalitarian societies, while chiefdoms, paramount chiefdoms, and states have established progressively higher degrees of hierarchical structure. Detailed definition in Appendix D.

[40]Note that the culture zones are more finely graded than the ACE data.

[41]We constrain our sample to cells located in the present PRC when using this panel data.

[42]Data limitations in Whitehouse et al. (1975) preclude the construction of a panel for all of eastern Asia.



(a) 7,000-5,000 BCE

(b) 5,000-3,000 BCE

(c) 3,000-1,000 BCE

(d) 1,000-221 BCE

Figure 6: Evolution of Chiefdoms and Complex Societies (7,000-221 BCE)

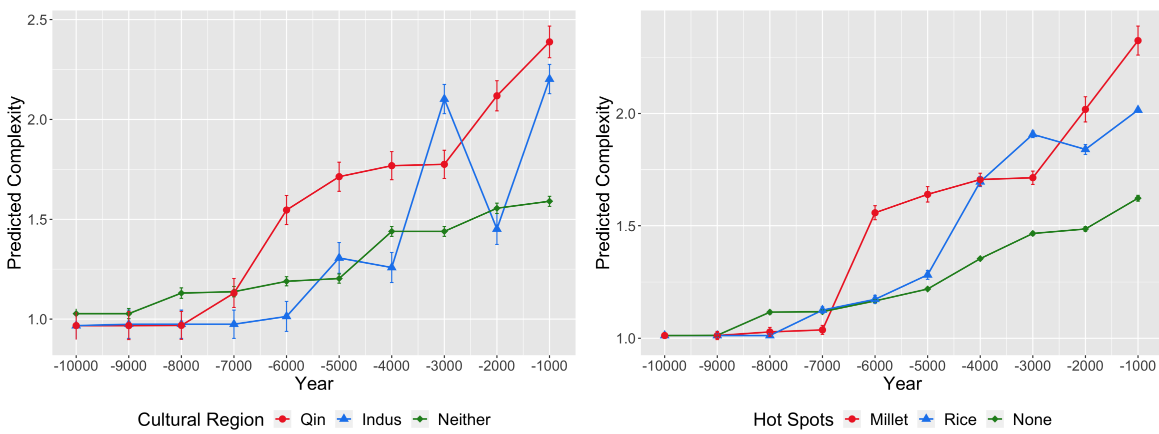
cultural way of life trigger the emergence of complex societies and early state-building projects in clusters of land highly productive of millet or rice cultivation in eastern Asia? Moreover, do these early chiefdoms and proto-states predict the rise of Sinitic states? Addressing these questions requires us to examine i) the divergence in terms of social complexity between agricultural hotspots and the rest of eastern Asia, and ii) the singular importance of millet hotspots in fostering the emergence of complex societies in general and the rise of Erlitou in particular – the region's earliest known supra-local political center.

We begin by examining the evolution of social complexity between 10,000 BCE-1 CE using our full sample. We first grouped these civilizations into three cultural regions: those that fall within the boundary of the future Qin – China's first Empire, the Indus (i.e., south Asian) cultures, and the rest of eastern Asia (Figure B.9). We then conducted our analysis by estimating the following equation using OLS

$$Y_{ikt} = \alpha + \sum_{k \in \{Qin, Indus, Neither\}} \beta_{tk} \cdot cultural\ region_k \cdot t + \gamma_t + \gamma_i + \varepsilon_{ikt}, \tag{4}$$

where Y_{ikt} is the social complexity measure introduced in the previous section, i.e., the unweighted average of 10 indicators selected to measure the level of social complexity in cell i in hotspot k in period t; γ_t and γ_i are a complete set of period and cell-level fixed effects, $cultural\,region_k$ is a dummy variable indicating whether a cell belongs to the cultural region k=Qin, Indus, or neither (i.e., the rest of eastern Asia), and ε_{ikt} is the error term. We account for the dependence between observations by clustering the standard errors at both the cell and period levels.[43] Our estimates, reported in Figure 7(a), show that the regions that subsequently became the Qin Empire diverged from both the Indus cultural region and the rest of eastern Asia around 6,000 BCE – a long time before the emergence of the first state at Erlitou. This result strongly suggests that the Qin Empire had deep historical roots in regions that diverged early from the rest of eastern Asia.

A key determinant of this divergence is the geographic distribution of millet and rice hotspots, from which social complexity probably evolved. To show that this was the case, we replicate the analysis using caloric suitability hotspots for millet and rice (japonica/indica) instead and find that millet hotspots also diverged from the rest of eastern Asia from around 6,000 BCE, with rice hotspots catching up after 4,000 BCE as shown in Figure 7(b).[44]



(a) Cultural Regions

(b) Crop Hotspots

Figure 7: Evolution of Social Complexity by Cultural Region and Hotspots Category

These results lend credence to the hypothetical positive influence of millet and rice in general and their hotspots in particular on the emergence of social complexity in early eastern Asia. To identify this relationship causally, we employ an event study design that relies on the approximate dates of the domestication of these crops. Specifically, for both millet and rice, we compare the evolution of social complexity between their respective hotspots and non-hotspots before and after their domestication based on the following specification

$$Y_{itk} = \alpha + \sum_{n=-\underline{J}}^{\overline{J}} \beta_{ikt}\mathbb{I}(t=n) + \gamma_t + \gamma_i + \varepsilon_{ikt}, \tag{5}$$

[43] We obtained similar results when using standard errors to correct for spatial autocorrelation.

[44] Additionally, Figure B.12 replicates the analysis when a distinction is made between japonica and indica rice. We observe that japonica rice hotspots (China-based) caught up after 4,000 BCE and indica rice (India-based) hotspots both caught up after 3,000 BCE. In Figure B.13, we report the changing patterns for individual social complexity indicators that underlie our main measure.

where, as before, Y_{ikt} denotes the level of social complexity for cell i in region k=millet (or japonica/indica rice) hotspot, or no hotspot in period t; γ_t and γ_i stand for a complete set of the period and cell-level fixed effects, $\mathbb{I}(t = n)$ indicates whether the period t is $n = -J, \ldots, J$, where J indicates the number of periods relative to the domestication of millet or rice.[45] Figures 8(a)-(b) show that the domestication of these two crops is associated with an increase in the level of social complexity in their respective hotspots.[46]

Next, we employ the panel data for archaeological settlement sites and cultures between 7,000-221 BCE. We replicate the event study design but this time using the number of archaeological settlement sites and cultures as our outcomes. Given data limitations, our sample is confined to cells located in the PRC only. Figures 8(c)-(f) show that the domestication of these two crops is associated with an increase in the number of sites (Figures 8(c)-(d)) and number of cultural zones (Figures 8(e)-(f)) in their hotspots.[47] The above results suggest that the domestication and adoption of millet and rice in their hotspots was essential for state formation. However, the effect is only significant for millet, suggesting that it played a more central role than rice did in the growth of social complexity.[48] As these settlements competed with one another, the larger political units of proto-states were formed. Indeed, it was in precisely such a millet hotspot that Erlitou – the region's first fully-fledged early state – came about. This particular finding is also consistent with the well-known historical fact that the Sinitic states expanded from a predominantly "millet-world" to a "rice-world".

We believe there are many reasons why millet areas saw more settlements initially, and, perhaps because of that, were poised to absorb the south subsequently. For example, millet can diffuse faster and more widely than rice because it is less demanding when it comes to water (irrigation) and labor requirements. Millet is a drought-resistant crop (Heuzé et al., 2015) that provides a similar amount of calories as rice before the technology to crop rice several times a year was developed, which did not arise until long after the Sinitic states were established (Figure B.10). Additionally, given its earlier domestication and diffusion (Table C.2 columns (1)-(3), Figure B.11), the spread of millet gave rise to a greater geographic scope for conflict, providing the preconditions for the emergence of a more hierarchical society. To the extent that the millet-dominated areas were located geographically in the north – a region that had frequent interactions with nomadic pastoralist societies – these evolutionary forces were reinforced with greater vigor there, as military skills such as horse riding and archery were quickly adopted from the nomadic neighbors (Turchin et al., 2016; Su, 2016).[49]

Finally, we use data on the cross-section of settlements covering our full sample (Figure B.8) to

[45]To ensure that our estimates are not affected by issues related to heterogeneity or staggered adoption, we analyze each crop individually by comparing its hotspots with non-hotspots.

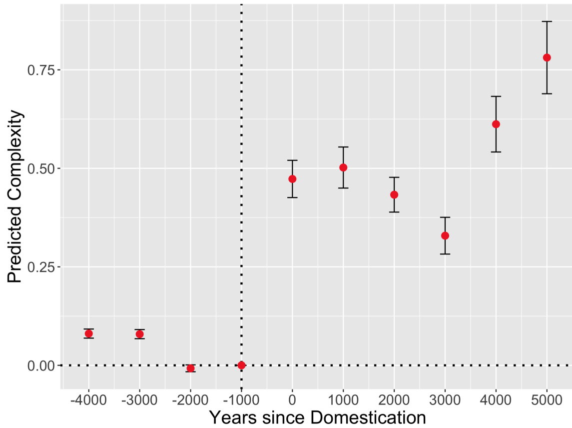
[46]Figure B.14 replicates the analysis but distinguishes between japonica and indica rice. In Figure B.15, we report the results of all underlying indicators one at a time. Specifically, the domestication of millet and rice are associated with an increase in population density (Figures B.15(a)-(b)), urbanization (Figures B.15 (c)-(d)), political integration (Figures B.15(e)-(f)), social stratification (Figures B.15(g)-(h)), technology (Figures B.15(i)-(j)), and fixity (Figures B.15(k)-(l)) in their hotspots.

[47]We also report results for the number of sites weighted by their settlement size (Figure B.16(a)-(b)), and both their duration of existence and size (Figure B.16(c)-(d)).

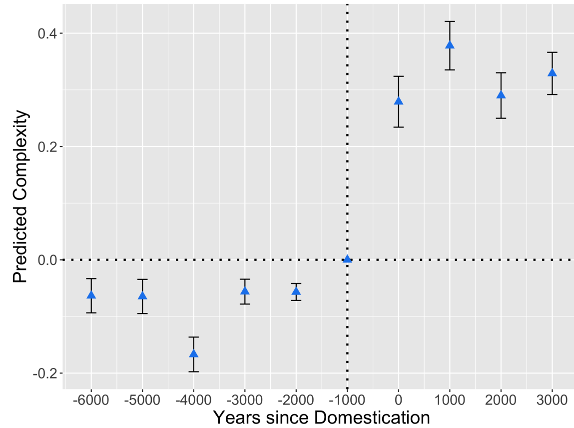
[48]While civilizations and settlements also existed in the rice areas especially after the third millennium BCE, there were more in the millet hotspots.

[49]That the best horses for military purposes were long procured from lands to China's north and northwest and were better adapted to northern climates may have added to the advantage, as well.

Social Complexity

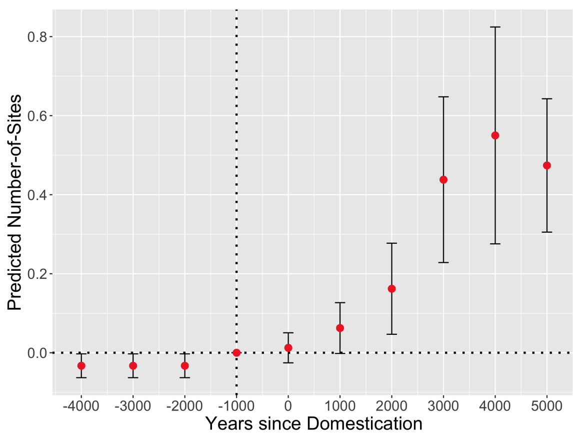


(a) Millet Hotspots

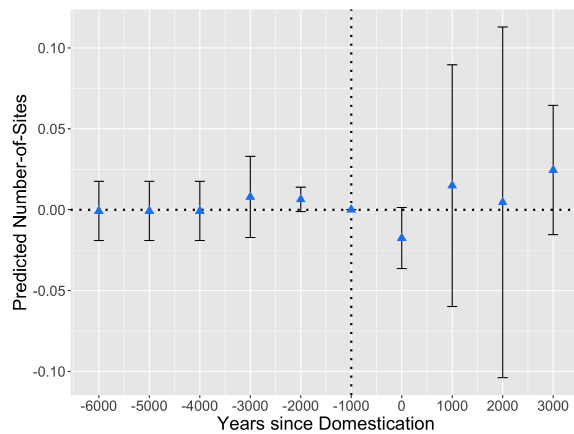


(b) Rice Hotspots

Number of Sites

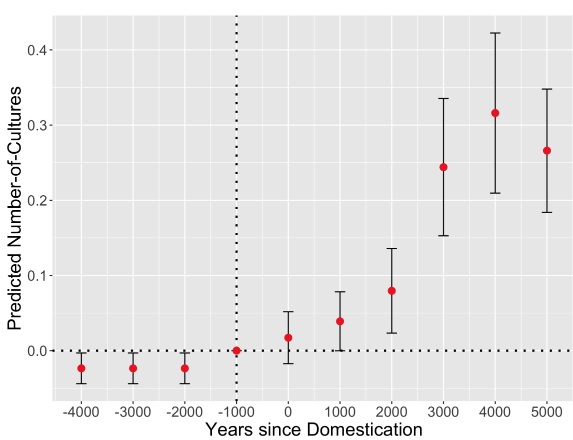


(c) Millet Hotspots

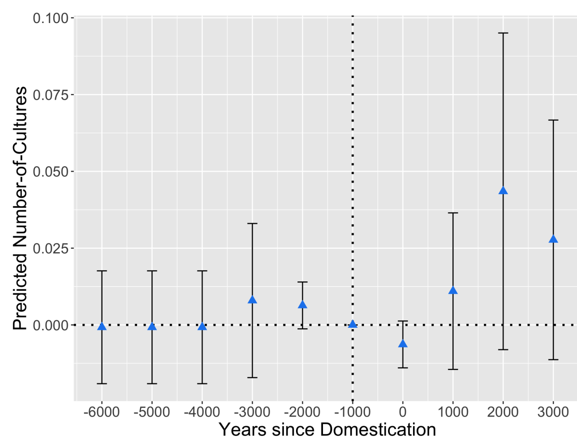


(d) Rice Hotspots

Number of Cultures



(e) Millet Hotspots



(f) Rice Hotspots

Figure 8: Event Study of the Impact of Agriculture Adoption on Complex Societies

check for robustness. Specifically, we analyze the association of hotspots and an earlier adoption of agriculture and the number of settlements in a cell and its proximity to Erlitou (i.e., whether it is located within one week of HMI distance), respectively, estimating the following equation using a spatial-error model to alleviate concerns about spatial autocorrelation (Anselin, 2001)[50]

$$Y_i = \beta_0 + \sum_k \beta_k Hotspot_{ik} \cdot YSA_i + \beta_k Hotspot_{ik} + \beta_1 YSA_i + C_i + \varepsilon_i, \tag{6}$$

where, Y_i denotes the (inverse hyperbolic sine of the) number of settlements in cell i or whether it is located within one week HMI distance from Erlitou; $Hotspot_{ik}$ denotes whether cell i is located in hotspot k=millet (or rice); YSA_i is years since the adoption of agriculture in cell i; and C_i is a set of basic geographic and climatic characteristics of cell i.[51]

The results in Table 1 suggest that being in a millet hotspot has a large and significantly positive association with the number of settlements and proximity to Erlitou. In terms of magnitude, a millet hotspot increases the number of settlements by 52 percent (column (1)) and the probability of being close to Erlitou by nearly 20 percentage points (column 5). Columns (2) and (6) show that this strong positive association is driven by both the scale effects of the hotspots and the number of calories that are produced in the cell. Similarly, early adoption of agriculture is positively associated with both the number of settlements and proximity to Erlitou (columns (3) and (7)).[52] Finally, in columns (4) and (8), we interact hotspots with YSA. In the case of millet, the positive and significant association is driven primarily by this interaction. In terms of magnitude, cells that were a millet hotspot *and* adopted agriculture earlier by one standard deviation have 69 percent more settlements and 43 percentage points higher probability of being within one week of HMI distance from Erlitou. Simply put, settlements were more likely to appear in hotspots millet had diffused to earlier. The interaction between rice and YSA has a similar effect on settlements and distance from Erlitou, except it is much smaller in magnitude.[53] These results seem to be further confirmed in Figure 6, which shows that state-building activity was concentrated around Erlitou, in the millet hotspots close to the centroid of the earliest millet and rice domestication centers. In particular, the centroid of all proto-states located in the current PRC is located in the *same* cell as the centroid of the earliest domestication centers, less than 160km from Erlitou.[54]

[50]We use a 500km neighborhood for the results presented in the main body of the paper. As we show in Appendix C.3.1, the results are robust to varying the size of the neighborhood, as well as using OLS with corrections for spatial autocorrelation (Colella et al., 2019). See Appendix C.3.2.

[51]Main controls include absolute latitude, longitude, land size, elevation, temperature (monthly average mean), precipitation (monthly average mean), terrain ruggedness, and distance to coast. All specifications control for tectonic-plate fixed effects. Detailed data sources are provided in Appendix D. To simplify the interpretation of the results, we standardize all variables to have a mean of zero and a standard deviation of one.

[52]In terms of magnitude, a one standard deviation increase in YSA increases the number of chiefdoms by 2 percent and the probability of being close to the Erlitou by about 4 percentage points.

[53]We further confirm the combined importance of millet hotspots and adoption of agriculture for the emergence of early states using semi-partial R-squares, which were computed to show the share of the total variation in the outcome variable that is uniquely associated with an independent variable after removing any common variation with other controls in the regression. As shown in Table C.2, millet hotspots and years since the adoption of agriculture have the largest semi-partial R-squared in the analysis. In particular, the unique variation associated with the two variables explains between 1.4-5 times as much as the unique variation associated with all other controls combined in the full specifications.

[54]The centroid of chiefdoms or proto-states in the pre-Erlitou years (3,500-1,700 BCE) is calculated based on the

In summary, our empirical results strongly support the proposition that: i) in terms of social complexity level, millet hotspots began to diverge as early as 6,000 BCE, while rice hotspots caught up around 4,000 BCE; ii) in terms of the emergence of complex societies, millet hotspots had more settlements and cultural heterogeneity. These conditions provided fertile ground for the emergence of the first state in eastern Asia.

Table 1: Hotspots, Early Agriculture, and the Emergence of China's First State

	Number of Chiefdoms (Inverse Hyperbolic Sine)				Distance from Erlitou (Indicator, $\leq$ 1 week)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Hotspot Millet	0.52***	0.26***	0.27***	-0.66***	0.20***	0.14***	0.15***	-0.43***
	(0.03)	(0.04)	(0.04)	(0.08)	(0.02)	(0.02)	(0.02)	(0.05)
Hotspot Rice	-0.14***	-0.06*	-0.06*	-0.09**	-0.07***	-0.01	-0.01	-0.02
	(0.03)	(0.04)	(0.04)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
Millet Caloric Suitability		0.11***	0.10***	0.08***		0.02**	0.00	-0.01
		(0.01)	(0.01)	(0.01)		(0.01)	(0.01)	(0.01)
Rice Caloric Suitability		-0.06***	-0.06***	-0.03		-0.05***	-0.05***	-0.03**
		(0.02)	(0.02)	(0.02)		(0.01)	(0.01)	(0.01)
Agricultural Adoption			0.02**	0.01			0.04***	0.03***
			(0.01)	(0.01)			(0.01)	(0.01)
Millet Hotspot $\times$ Agricultural Adoption				0.69***				0.43***
				(0.05)				(0.03)
Rice Hotspot $\times$ Agricultural Adoption				0.06**				0.01
				(0.03)				(0.02)
Plate Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo-R^2	0.31	0.33	0.33	0.39	0.25	0.26	0.27	0.33
Observations	2779	2779	2779	2779	2779	2779	2779	2779

Notes: All variables except hotspot indicators are standardized to have mean 0 and standard deviation 1. Main controls include longitude, latitude, land size, elevation, temperature, precipitation, ruggedness, and distance to coast. Spatially autocorrelated disturbances considered within 500kms. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

5 The Making of a Mega-state

5.1 The "Race"

To put the expansion of what became the Chinese mega-state from its original center into perspective, we use a "survival analysis" to compute the evolution of the probability that a cell would be annexed for the first time into the growing empire. To conceptualize this analysis, we classified cells into i) the "early adopters" (defined by whether they had adopted agriculture for at least 3,000 years), and ii) "close cells" (defined by whether they could be reached from Erlitou within two weeks of travel. We

location of sixty settlements enclosed by trenches and sixty-seven settlements enclosed by walls. See Xu (2018).

then constructed the following typology: early/close, early/distant, late/close, and late/distant. The results, depicted in Figure 9, show that China had an obvious proclivity to annex the early adopters (green circle and green square) at an earlier stage of state-building; the hazard ratio shows that early adopters closer to Erlitou (green circles) were more likely to be absorbed by the Sinitic states in the process of autochthonous state building. At later stages, the hazard ratio shows that China was more successful in incorporating the late adopters located close to it (purple diamonds) than the early adopters located farther away (green squares), as, with the passage of time the early/distant cells had already developed states with sufficient military capacity to resist annexation by China.

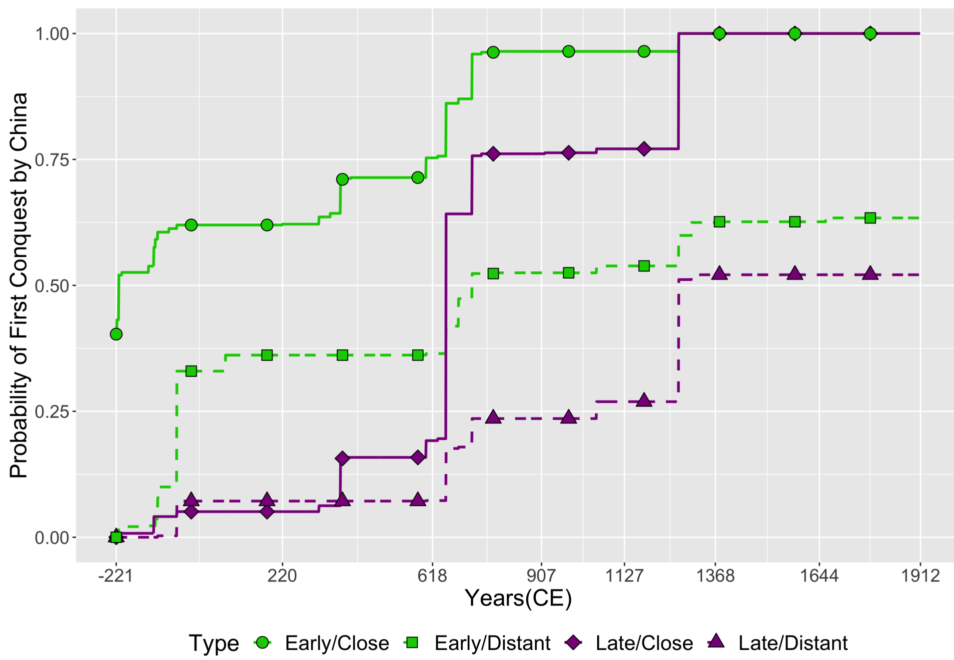


Figure 9: Probability of the First Conquest by China

On the basis of the above findings, we now examine the interaction between years since the adoption of agriculture and distance from Erlitou on stickiness to China. Our hypothesis implies that this interaction term should be negative and significant, reflecting the beneficial effect of early adoption of agriculture on autochthonous state-building and eventual autonomy for those in locations not easily accessible from Erlitou. We estimate the following equation using a spatial error model[55]

$$Y_i = \beta_0 + \beta_1 YSA_i \times Distance\ Erlitou_i + \beta_2 YSA_i + \beta_3 Distance\ Erlitou_i + \beta_k' C_i' + \varepsilon_i, \qquad (7)$$

where Y_i is the inverse hyperbolic sine transformation of the (hybrid) stickiness to China for cell i over the 221 BCE to 1911 CE period.[56] YSA_i denotes years since the adoption of agriculture in cell i, $Distance\ Erlitou_i$ is HMI distance from Erlitou (reflecting how isolated a cell is from Erlitou). C_i'

[55]We use a spatial error model with a cut-off of 500km to correct for spatial correlation. Our results are robust to using other cutoffs (250km, 750km, and 1,000km) as well as using OLS with corrections for spatial autocorrelation following Colella et al. (2019).

[56]Given the large number of zeros and the wide range in our stickiness data, we perform an inverse hyperbolic sine transformation, which is similar to a log-transformation, but does not introduce biases in its handling of zeros.

is the set of characteristics of cell i including the set of basic geo-climatic controls;[57] and a set of additional controls including its isolation from the rest of the land mass, its HMI distance to major rivers in eastern Asia, whether it is located in millet/rice hotspots, and its caloric suitability from cultivating millet/rice. We estimate this equation for each of the three measures of stickiness to China – territorial, cadastral, and hybrid, respectively. Our main hypothesis implies $\beta_1 < 0$.

Table 2 presents our regression results. Column (1) shows estimates of the interaction between YSA and distance from Erlitou, and confirms the significance of the predicted negative coefficient.[58] This result implies that, conditional on their distance from Erlitou, cells that adopted agriculture earlier were less likely to be absorbed by China. Similarly, holding YSA constant, cells that were closer to Erlitou were more likely to be incorporated into China. Together, these results suggest that the "race" between the growth of local state-building projects that started with the adoption of the agricultural way of life, on the one hand, and the expansion of the power-projection capabilities of the earliest states, on the other, (as captured by YSA and distance from Erlitou, respectively), determined the broad pattern of extension of a Chinese mega-state in eastern Asia during the last 2,200 years.

Figures 10(a)-(c) show the marginal effect of YSA on the three stickiness measures based on the specification in Column (1) of Table 2. Consistent with our hypothesis, for cells located close to Erlitou, earlier adoption of agriculture increased stickiness to China. But for cells located farther away, the impact of YSA on stickiness becomes negative. For example, for cells located closer to Erlitou by one standard deviation (compared to the average location), a one standard deviation increase in YSA increases stickiness by about 0.16 standard deviations. The opposite outcome occurs for cells located farther away from Erlitou. Similarly, Figures 10(d)-(f) show the marginal effect of the distance from Erlitou. As expected, given the prevailing technological (transport) constraints, the marginal effect of distance is invariably negative. However, consistent with our hypothesis, the earlier adoption of agriculture deepens the negative effect of distance even further. In context, the positive impact of early adoption of agriculture on stickiness turns negative at precisely the distances that other eastern Asian states - Korea, Vietnam, Myanmar, Japan, Cambodia, Laos, and Thailand - emerged. This result helps to elucidate the emergence of agrarian societies outside China's core, which started their own state-building projects well after the birth and initial expansion of states around Erlitou and persisted into modern times as neighbors rather than provinces of China.

To further confirm this result, we examine the evolution of stickiness to China between 221 BCE-1,900 CE, estimating the following equation

$$Y_{it} = \gamma_t + \gamma_i + \beta^1 YSA_i \cdot t + \beta^2 Distance\ Erlitou_i \cdot t + \beta^3 YSA_i \cdot Distance\ Erlitou_i \cdot t + \varepsilon_{it}. \tag{8}$$

Figure 11 presents the coefficients of the interaction terms $\beta^3 \cdot t$. The results are consistent with the significantly negative effect of the interaction term in the cross-sectional analysis. Moreover, the finding of this joint effect becoming increasingly negative over time, suggesting the cumulative effect of these forces.

[57] Refer to footnote 51 for details.

[58] Tables C.4 and C.5 show that our results are robust to using other stickiness measurements (Territorial and Cadastral China).

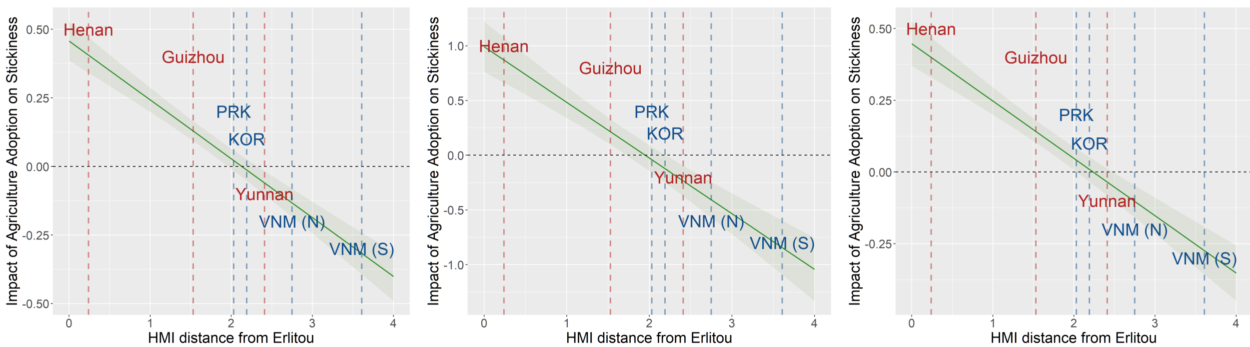
Table 2: Heterogeneous Effects of Distance and Agriculture on *Stickiness* to China

	Stickiness to China (Hybrid)				
	(1)	(2)	(3)	(4)	(5)
Distance from Erlitou × Agricultural Adoption	-0.16***				
	(0.02)				
Distance from Proto-states Centroid × Agricultural Adoption		-0.17***			
		(0.02)			
Distance from Domestication Centroid × Agricultural Adoption			-0.17***		
			(0.02)		
Distance from Erlitou × Millet Hotspot				-0.37***	
				(0.05)	
Distance from Erlitou × Rice Hotspot				-1.00***	
				(0.05)	
Distance from Erlitou × Millet CSI					-0.20***
					(0.01)
Distance from Erlitou × Rice CSI					-0.32***
					(0.02)
Agriculture and Distance Main-Effects	Yes	Yes	Yes	Yes	Yes
Plate Fixed-Effects	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes
Advanced Controls	Yes	Yes	Yes	Yes	Yes
Pseudo-R^2	0.81	0.81	0.81	0.83	0.84
Observations	2037	2037	2037	2037	2037

Notes: The dependent variable is the inverse sine transformation of stickiness to China. All variables except hotspot indicators are standardized to have mean 0 and standard deviation 1. Main controls include longitude, latitude, land size, elevation, temperature, precipitation, ruggedness, and distance to coast. Advanced controls include isolation (from the rest of the land mass), HMI distance to major rivers in eastern Asia, whether located in millet/rice hotspots, and caloric suitability for millet/rice. Spatially autocorrelated disturbances considered within 500kms. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level, all for two-sided hypothesis tests.

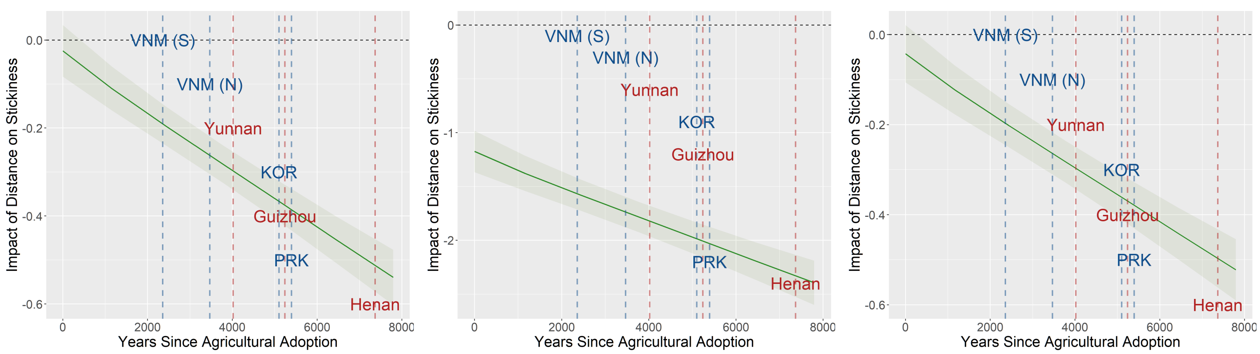
While these results support our hypothesis consistently, a concern is that the distance from Erlitou is probably endogenous, as discussed in Section 3.3.1. To further alleviate this concern, we replace the distance from Erlitou with more exogenous proxies for the location of emergence of the first state; namely, the distance from the centroid of early chiefdoms and of the earliest millet and rice domestication centers, respectively. Columns (2) and (3) in Table 2 present the results of these analyses and find similar significant and negative effects. Another concern is that the results may be confounded by unobserved factors that affect the incentive to adopt agriculture; examples include the cultural similarity between civilizations, seasonality, and climate shocks (Ashraf and Galor, 2013; Matranga, 2021). To alleviate this concern, we replace YSA by the more exogenous millet and rice hotspots and caloric suitability measures, and interact the distance from Erlitou with these alternative measures. Column (4) of Table 2 reports the result of interacting distance from Erlitou with a dummy indicator of whether a cell was in a millet or rice hotspot, and find similarly significant and negative effects on stickiness. In addition, we find the same negative significant result in column (5), in which we interact

Years since the Adoption of Agriculture



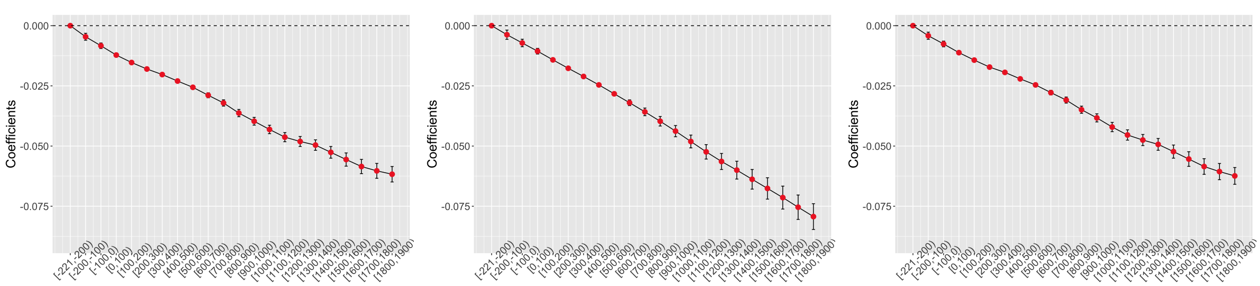
(a) Territorial (b) Cadastral (c) Hybrid

Distance from Erlitou



(d) Territorial (e) Cadastral (f) Hybrid

Figure 10: Heterogeneous Effects of YSA and Distance on Stickiness



(a) Territorial (b) Cadastral (c) Hybrid

Figure 11: Heterogeneous Effects of YSA and Distance on Stickiness (100 Years)

distance from Erlitou with the caloric suitability for millet and rice, respectively.[59] On the whole, these results provide strong support for our hypothesis regarding the "race" between the early starter and neighboring autochthonous states. In particular, they confirm the beneficial effect conferred by the earliness of adopting agriculture on autochthonous non-Sinitic states formation in places requiring

[59]Figures B.22(a)-(c) show the marginal effect of hotspots on stickiness, and Figures B.22(d)-(f) show the marginal effect of HMI distance from Erlitou on stickiness.

more than 2.2 weeks of HMI distance from the earliest political center in eastern Asia.

5.2 Historical Narratives

Below, we illustrate our main results by discussing two cases in which the expansion of the Chinese state encountered other autochthonous state-building projects: the Korean peninsula and Vietnam. Although both regions experienced periods of Chinese rule, these were intermittent and short-lived. These nascent states allowed their people to attain and keep distinct ethnolinguistic identities, coalesce around their independent state-building projects, and ultimately repel Chinese expansion.

In the Korean peninsula, the first state (Old Choson) was established around the 4th century BCE, and there is evidence of complex societies stretching back a few centuries earlier. The region was first conquered by Sinitic states three hundred years later. The peninsula, especially the northern part, experienced China's rule five times.[60] However, Korea did not become a part of China in the long run partly because some northerly portions were among the first places beyond what is currently China to adopt millet-based agriculture around 3,500 BCE. The relatively early adoption of agriculture gave them a head start, which resulted in local states co-existing with external rule in most periods. Indigenous languages and cultures were sustained, and the growing population and agricultural surplus favored local state-building projects. External events that weakened the Chinese empire created the opportunity for these local states to exercise more control and gain independence. For example, as the Western Jin confronted the instability that would cause its northern territories to break up into multiple kingdoms, the most notable of the Korean polities, the Koguryŏ (37 BCE-668 CE), conquered the Jin commanderies in 313 CE, leading to the waning of Chinese presence in Korea, and its full disappearance by the middle of the fourth century CE. There were other attempts to annex Korea during the Tang dynasty(618-907 CE) but they could only impose indirect control, setting up a protectorate general. But in fact the two indigenous states of Balhae (698-926 CE) in the north and Silla (57 BCE-935 CE) in the south had long controlled most of today's Korea.[61] From the late 1300s, a single Korean-based state was usually able to govern the whole peninsula, successfully fighting off a Japanese invasion in the late 1500s and two Manchu invasions in the early 1600s. Today, the Korean peninsula is one of the most ethnically homogeneous regions of the world, with its overwhelming majority speaking a language classified as "language isolate" rather than a member of the Sino-Tibetan language family (Lewis et al., 2009).

A similar pattern occurred to the south of China's core, where indigenous state formation had been going on long before its seizure by Sinitic states. The earliest verifiable united kingdom (Lạc) appeared between 1,000-500 BCE in the Red River Delta. This region contains some of the Asian mainland's most fertile agricultural land south of the North China Plain and adopted agriculture as early as 2,000 BCE. The Qin dynasty pushed southwards and at least nominally conquered the territories that became China's southernmost provinces. However, the state of Nam-Việt (Nanyue) which included much of present-day Guangxi and Guangdong provinces plus northern Vietnam, maintained independence from

[60] Specifically in the Han, the Wei, the Western Jin, the Tang, and the Yuan dynasty.

[61] Balhae was followed by the semi-sinicized and "Manchuria"-centered Liao dynasty, which controlled the northern edge of China proper and that of the Korean peninsula. Liao rule was followed by overlordship by the Mongols during their rule in China as the Yuan dynasty.

China between 207 and 111 BCE. A good part of northern Vietnam was under China's control until the 10^{th} Century.[62] But rapid cultural assimilation was not to occur in what became Vietnam. Forces based in northern Vietnam initiated several uprisings against the rule of the Han and later Sinitic states, including the Trưng Sisters rebellion from 40-43 CE, the brief establishment of the independent Early Ly Dynasty from 544-602 CE, and several failed insurrections in the 7^{th} through 9^{th} centuries. Finally, in 938 CE, northern Vietnam established lasting local rule during the period of civil war in the Chinese empire following the Tang dynasty. While China briefly regained control of northern Vietnam for a twenty-year period during the Ming Dynasty, unification of Vietnam by rulers who appealed to its non-Chinese ethnic identity to resist incursions from the north made those decades the sole exception to local-based governance until colonization by France in the late 19^{th} century. The Vietnamese language spoken throughout the resulting country is classified as being of the Austroasiatic family. What became the southern Chinese provinces were drawn steadily into China from the Han Dynasty onwards, though they remained linguistically diverse, with local dialects becoming recognizably Chinese in structure but remaining less easily intelligible to speakers of other Chinese dialects than were the dialects of China's north. Only Beijing-controlled mass education and mass media of the most recent decades have begun to alter this.[63]

6 Conclusion

The reasons behind a large, unified China and a fragmented Europe has long been a subject of an intense debate. In this paper we address the specific question of why China emerged and persisted in eastern Asia as a large core state, and why some polities, which once existed independently in history, ended up as a part of this enormous empire while others became separate modern states. To do so, we propose and empirically test a theory of endogenous formation and persistence of large states. We hypothesize that the relative timing of the emergence of agricultural societies and their distance from each other set off a race between the earliest state, which would become China, and neighboring autochthonous state-building projects in eastern Asia. In a sense, diffusion of the agricultural way of life, and the process by which that way of life tends to eventually beget states, were in a figurative race, as the state arising within the initial agrarian heartland expanded millennia after agrarian life had reached far-flung peripheries. By using a newly constructed dataset of the Sinitic state's historical presence, prehistoric development, diffusion of agriculture, and migratory distance across $1° \times 1°$ degree grid cells in eastern Asia, we confirm the hypothesis that only early adopters of agriculture located far enough away from Erlitou – the earliest proto-state in central China – could complete their own state-building projects and ended up as independent states. Distance played a uniquely important role in this long-drawn process presumably because there was sufficient time for these remotely located societies to build and reinforce ethnic and linguistic identities, while those located nearby were conveniently

[62] During the Western Han dynasty, China also absorbed southern Vietnam.

[63] In the early 1950s, less than half of the Chinese population, 41 percent, could understand standard Mandarin (Putonghua) (regardless of whether they could speak or not); this number rose to 90 percent after three decades. By 1984, still only half of the population could communicate (both understand and speak) in Mandarin (Putonghua); this number rose to 81 percent in 2020 (Chen, 1999; Ministry of Education of the People's Republic of China, 2004, 2020).

annexed by the historical Sinitic states and became a part of China.

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