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

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Abstract

We propose and empirically test a theory for the endogenous formation and persistence of large states, using China as an example. We suggest that the relative timing of the emergence of agricultural societies and their distance to each other set off a race between autochthonous state-building projects and the expansion of neighboring (proto-)states. Using a novel dataset on the Chinese state's historical presence, the timing of agricultural adoption, social complexity, climate, and geography across 1×1 degree grid cells in East Asia, we provide empirical support for this hypothesis. Specifically, we find that on average, cells that adopted agriculture earlier or were close to the earliest archaic state in East Asia (Erlitou) remained longer under Sinitic control. In contrast, earlier adoption of agriculture decreased the persistent control of the Chinese state in cells farther than 2.8 weeks of travel from Erlitou.

Keywords: Comparative Development, State-Building, Emergence of States, Agricultural Adoption, Isolation, Neolithic Revolution, Social Complexity, East Asia, China, Erlitou

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 played a fundamental role in the course of human history. Among other functions they typically serve, states have been the main societal actors affecting social relations, development, and conflict (Boix, 2015; Claessen, 1978; Fukuyama, 2011). Understanding the emergence, evolution, and persistence of states is thus key to the understanding of human organization. The Chinese state is of particular interest as it is the only example with an uninterrupted existence of more than 2,000 years, unifying a region almost the size of Europe but under one government. No states in Europe have been able to survive as long a time as China while controlling a territory the size of its entire continent. To varying degrees of success, the extended presence of the Chinese state has homogenized ethnicities, language, and culture in the regions under its control. In marked contrast, during the same millennia, the lands that had 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 this contemporary population holding religious beliefs also imported from outside of their immediate region, and with little continuous thread of culture, language, or religion connecting them to the world of the third millennium BCE.

We propose and empirically test a theory for the endogenous formation and persistence of states, using China as an example. We suggest that the relative timing of the emergence of agricultural societies and their distance to each other set off a race between autochthonous state-building projects and the expansion of neighboring (proto-)states. Specifically, following a long tradition, we hypothesize that the early adoption of agriculture set in motion development processes conducive to the emergence of complex hierarchical societies (Boix, 2015; Diamond, 1997; Fukuyama, 2011). In particular, the domestication of crops, especially grains like millet and rice, provided the fertile ground for the increase in population that could allow proto-states to emerge, primarily in clusters of highly suitable land.[1] As these complex societies evolved, they competed with each other as they expanded to nearby locations. These evolutionary forces agglomerated clusters of proto-states into larger isolated states. In turn, as these larger states expanded, they encountered resistance from other autochthonous state-building processes. Our theory implies that in East Asia, complex societies and proto-states should emerge in clusters of land highly productive for millet and (to a lesser extent) rice cultivation. Moreover, it suggests that Sinitic states should rise out of the earlier proto-states, which existed in the heart of current China. Finally, our main prediction is that two forces determined the ability of the Chinese state to expand and persistently control a region: its distance to China's core and its level of autochthonous state-building as determined by its timing of agricultural adoption. In particular, we expect these two forces to interact and generate heterogeneous effects on the stickiness to China.

To test these predictions, we constructed a novel dataset documenting the historical presence of the Chinese state, timing of agricultural adoption, social complexity, climate, and geography across $1^\circ \times 1^\circ$ grid cells in East Asia. In particular, we compiled the location of borders and cities in China between

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[1] Our approach does not try to resuscitate the view that agricultural productivity is sufficient for the emergence of states, a view that has been amply criticized (Boix, 2015; Carneiro, 1970; Fukuyama, 2011). Yet, we view agriculture as providing the fertile ground for the emergence of hierarchical complexity and population density.

221 BCE and 1911 CE and constructed measures of stickiness to China across these cells, reflecting the length and intensity of their incorporation into Sinitic states. Additionally, using archaeological and geographical data, we measured the number of years since the adoption of agriculture (YSA) in each cell. Furthermore, we compiled data on the location of early proto-states within the extent of contemporary China, including the precursor of the Qin dynasty – Erlitou.

We empirically analyze the predictions of our theory in three steps. First, we show that contemporary China's core has historical roots in regions that initially developed and diverged from the rest of East Asia as early as 7000BCE. Specifically, social complexity developed after the domestication of millet and rice, spatially concentrating in clusters of land highly suitable for the cultivation of these two crops. Second, we show that millet and rice hot-spots are able to predict the adoption of agriculture as well as the location of Erlitou – the earliest archaic state developed in northern China. These analyses suggest that agricultural potential and the timing of the adoption of agriculture played a central role in the emergence of autochthonous state-building efforts.

Finally, we show that the level of stickiness to China is predicted by the race between autochthonous state-building and the Chinese state's expansion. In particular, we establish that a cell's distance to Erlitou and its timing of agricultural adoption determined its level of stickiness to China. We find that a one standard deviation increase in the distance to Erlitou (6 days of travel) decreases the probability of being part of the Chinese state by 23 percentage points, whereas a one standard deviation increase in years since agricultural adoption (2,600 years earlier) increases the probability by 4 percentage points. Millet and rice hot-spots increase the respective probability by 10 and 12 percentage points, whereas isolated cells have a 52 percentage points greater probability of being part of the Chinese state. Additionally, and in line with our theory, we find heterogeneous effects of these two forces, which sheds light on why among equally distant regions in East Asia, the more agriculturally suitable areas are not part of China, while less suitable ones are. The interactions between both forces reflect the beneficial effects of agriculture on autochthonous non-Sinitic state-formation, which reduces the probability of China controlling the territory located far from its core even further. Specifically, our analysis finds a significant negative effect of the interaction between distance to Erlitou and YSA, implying that the initial positive effect of YSA on stickiness becomes negative for cells farther than 2.8 weeks of distance from Erlitou. Similarly, the initial negative effect of distance to Erlitou on stickiness is positive and significant when agriculture was adopted after 1000 BCE.

Having examined the race between agriculture and state-formation, we also examine the persistent effect of stickiness on contemporary China and East Asia. We show that increasing historical stickiness in a cell by 1 percent increases the probability of belonging to contemporary China by around 5 percentage points. Moreover, higher historical stickiness in a cell is associated with smaller linguistic distance to Mandarin of the languages spoken by its inhabitants.

Our paper contributes to a number of literature. First, it relates to the literature on the deep roots of comparative development that views the potential persistence of cultural and institutional phenomena with roots in environmental factors (geography, terrain, soil, climate) as key to understanding how economic development varies across space and time (e.g., Acemoglu et al., 2005; Ashraf and Galor, 2013; Ashraf et al., 2010; Michalopoulos, 2012; Nunn, 2012; Özak, 2018; Spolaore and Wacziarg, 2013).

Second, our work is also relevant to the literature on state formation (Boix, 2015; C., 1992; Carneiro, 1970; Diamond, 1997; Gennaioli and Voth, 2015; Olson, 1993; Scott, 2017; Wittfogel, 1957), as we seek to understand how large states emerged and expanded. Our theory is closely related to circumscription theory, as it also views concentrations of agriculturally productive land and conflict as drivers of state formation, yet we extend it to consider the competition between states to understand their evolution and persistence. Moreover, while we drew inspiration from Borcan et al. (2018) who treated the state as an exogenous institution, our emphasis on the race between years since agricultural adoption and distance to Erlitou sheds light on the evolution of states and state history as an endogenous process. It is in this spirit that our work complements that of Alesina and Spolaore (2005), who emphasize the endogeneity of nation size and border.

Third, our work also contributes to the fast-growing literature on the origins and persistence of China, including those comparing it to the political fragmentation of western Eurasia during most of its history. For instance, Ko et al. (2018) emphasize the different extents of external military threats in western Eurasia versus China. Likewise, Chen and Ma (2020) similarly emphasize the importance of conflict to account for China's unification and fragmentation over longue durée history. Like Bai and Kung (2011), both papers emphasized the important role of Sino-nomadic conflict in shaping Chinese history (Barfield, 1992, 2001; Graff and Higham, 2012; Lattimore, 1940; Turchin, 2009). More closely related to our paper, Fernández-Villaverde et al. (2020) use simulations based on macro-level differences in geography between western versus eastern Eurasian to test the "fractured-land" hypothesis; which posits the pivotal role played by topography in accounting for a unified China and a fractured Europe.

The remainder of our paper is organized as follows. In Section 2, we provide both a historical background and a conceptual framework for making sense of the emergence and persistence of a mega-state in East Asia for more than two millennia. In Section 3, we introduce our data sources and explain the construction of variables to be used in the empirical analysis. The empirical analysis of the hypothesized relationship regarding the race between the timing of agricultural adoption and other agricultural characteristics and distance to Erlitou is the subject of Section 4. In Section 5 we provide evidence to show that long before 221 BCE Erlitou was already exhibiting signs that it would become the first proto-state. Section 6 concludes.

2 Historical Background

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 contributing factors to the increasing technological and social complexity of society since our species' emergence in Africa and its subsequent spread to all world regions. We focus on three factors, which we consider fundamental sources of variation in the levels of development of societies throughout history. These are (1) the fact that different groups of domesticates emerged independently in different regions of the world and at different times over the past eleven or twelve millennia, (2) the geographic obstacles to the rapid diffusion of knowledge among those regions given the prevailing modes of travel and communication in pre-modern times, and (3) the tendencies towards endogenous

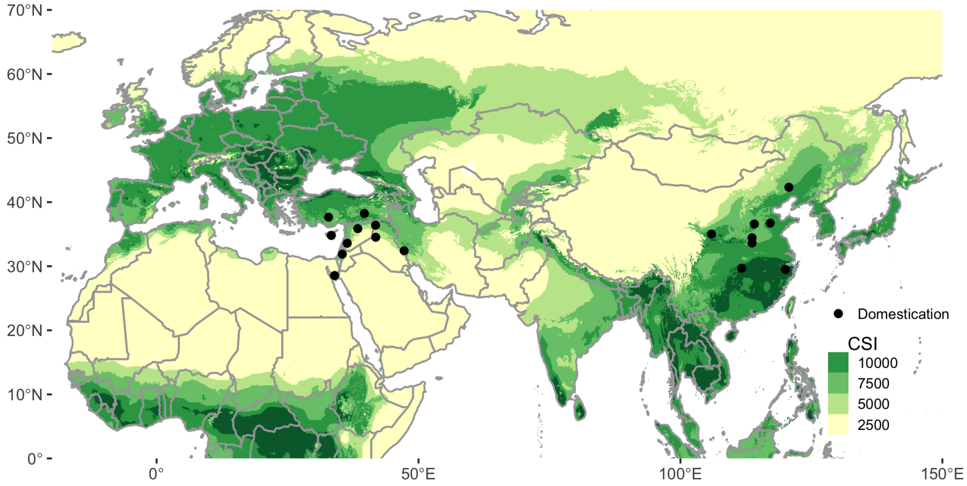

Figure 1: Pre-1500 Calories and Agriculture Origins

emergence of social stratification and of increasingly large-scale polities, when a sufficiently productive set of domesticates was present.

An important initial condition in our story is that major instances of domestication of cereal crops crucial to Eurasian history occurred separately in portions of eastern and western Asia separated by a large expanse of difficult-to-traverse and agriculturally inhospitable terrain. In eastern Eurasia, the middle and lower portions of the Yangtze and Yellow river systems, including their numerous tributaries and the Huai river between the two, saw the domestication of broomcorn and foxtail millet (Panicum miliaceum and Setaria italica) and wetland rice (Oryza sativa Japonica).[2] In Asia's west, separated by thousands of miles from those Pacific-draining river systems, 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.[3] This pattern is clearly visible in Figure 1, which depicts the suitability of land for agriculture measured in terms of its caloric potential. The two fertile regions in the west and east were separated by a large area with very low caloric potential. Additionally, Figure 1, which depicts the locations where agriculture originated in Eurasia, revealing that the origin of agriculture in the Far East is located close to the most fertile lands, whereas in Europe the origins are more distant.

One testament to the extent of their isolation is that the main crops of East Asia and the corresponding crops of West Asia had not substantially diffused between these regions during the first few thousand years of cultivation, periods that saw the gradual build-up of settled populations and

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[2] 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.

[3] 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 3000 BCE, so they could have influenced somewhat the dynamics of large state-building, 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.

the emergence of complex societies occurring in each region independently.[4] One example (and consequence) of the separation of eastern from western agrarian societies that lasts to this day is the highest prevalence of lactose intolerance in East Asia populations (Sahi, 1994).

Every known early civilization that subsequently gave rise to large empires, cities, and a highly specialized occupational division of labor (as in soldiers, tax collectors, administrators, and artisans, etc.), was preceded by a gradual build-up of a settled population, the growth of which relied on a suite of domesticated crops and animals and gradually improved agricultural techniques (Diamond, 1997).[5] But it was only after a protracted period that the archaeological record of each region begins to show appreciable changes in population density, social stratification, and the emergence of population centers marked by walled fortifications, elaborate elite burials, and sites of religious rituals.[6] While agricultural intensification and emergence of proto-states were occurring in regions near the earliest domestication sites, cultivation was spreading and crops were being adapted to climates and soils further afield, with similar social changes often following.

A central idea guiding our analysis is that the diffusion of agricultural systems and the development of states and empires in eastern Asia generated a race between the processes of crop diffusion, on the one hand, and state expansion, on the other. Specifically, agrarian systems provided the underpinnings for the emergence of state-level societies, diffusing over time to climatically suitable areas nearby. Similarly, the development of states spread and reinforced ethnolinguistic identities in their periphery. These dynamics suggest that whenever the spread of agriculture from the original core area of China sufficiently preceded the development of large states there, it allowed these agrarian societies to travel down the path of state-formation before coming in contact with expanding Chinese polities, thereby providing them with the means to resist long-term incorporation into China. For instance, while both northern Korea and northern Vietnam experienced intermittent and short-lived periods of Chinese rule,

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[4] 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 more a delicacy for elites than a staple in China as late as the 7th century CE, though it was to displace 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 not only in what is now China but also in Korea, Japan, and Vietnam by the time that elements of the west Asian agricultural package had reached this zone. South Asia had its own domesticates but grew more populous after the arrival of the domesticates of both west and east Asia (e.g. Indica rice is now known to have genetic contributions from both Chinese (Japonica) rice and a less nutritious Indian domesticate (Fuller, 2011; Fuller et al., 2016). Tibet and southeast Asia experienced agriculture-based population expansions based also on some local plant and animal foods, but mainly on crops diffused from both east and west Asia (Crawford, 2006).

[5] The Mesopotamian civilizations of Sumer, Akkad, Babylon and Assyria, the Mesoamerican civilizations of the Olmec, Maya, Toltec, and Aztec, and the first east 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, and which in the Indus case was supplemented by local domesticates (Allen, 1997; Murphy and Fuller, 2017). The independent domestications of maize in Mesoamerica, oats, barley, and wheat in Mesopotamia, and millet and rice in China were gradual processes. Yang (2020) provides evidence that population growth at sites along the Yellow River and tributaries during the fourth millennium BCE was spurred by the better exploitation of complementarities between pig rearing and millet production, including the feeding of millet stalks and other vegetation not eaten as grain to pigs and the application of pig manure as fertilizer to raise millet yields.

[6] Typically, it took thousands of years from the early experimentation with wild precursor plants to the gradual modification 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).

the latter failed to prevent the people of distinct ethnolinguistic identities from forming autochthonous state-building projects.

Thus, the different timing in the adoption of the agricultural lifestyle created a gradient of social complexity across which states emerged. In fact, East Asian agrarian systems had spread, intensified, and improved for four to six thousand years, before the first proto-state emerged, followed by local states, and finally empires in what later became China. In the meantime, the East Asian agricultural package had spread from their initial zones of domestication into surrounding and distant areas, laying the foundations for populous agrarian societies in those regions where linguistic and cultural identities deviated from China's heartland on various levels.

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 on a fixed core area. This area is slightly smaller than the so-called China proper which comprised the eighteen provinces of the Qing dynasty but nonetheless was densely populated by the Han Chinese and directly controlled by the central government Harding (1993). But we seek to be more specific about the definition of this core area, by constructing a conceptual measure called "stickiness to China" based on the data on boundary shifts for over 2,000 years; specifically, only areas with a stickiness level higher than 85 quantiles would be regarded as China's core. Figure 2 provides a visual comparison of our construction of China's core and the original China proper as conventionally defined – an area that began to assume a leading position in East Asia in terms of social complexity from around 7,000 BCE. Moreover, after China was unified for the first time in 221 BCE, this core area remained under unified rule for 75 percent of the time during the subsequent 23 centuries.[7]

The political center of this core area is Erlitou, which was the largest urban settlement of the earliest archaic state developed in northern China (Liu and Xu, 2007).[8] What deserves emphasis is that 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. Indeed, Erlitou played a fundamental role in the eventual unification of China's core areas by the rulers of the Qin state. Not only was Erlitou the capital of this early archaic state, it also was located close to the centroid of the proto-states that emerged between 3,500-1,700 BCE periods (Figure A2). Moreover, it remained close to the centroid of the Chinese state-building project over the next three millennia. The administrative centers of most dynasties remained basically at the same latitude (34° north) and usually within a few degrees west or east of Erlitou.[9]

Chinese state-building was centered far from the East China Sea until late in its history, retaining a north and west-facing defensive focus, ignoring the lands across the sea. This state of affairs remained even during the Yuan dynasty, which built its capital at what became Beijing, a mere 150 km from the Bohai Sea inlet of the western Pacific. Indeed, China never attempted to rule the Japanese

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[7] For another 12 percent of those years, this area was divided into two states – (usually typically one northern and one southern), making it the core of what the world of recent centuries has called China. Figure A1 provides a detailed description of the centralized periods.

[8] Some scholars consider Erlitou to be the capital of the mythic Xia Dynasty, China's first, although there remains controversy around this (Xu, 2018).

[9] Only with the shift of the capital to Beijing beginning in the late 1200s CE did the capital move on a long-term basis towards a more northeasterly direction, but that still left the center just 5° north and 4° east of Erlitou.

islands, nor did it incorporate the island of Taiwan into its administrative structure until after the Ming Dynasty in the 16th century. Given these historical conditions, our analysis faces two main challenges. The first, is to account for the formation of China's core.[10] The answer needs to address how the empire-building project that began in earnest in millet-growing northern China was able to incorporate and hold the rest of China's core,, while failing to persistently project power into Korea, Vietnam, Myanmar, and other eastern Asian lands in which agrarian societies took root. Second, we need to explain the formation of the frontier, i.e., how did China eventually come to rule over areas peripheral to its original core that were less hospitable to agriculture.[11] We will address the process by which such peripheral areas such as Manchuria and Inner Mongolia came to be under Chinese rule with a similar framework.

Our key challenge is to examine the race between state-building and agricultural diffusion on a location's stickiness to China by analyzing the interaction between these two forces. On the one hand, places relatively close to (far from) Erlitou should have a larger (lower) chance of becoming part of China, conditional on their timing of adoption of agriculture. On the other hand, conditional on their distance to Erlitou, places that adopted agriculture relatively early (late) should have a lower (higher) chance of absorption into China. What the above predictions imply is that earlier agricultural adoption and greater distance from Erlitou combined should yield a coefficient that is negative and significant.

3 Data

3.1 Geographic Coverage

We focus on the portion of Asia in which the Chinese state had the potential to project power or incorporate.[12] Thus, we select the area located between 70° to 150° east and 0° to 60° north. It ranges far enough to the west to the area unsuitable for agriculture that separates the western and eastern agricultural centers, comprising more than 40 percent of Eurasia's longitude or 48 percent of Asia's. Thus, it excludes the most proximate advanced areas of western Eurasia, including Persia, Mesopotamia, Anatolia, and Greece. This choice highlights the isolation of East Asia from the continent's other early developed zones, a factor we will emphasize when analyzing China's relative unity and persistence. We split this geographical area in which the Chinese state could potentially emerge and expand into cells $1^\circ \times 1^\circ$, which we use as our unit of analysis for the exploration of our hypothesis (see Figure 2).

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[10] This includes the entire rice-growing Yangtze River valley from Chengdu (in the west) to Jiangsu (in the east), as well as to conquer territories further south, between the Yangtze and present-day Southeast Asia.

[11] These areas include the current provinces and autonomous regions of Qinghai and Xinjiang, as well as China's three northeast provinces collectively known as Manchuria, which, until recent centuries were not considered part of the heart of agrarian China but viewed as part of the vast, more modestly populated Eurasian steppe reaching westward to Hungary.

[12] In particular, since East Asia had few contacts with Sub-Saharan Africa and Oceania, while contact with the Americas was non-existent between the beginnings of settled agriculture and the late 15th century CE, inclusion of these regions in the analysis would not make sense. The area of potential interest for understanding China's emergence lies mostly in the eastern half of Asia, with occasional direct and indirect contacts spanning the entire Eurasian landmass and North Africa.

3.2 Stickiness to China

To construct a variable of stickiness to China, we measure, for each 1°×1° cell, the number of years since it has been a part of the Sinicized states. For robustness, we construct two alternative measures. Our first measure is territorial China, which is based on the historically documented political boundaries of the territories ruled by various Chinese dynasties at different points in time. Territorial China codes whether a cell fell within the area over which the Chinese state exercised military control and had the apparent power to repel invaders according to historically documented sources. Since this measure may not reflect the presence of the Chinese state, we construct a second measure – cadastral China – using the presence of county seats, which indicates a more direct form of rule and taxation. Cadastral China codes whether a cell contained any county seats, in which they also included the residence of a substantial ethnic Han population and officials. We find that territorial China is about three times the size of cadastral China. Temporally, our data covers the period 221 BCE to 1911 CE (2132 years) and measures the number of years a cell was part of territorial/cadastral China. In doing so it also documents the territorial changes across dynasties for a period of more than twenty-one centuries.

3.2.1 Territorial China

To construct this measure, we digitized the original maps collected by Tan (1982).[13] To shorten the time interval between maps, we supplement it with additional sources.[14] In total, we digitized a sequence of ninety-nine maps for historical China, with borders assumed to remain fixed for an average duration of approximately 22 years. Figure A3 shows the number of maps we have generated for every one hundred years.

Since boundary shifts alone may not fully reflect the cultural and institutional changes that occurred under the presence of the Chinese state, we weigh this number by the levels of Sinicization of dynasties, as well as by the strength and type of rule of each dynasty over their territory in a given moment of time. We construct for each cell c a measure of the number of years it was under dynasty d's control (T_{cd}), the strength of the dynastic rule in the cell (R_{cd}), and for each dynasty d its Sinicization Index (SI_d). SI_d thus captures how culturally and institutionally Chinese a dynasty was (Figure A4). The detailed coding procedure is available in Appendix D. We define R_{cd} by characterizing the territories of most dynasties in two parts: the directly ruled core (R_{cd}=1) and the surrounding areas with varying degrees of autonomy (R_{cd}=0.5).[15] Doing so allows us to create for each cell c a weighted number of years it was under each dynasty d, namely its stickiness to China under dynasty d as

$$\bar{T}_{cd} = T_{cd} \cdot R_{cd} \cdot SI_d \tag{1}$$

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[13] Tan's maps are also the primary source for the China Historical Geographic Information System (CHGIS). However, CHGIS only has boundary information for late Qing (in 1820 and 1911), which required us to digitize Tan's map for all other dynasties.

[14] They include General History of Chinese Administrative Divisions Zhou (2017), and General History of Boundary Shifts of China (Gu and Shi, 1993).

[15] 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 across dynasties. For example, Xinjiang was the "Xiyu Protectorate" in the Western Han dynasty and was a "Dependencies" in the Qing dynasty before 1844.

and also its (total) stickiness to China as the average of these across dynasties, i.e.,

$$\bar{T}_c = \sum_d \bar{T}_{cd} = \sum_d \bar{T}_{cd} \cdot R_{cd} \cdot SI_d \tag{2}$$

3.2.2 Cadastral China

As our second measure of stickiness, cadastral China refers to places with dense Chinese populations, to the extent of supporting the establishment of a county seat for governance. More specifically, we base this measure on the actual historical presence of the Chinese state. This definition allows us to overcome the arbitrariness of deciding on the level of Sinicization of the dynasties, so that we can directly code the number of years the Chinese state was present in a cell c. We construct this measure from various sources. First, we use CHGIS Version 6, which provides a partial time-series of county seats that excludes historical counties located outside of the boundaries of today's PRC.[16] A limitation of this data, however, is that it fails to include a large number of counties established by the non-Han dynasties (e.g., Liao and Jin). Thus, we geocoded the missing historical counties by hand based on Zhou (2017). Figure A5 shows the distribution of the counties available in CHGIS (yellow) and the additional ones we geocoded (green). The graph shows that the majority of counties are located in China's core and the second tier.

Based on the location of these counties, we construct a cell-level measure of cadastral China. Specifically, we assign to each cell c the number of years under dynasty d in which it had at least one county (T_{cd}). Additionally, we weigh this state presence by the strength of rule using the number of counties present in each year as a proxy (e.g. R_{cd} =5 if there are five counties in that cell). Note that by construction SI_d=1, since for each year we take the actual location of the Chinese state as given by the counties.

3.2.3 A hybrid of territorial and cadastral China

With territorial China emphasizing the range that China can project its military and political influence and cadastral China reflecting the actual distribution of Chinese populations and the presence of state bureaucracy, we can interpret the former as representing an upper-bound estimation of China's true territorial expansion and the latter as a lower-bound estimate. For robustness, we combine these two measures to produce a third, intermediate indicator of past inclusion in Chinese polities as an alternative measure of stickiness to China. Specifically, without changing the definition of territorial China, we replace R_{cd} with the presence of county seats (R_{cd}=1 as long as there is a county, R_{cd} =0.5 if no county presence).[17]

Figure A6 depicts the spatial distribution of our aggregate cell-level stickiness to China for more than 2000 years for these various measures, while Table A1 provides the summary statistics of the main variables for our full sample as well as subsamples classified by levels of overall stickiness across

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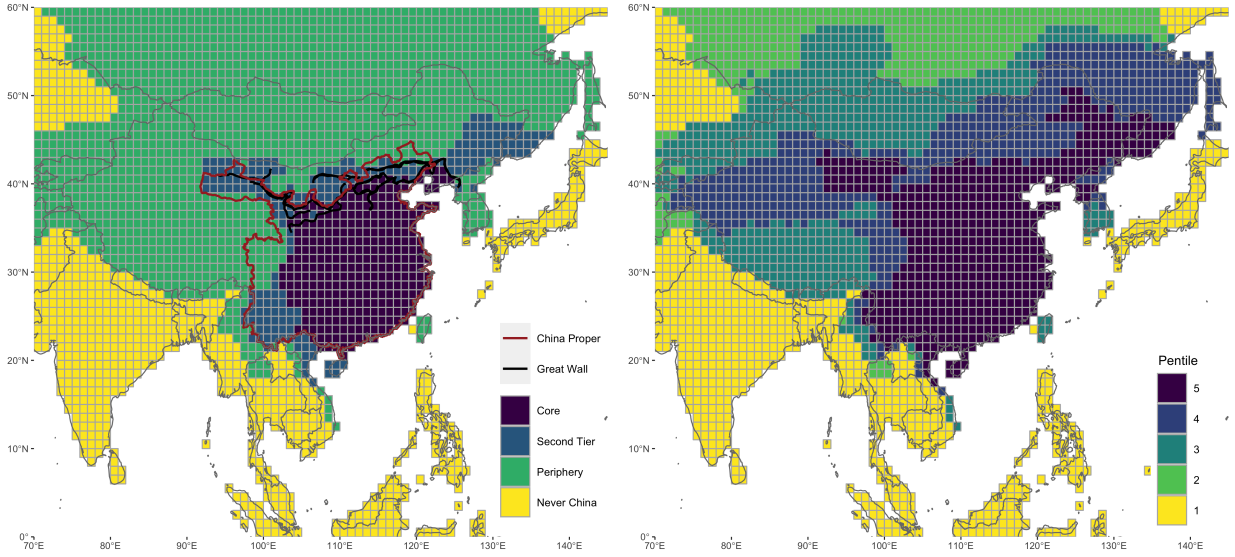
[16] CHGIS, Version: 6. (c) Fairbank Center for Chinese Studies of Harvard University and the Center for Historical Geographical Studies at Fudan University, 2016.

[17] We experimented with three alternative multiplicative weights to rescale for absence of county cells; not only 0.5 but also 0.3 and 0.1 to give less weight still to areas in which dynasties did not set up counties.



(a) Tiers

(b) Pentiles of Distribution

Figure 2: Stickiness to China (Territorial)

two millennia. Over these two millennia, 70 percent of the cells in our sample were conquered by China at least once, and 20 percent had county seats at least once. To simplify things, we classify our sample into four categories based on the distribution of territorial stickiness to China: China's core (above 85th percentile), second-tier (75th-85th percentile), periphery (below 75th percentile), and never China. Figure 2 maps these three tiers and the distribution of our territorial measure for comparison. Our classification implies that the area covered by the core and the second tier is very similar to the area Harding (1993) calls China proper. Also, the cutoff dividing the core and the second tier is similar to the average stickiness of cells crossed by the Great Wall (1,300 years), implying that all the great walls built across dynasties for defensive purposes against the nomads are located within the second tier, reflecting the transition from farmland to pasture in these areas.

3.3 Main Independent variables

Based on our hypothesis, we group our key independent variables into two sets. The first is related to the diffusion of agricultural practices and the second to the potential projection of power and expansion of the first Chinese state. Of especial importance for our hypothesis are measures pertaining to the timing of adoption of agriculture and distance from Erlitou.

3.3.1 Years since agricultural adoption

To estimate the number of years since agricultural adoption (YSA) in a cell, we use the data on the spread of agriculture across Asia, based in turn on currently available archaeobotanical evidence collected from 481 independent archaeological sites. We construct this measure following the methods

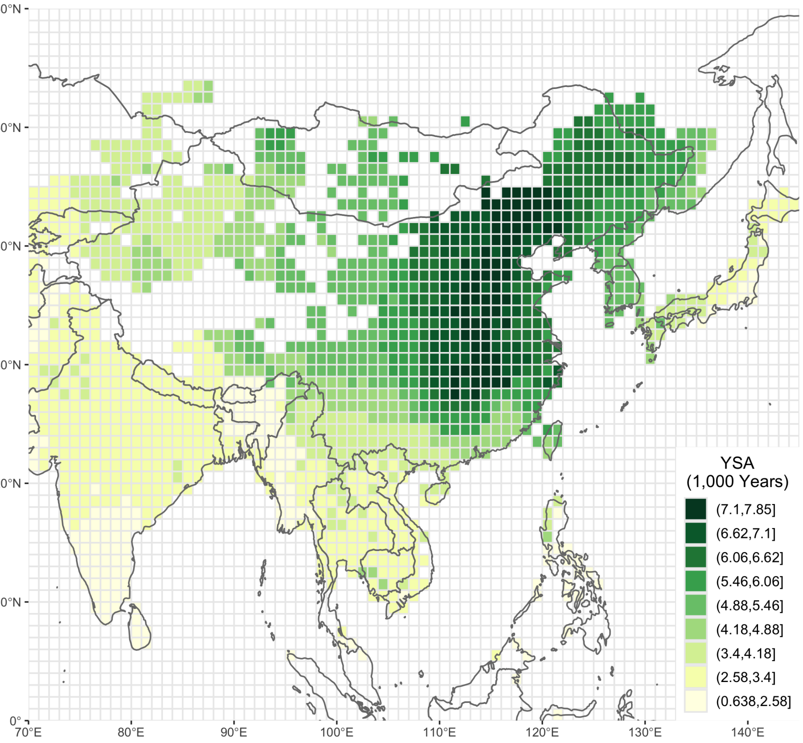


Figure 3: Years Since Agricultural Adoption

of Pinhasi et al. (2005). Specifically, given the archaeological data on the location and the timing of the diffusion of various crops in East Asia (Silva et al., 2015; Stevens and Fuller, 2017), we use the Inverse Weighted Distance (IWD) method to construct measures of the timing of diffusion across our grid cells for each of the three native original grain crops – foxtail millet, broomcorn millet, and rice – and one later-arriving cereal (wheat).[18] Based on the sites and dates given in these sources, we interpolated the timing of agricultural adoption to cells with no records. Specifically, we predict the years since agricultural adoption in a cell c as the weighted average of the YSA of cells located closer than a week of migratory distance from c that contain information, where the weights are a function of the inverse of the distance to cell c. We make this interpolation separately for each crop and set the date of agricultural adoption in a given cell to be the earliest predicted date across crops.[19]

Since agriculture could only be adopted in regions habitable by humans, we restrict our predictions to only areas where the geo-climatic conditions supported human presence and agriculture (Burke et al., 2017; Wren and Burke, 2019; Xu et al., 2020). Specifically, we assume that cells never adopted agriculture if their geo-climatic conditions predict them to have a population density of fewer than 2 people per square kilometer in the year 1 CE. We predict the probability of a cell having this level

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[18] Data on foxtail millet, broomcorn millet, and wheat's diffusion are from Stevens and Fuller (2017); data on the diffusion of rice is taken from the Rice Archaeological Database (Silva et al., 2015).

[19] By definition, IWD 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 A7). 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 the timing of agricultural adoption and a set of geo-climate variables, including the distance to the original locations, using the sample of the interpolated data (see Appendix E).

of population density using latitude, elevation, ruggedness, mean temperature, mean precipitation, extreme temperatures, temperature volatility, precipitation volatility, optimal caloric suitability, and length of the fallow season. We estimate the probability using a logistic regression, which included the levels and squares of each geo-climatic characteristic, as well as an indicator that identified the ventiles of each characteristic in which population density was low.[20] Figure 3 depicts the predicted spatial distribution of the timing of agricultural adoption.

Given the historical importance of millet in Chinese agriculture, it is crucial to uncover concentrations of land suitable for its cultivation to identify the potential initial locations of the Chinese state, as well as its potential for expansion. Further, given the importance of population growth in our analysis, we include measures of caloric suitability for agriculture and the location of hot-spots of areas suitable for the millet and rice. Our agricultural suitability measures capture the caloric output obtainable from each crop under low levels of inputs and agro-climatic conditions in a cell (Galor and Özak, 2015, 2016). Millet and rice hot-spots identify clusters of areas with above-average suitability for cultivating foxtail millet and rice.

3.3.2 Human Mobility Index

The ability of the Chinese state to project military power and control a region, and expand geographically, depended crucially on its relative isolation from competing states. In particular, the distance to the first Chinese state is especially relevant. Thus, we estimate the distance from any cell to Erlitou by using the Human Mobility Index (HMI), which estimates the minimum travel-time accounting for human biological, geographical, and pre-modern technological (before steam power) constraints (Özak, 2010, 2018).[21] By using HMI distances, we capture the potential to move armies, conduct trade, and have communication between regions using prevailing technologies. Figure 4 depicts the locations of the hot-spots of millet and rice, as well as the iso-time curves for the distance to Erlitou. For robustness, we also compute the distance of each cell to the centroid of archaeologically identified walled or trench-bounded sites that existed before 1800 BCE (before Erlitou was considered the center of a state in the fullest sense).[22]

Since the Chinese state may not have been the only state expanding, and a cell may also have started an autochthonous process towards statehood if it had access to agricultural and other technologies, it is important to account for its level of isolation (Ashraf et al., 2010). To this end, we construct for each cell its level of isolation from the rest of Eurasia as its average HMI distance to all other cells on this continental mass. Given the importance of rivers as a form of transportation, we also measure its HMI distance to major rivers. We use the distance to major rivers, and not to the coast because inland waterways were the most important transportation network in pre-modern

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[20] The results are similar for various alternative specifications.

[21] We use the HMI with seafaring, which includes estimated travel times, including sea routes for which historical data are available. The latter are crucial for permitting measurements of distance from Erlitou to points in Japan, Taiwan, and other locations to which a sea route is either necessary or preferable from the standpoint of travel time minimization.

[22] The distinction between proto-state and full state is made on the basis of the presumed number of hierarchical levels between village, hamlet, or neighborhood-level leaders and the top level of political authority as well as estimated area and number of people included, presence of specialized soldiers, and tax collectors. The distinction follows Borcan et al. (2018) and sources discussed there.

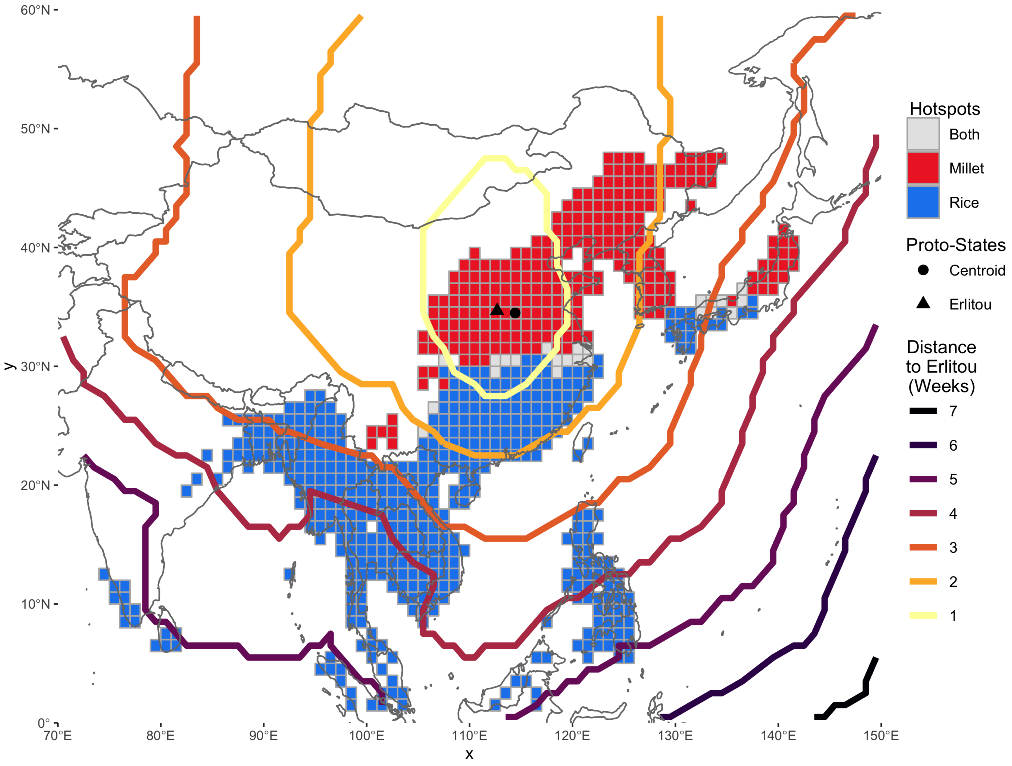

Figure 4: HMI Distance to Erlitou and Crop Hotspots

China (Elvin, 1973).

To account for additional confounding forces, our regressions include a basic set of controls, including absolute latitude, land size, elevation, temperature (monthly average mean), precipitation (monthly average mean), terrain ruggedness, and distance to coast.[23]

3.4 Additional Outcome Variables

3.4.1 Language distance to Mandarin

In addition to the two stickiness measures we additionally use the World Language Mapping System (WLMS) Version 19 (2016) to construct language distance measures to analyze persistent effects of the presence of the Chinese state.[24] WLMS provides detailed information on approximately 7100 living languages across the world (location and coverage). The language polygons in the WLMS allow us to identify languages spoken in each grid cell in recent years. Following Fearon (2003), we use this data to compute the linguistic distance between each language and Mandarin to compute an

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[23] Detailed data sources are provided in Appendix C. We standardize all variables to have a mean of zero and a standard deviation of one in order to simplify the interpretation of the results.

[24] Although it would be interesting to use the average language distance of a cell's inhabitants from the then extant Chinese of the Han core as a predictor of the likelihood of Chinese rule in our regressions to predict incorporation into China in the earlier centuries, it is not possible given the lack of data. So, we use distances of languages spoken today for a number of analyses investigating how duration of direct rule and various geographic factors impact linguistic heterogeneity and linguistic distance from Mandarin Chinese today.

unweighted average linguistic distance over languages spoken in a cell. In particular, the distance between two languages is a decreasing function of the number of common branches in the language tree. Mandarin is a third-level classification of the Sino-Tibetan language family: Sino-Tibetan—Chinese—Mandarin(CMN).[25] Linguistic distances to Mandarin averaged over the cells in our sample range from 0 to 3, with a mean of 2.47. Figure A8 illustrates this measurement.

3.4.2 Chiefdoms and Proto-States before Erlitou

To explore the location of where the first state in China appeared, we digitized the chiefdoms/proto states that had the potential of becoming the center of Chinese state-building. Prior to the formation of states, societies may experience varying degrees of complexity in social organization, with the more complex ones being more likely to evolve into a formal state.[26] Using the location and the time of existence of over 1000 wall- or trench-enclosed settlements dating to 7000-1350 BCE, Xu (2018) provides the most comprehensive data on the location and size of prehistoric chiefdoms or proto-state societies. According to his categorization, tribal societies appeared in China by around 7000 BCE, chiefdoms and paramount chiefdoms during the late Yangshao period (beginning from 3500 BCE), whereas the first state-level society (Erlitou) emerged in 1700 BCE (Xu, 2018). For our purpose we focus on chiefdoms or paramount chiefdoms in the pre-Erlitou years 3500-1700 BCE in what is today's China. Altogether there are sixty settlements enclosed by trenches and sixty-seven settlements enclosed by walls, respectively, during this period. We digitized these data and mapped them to the grid cell level.

4 Agricultural Origins of Chinese State-Building at Erlitou

In this section we test whether complex societies and state-building projects in East Asia emerged after the adoption of agriculture in clusters of land highly productive for millet and rice cultivation. Moreover, we examine whether these early proto-states predict the rise of Sinitic states in the same locations. In this quest, we also address concerns about how Erlitou and not Beijing or other important cities in history became China's political center. In line with our hypothesis, we show that Erlitou's position was not a historical coincidence, but rather it was determined by geography and an evolutionary process that had already begun around 7000 BCE, when China's core began to exhibit signs of taking a leading position.

To conduct this analysis, we employ the data on societal complexity between 10,000 BCE and 1 CE from *The Atlas of Cultural Evolution (ACE)*, which maps out the borders of major cultural

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[25] We assign a distance of 3 to a language outside of the Sino-Tibetan family, 2 to a language outside of the Chinese group but within the Sino-Tibetan group (such as Tibetan, Burmese, or the Bai language spoken by an ethnic minority in China's Yunnan province), 1 to a language that is not Mandarin but falls within the Chinese language group (such as Min, Gan or Hakka), and zero to Mandarin itself.

[26] According to Diamond (1997), Johnson and Earle (2000), and others, societies can be categorized into the following types by their increasing level of complexity: band, tribe, chiefdom, paramount chiefdom or proto-state, and state. Band and tribe are relatively if not fully egalitarian societies, while chiefdoms, paramount chiefdoms, and states have established progressively higher degrees of hierarchical structure. The standard classification used by these authors is based on five aspects: size and composition, governance type, religion serves as a tool of state resource extraction, economy characteristics (having tribute/tax), and degree of social stratification.

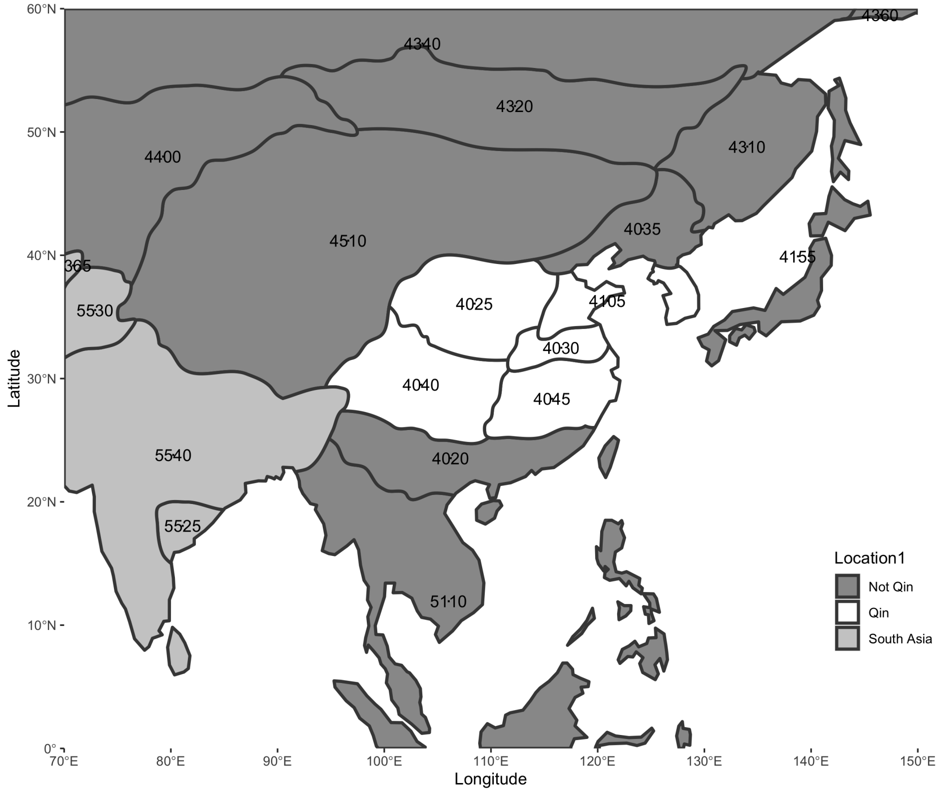

Figure 5: Cultural Regions in ACE (3,000BCE)

regions around the world (Peregrine, 2003). During this period, the number of cultural regions in East Asia averaged between nine and nineteen. Using 3,000 BCE as an example, Figure 5 depicts the distribution of cultural regions in our area of analysis. As a first approach, we grouped these cultural regions into three categories: those contained within the range of the future Qin, China's first Empire (white regions), out of Qin's range (dark gray), and the Indus cultures (light gray). For each cultural region, there are a number of measures that can serve as proxies for its stage of development, including its reliance on agriculture, population density, political integration above the band or small settlement, social stratification, fixity, writing system, use of money, technology level, urbanization, and transportation. As a summary measure of these characteristics, we construct an index to reflect their average societal complexity (SC) across time.

We study the evolution of SC across cultural categories (the future Qin, the Indus, and so forth), by regressing SC on a complete set of time and cultural category fixed effects, as well as their interactions. Figure 6(a), which reports the results of this analysis, shows that the regions that were to subsequently become the Qin Empire began to diverge from both Indus and the rest of the regions around 7,000 BCE, exhibiting signs of cultural complexity well before the emergence of the first state at Erlitou (Liu, 2005).[27] The Indus culture began to catch up around 4,000BCE. According to our hypothesis, the observed timing of this divergence and catching-up was probably driven by the underlying agricultural practices adopted in different regions. This result suggests that the future Qin empire had historical

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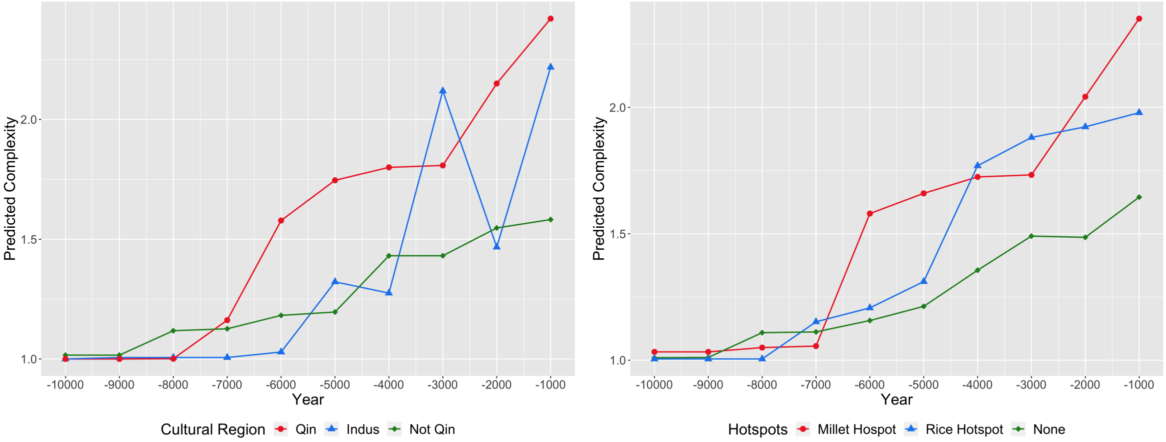
[27] Detailed changing patterns for each indicator are presented in Figure A9.

roots in the regions that initially developed and diverged from the rest of East Asia. To better understand the underlying forces behind it, we explore the evolution of social complexity across regions that are hot-spots for millet and rice from those that were not. This particular strategy is advantageous because caloric suitability hot-spots capture the potential that a region was more likely to develop into a complex society by farming a crop with the potential of positive spatial spillovers, by generating scale effects beyond the output surplus in only one location and allowing for diffusion into neighboring areas. Thus, we replicate the analysis using caloric suitability hot-spots for millet and rice and find similar results; millet hot-spots diverged from the rest of the regions from around 7,000 BCE, with rice hot-spots catching up after 4,000 BCE (Figure 6(b)).



(a) Cultural Areas

(b) Crop Hotspots

Figure 6: Evolution of Societal Complexity

These results lend credence to the hypothesized positive and significant role of millet and rice and their hot-spots in explaining the boundary of early China. To further verify this, we employed an event study using the approximate dates of the domestication of millet and rice to analyze the impact of domestication on the level of societal complexity. The results in Figures 7 and A9 provide additional evidence in support of our hypothesis. In particular, our results suggest that the domestication of these two crops provided the material conditions that supported an increase in population (Figures A9(c)-(d)) and accordingly societal complexity. In line with our hypothesis, the arrival of agriculture in a location sets off processes of complexification of society that led to more stratification and political integration (Figures A9(g)-(j)).

Millet and rice hot-spots were essential in this process, as they provided the conditions for the emergence and expansion of early proto-states. In our setting, the earliest well-attested sites of cultivation of millet and rice were all located inside their respective hot-spots. Thus, earlier domestication and cultivation of millet and rice resulted in an appreciable increase in population densities and societal complexity in their respective hot-spots, which, in turn, was followed by a commensurate increase in the number of chiefdoms in this area (Figure A10).[28] As these chiefdoms competed and merged

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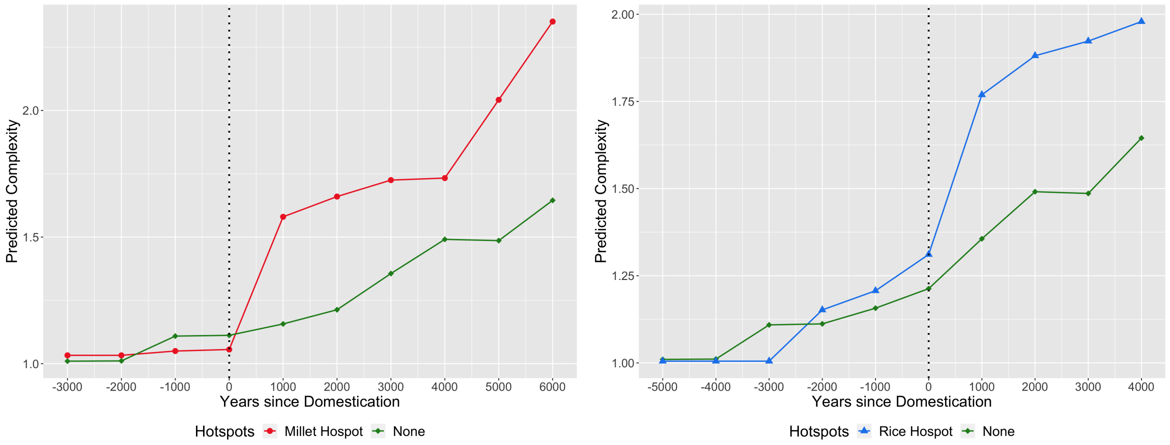
[28] For instance, of the five clusters of sites with well-established evidence of early millet cultivation – Cishan, Dadiwan, Houli, Peiligang, Xinglongwa, four are close to the Yellow River and one near the Liao River. In general, there is



(a) Millet Hotspot

(b) Rice Hotspot

Figure 7: Even Study on Impact of Domestication on Societal Complexity

to form ever-larger units, it was likely that this process would lead to the formation of the early proto-states. Erlitou, the actual first full-fledged state that appeared in China, is located in the millet hot-spot and was in close proximity to the early chiefdoms (Figure 4). In fact, the locations of these early chiefdoms are accurate predictors of the probable site from which an early state would emerge, locating it about 161km from Erlitou (Figure A2).

We now examine more formally the role of hot-spots and their agricultural potential on the emergence and diffusion of agriculture using a spatial error model (Anselin, 2001).[29] Table 1 finds a significant positive relationship between the timing of agricultural adoption and the location and suitability of millet hot-spots. In terms of magnitude, being a hot-spot for millet suggests that agriculture was probably adopted there 1,634 years earlier, controlling for geography and climate. Similarly, rice hot-spots are associated with a later adoption of agriculture (443 years) after including the same controls (column (2)).[30]

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indeed a consensus among the archaeobotanical experts that this crop was first domesticated in this region and diffused outwards from it to most of Asia, reaching Korea around 3250 BCE, Vietnam around 2000 BCE, and Japan around 700 BCE (Stevens and Fuller, 2017). In the case of rice cultivation, evidence suggests its presence in the clusters along the Yangtze River breaches (two), with the third near the Qiantang River, some 150 km south of the Yangtze. There are patches of evidence to indicate that pre-domesticated cultivation commenced around 7000 BCE - dates considered by archaeobotanical experts as coinciding with the region in which rice was first domesticated before spreading across Eurasia (Fuller, 2011). The locations of early cultivation and original domestication of these two crops were geographically close to each other(they were located inside their respective hot-spots, close to areas in which they overlapped). These circumstances provided the conditions for the Chinese agricultural package to emerge in the middle and lower reaches of the Yellow and Yangtze river systems and their tributaries from around 4000 BCE, thereby forming the backbone of the increasingly populous agrarian societies in what eventually became the pre-Qin "Warring States" and their aggregation into the Qin dynasty.

[29] We use a 500km neighborhood for the results presented in the main body of the paper. As we show in Appendix B.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 B.3.2.

[30] The estimates in column (1) suggest that, after accounting for the time-unvarying characteristics at the subcontinental plate level, cells that belong to millet hot-spots adopted agriculture 1.44 standard deviations or 3,362 years earlier. Similarly, cells that are rice hot-spots adopted agriculture 0.32 standard deviations or 747 years earlier, reflecting the later domestication of rice. As expected, additionally accounting for the geographic and climatic characteristics of the cell substantially reduces these estimates. Nonetheless, the positive impact of being a hot-spot for millet remains.

Table 1: Hotspots and the Emergence and Diffusion of Agriculture

	Years Since Agricultural Adoption				
	(1)	(2)	(3)	(4)	(5)
Hotspot Millet	1.41***	0.89***	0.98***	0.22***	0.16**
	(0.05)	(0.05)	(0.05)	(0.07)	(0.07)
Hotspot Rice	0.33***	-0.02	0.04	0.22***	0.12*
	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)
Hotspot Millet × Hotspot Rice			-0.71***	-0.29*	0.02
			(0.15)	(0.15)	(0.16)
Millet Caloric Suitability				0.34***	0.31***
				(0.02)	(0.02)
Rice Caloric Suitability				-0.17***	-0.03
				(0.04)	(0.05)
Millet Caloric Suitability× Rice Caloric Suitability					-0.13***
					(0.03)
Plate Fixed-Effects	Yes	Yes	Yes	Yes	Yes
Main Controls	No	Yes	Yes	Yes	Yes
Pseudo-R^2	0.34	0.56	0.57	0.60	0.61
Observations	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, 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.

To further examine the role of agriculture in generating the fertile ground for autochthonous state-building, we perform a more robust analysis and examine whether being a hot-spot for millet or rice, together with the timing of agricultural adoption, can predict a cell's proximity, i.e., within a week HMI distance, to Erlitou or the centroid of other early chiefdoms. The results in columns (1) and (6) of Table 2 suggest a significantly large and positive association between a millet hot-spot and proximity to the proto-state. Specifically, a millet hot-spot increases the probability of being close to the proto-state by nearly 30 percentage points – four times the average probability in our sample. Columns (2) and (7) show similar results after accounting for a cell's geographic and climatic conditions. The remaining columns suggest that the primary effect of being a millet hot-spot comes from its role in the adoption of agriculture. Additionally, early agricultural adoption is positively associated with proximity to the proto-state. In terms of magnitude, the estimates in columns (5) and (10) suggest that a one standard deviation increase in the number of years a cell has experienced agriculture increases the probability of being close to the early proto-state by about 7 percentage points. Moreover, the effect triples if the cell is a millet hot-spot, suggesting that proto-states are more likely to appear in locations where millet diffused early. We do not find the same effect for rice, however. These results are in line with

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However, the negative impact of rice hot-spots also affects the locations of millet hot-spots (column (3)). To the extent that a hot spot reflects a cell as having both above-average suitability on its own and belonging to a cluster of cells with above-average suitability, it is important to find out if both of these characteristics affected the timing of adoption of agriculture. We examine these related but separate roles in columns (4) and (5).

the view that millet has had greater potential for diffusion than rice (Stevens and Fuller, 2017). The fact that it was much easier to cultivate millet implies easier diffusion, giving rise to the emergence of multiple chiefdoms in these hot-spots. In turn, the co-existence of multiple chiefdoms easily gave rise to conflict among these mid-sized states, from which a larger state would emerge.[31]

Table 2: Hotspots and the Emergence of China's First State

	Cell is Located within 1 week distance to Erlitou					Cell is Located within 1 week distance to Centroid				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Hotspot Millet	0.27***	0.19***	0.15***	-0.42***	-0.38***	0.33***	0.25***	0.21***	-0.41***	-0.41***
	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.01)	(0.02)	(0.02)	(0.04)	(0.04)
Hotspot Rice	-0.06***	-0.07***	-0.07***	-0.04**	-0.03	-0.05***	-0.07***	-0.07***	-0.06***	-0.05***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Years since Agricultural Adoption			0.04***	0.03***	0.03***			0.05***	0.04***	0.03***
			(0.01)	(0.01)	(0.01)			(0.01)	(0.01)	(0.01)
Hotspot Millet × Agr Adoption				0.42***	0.38***				0.44***	0.44***
				(0.03)	(0.03)				(0.03)	(0.03)
Hotspot Rice × Agr Adoption				-0.00	0.01				0.02	0.02
				(0.02)	(0.02)				(0.02)	(0.02)
Millet Caloric Suitability					-0.00					0.01
					(0.01)					(0.01)
Rice Caloric Suitability					-0.02**					-0.01
					(0.01)					(0.01)
Semi-partial R^2 Millet & Agr	0.13	0.06	0.05	0.09	0.09	0.18	0.09	0.07	0.12	0.11
Semi-partial R^2 Others	0.01	0.05	0.04	0.02	0.02	0.01	0.06	0.04	0.03	0.02
Plate Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Pseudo-R^2	0.19	0.24	0.26	0.33	0.33	0.26	0.30	0.32	0.41	0.41
Observations	2779	2779	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, 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.

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[31] We further confirm the combined importance of millet hot-spots and the adoption of agriculture for the emergence of early states using semi-partial R-squares, which are 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 2, millet hot-spots and years since agricultural adoption have the largest semi-partial R-squared in the analysis. In particular, the unique variation associated with them explains at least three times as much as the unique variation associated with all other controls combined. Thus, millet hot-spots and years since agricultural adoption are the two main explanatory variables in accounting for the emergence of large states in our analysis.

5 The Race between Agriculture and Statehood in the Expansion of China

Our proposed hypothesis suggests that the distance from the early Chinese proto-state, the timing of agricultural adoption, and the agricultural productivity of land should collectively determine the extent of the later Chinese empire and the stickiness to China across East Asia. In particular, our hypothesis centers on the race between Chinese state building and the diffusion of agriculture. In this section, we examine this hypothesis empirically.

We begin our analysis by focusing on cells that did not belong to the earliest Chinese empire – the Qin. In our sample, only 10 percent of cells were in the Qin's territory – the rest did not fall under its control. Figure 8 shows the probability that China conquered a cell outside Qin's territory for the first time. Specifically, the probability of evolution over time for the four groups of cells is calculated according to whether a cell is relatively close to Erlitou – within two weeks of travel, and whether it adopted agriculture early – at least 3,000 years since adoption. A few striking patterns stand out in Figure 8. First, the Chinese state was effective in dominating regions close to its historical origin. For example, within 1,500 years, it had conquered – at least once – all areas within two weeks of travel from Erlitou. Second, the areas it initially conquered were those that adopted agriculture earlier, and were located close to its core in the hot-spots of millet suitability. Third, the distance to Erlitou appears to dominate the time of agricultural adoption, as the Chinese state first conquered cells that were close to Erlitou but adopted agriculture late, than it did for cells that adopted agriculture early but were more distant. Fourth, and more generally, it conquered the early agricultural adopters first, before it conquered the late adopters. Together, these patterns suggest that China's expansion strategy was consistent with what we hypothesized, with the caveat that what this figure shows was only the first conquest instead of permanent control.

5.1 What determined China's core territory over the longer run?

To examine the determinants of the Chinese state's long-run presence in a territory, we analyze the extensive and intensive margins of stickiness to China in two steps. First, we examine why a cell first became a part of China, i.e., cells with a positive level of stickiness. We then examine the determinants of the level of stickiness, conditional upon it being a part of territorial China in the first place. We estimate variations of the following equation

$$Y_i = \beta_0 + \beta'_m DIST_i + \beta'_n AGR_i + \beta'_k C_i + \varepsilon_i \tag{3}$$

where Yi measures either the extensive (0/1 dummy) or intensive (inverse hyperbolic sine transformation) margin of the stickiness to China for cell i over the 221 BCE to 1911 CE period.[32] $DIST_i$ is a vector of distance-related variables that includes cell i's HMI distance to Erlitou, its isolation index, and its HMI distance to the major rivers. AGR_i is a vector of agriculture-related variables that includes the number of years since cell i adopted agriculture, whether it is a hot-spot for millet or rice,

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[32] 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.

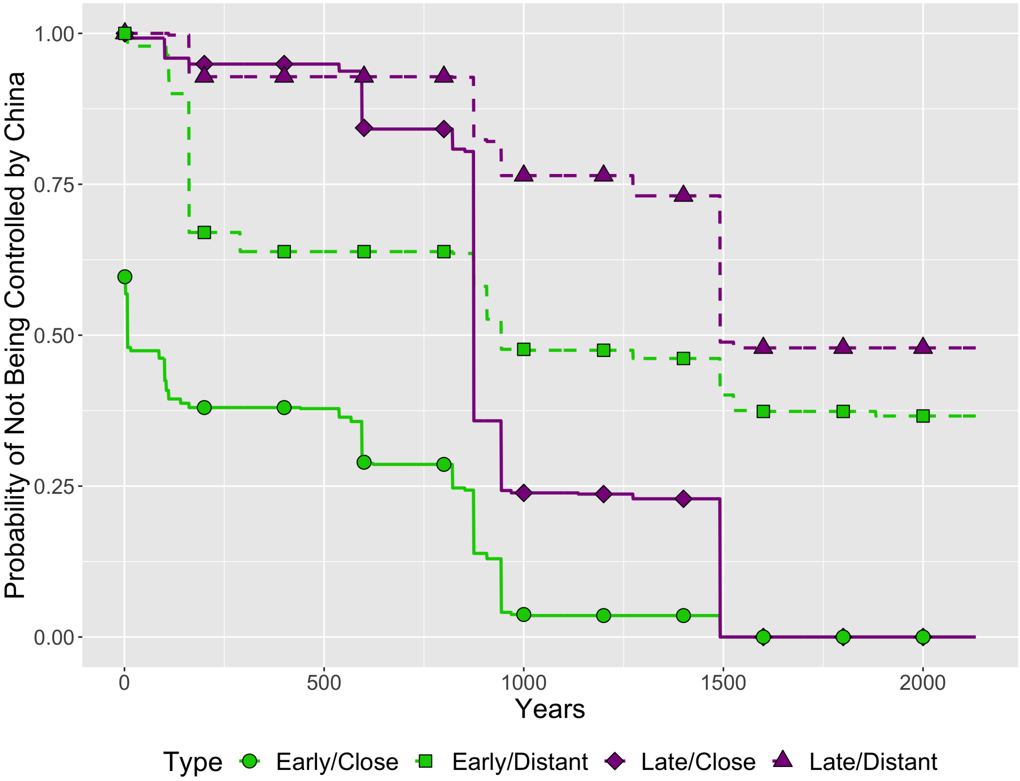

Figure 8: Survival Analysis

and its caloric suitability for millet and rice. Ci is a set of basic geographic and climatic characteristics of cell i that includes its longitude, latitude, land area, elevation, temperature, precipitation, ruggedness, and distance to the coast. We estimate this equation for each of our three measures of stickiness to China – -territorial, cadastral, and hybrid, respectively. As explained in section 3, territorial China focuses more on China's military and political influence, while cadastral China emphasizes the distribution and density of county seats, which were integral to administering agricultural taxes in most periods. We follow the same empirical strategy as in section 4 and use a spatial error model with a cut-off of 500km.[33]

Table 3 presents the results of this analysis. In Columns (1)-(3) we focus on the extensive margin, i.e., the probability that a cell ever belonged to China irrespective of the length of time or the type of rule imposed. In column (1), we find that both our set of distance and agricultural variables are negatively associated with the probability of ever incorporated into territorial China. In line with our hypothesis, we find that cells distant from Erlitou or adopted agriculture early have a lower probability of becoming a part of China's territory. In column (2), we find that being far away from Erlitou and major rivers decreases the probability of being in cadastral China while being relatively isolated from the rest of the continent or agriculturally suitable increases this probability. Column (3) analyzes the probability of being in cadastral China for the subset of cells that at some point belonged to territorial China. With the exception of major rivers, the results are qualitatively similar. In terms

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[33] Our results are robust to using other cutoffs (250km, 750km, and 1000km) as well as using OLS with corrections for spatial autocorrelation following Colella et al. (2019).

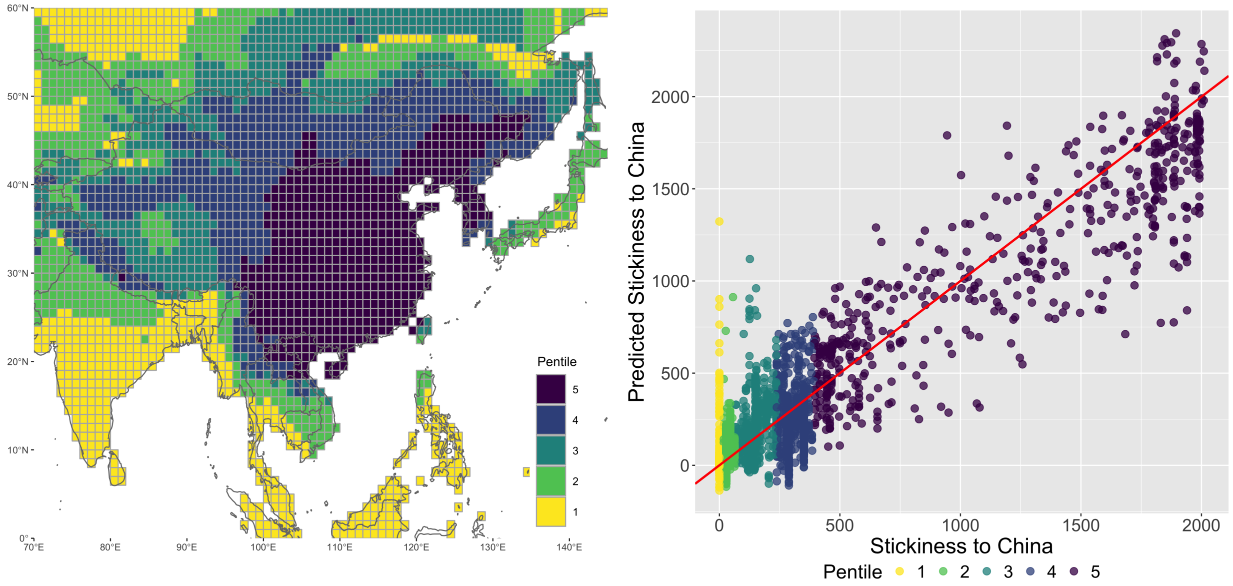
of magnitude, these last set of estimates imply that a one standard deviation increase in the distance to Erlitou - which corresponds to approximately 6 days of travel - decreases the probability of ever being a part of China by 23 percentage points, which is equivalent to the average probability of being part of the Chinese state. Regarding the adoption of agriculture, a one standard deviation increase – which corresponds to 2,600 years earlier, increases the probability of the presence of the Chinese state by 4 percentage points. Millet and rice hot-spots increase the respective probability of the Chinese state's presence by 10 and 12 percentage points, whereas isolated cells have a 52 percentage points greater probability of being part of the Chinese state.

Table 3: The Effect of Distance and Agriculture on *Stickiness* to China

	Extensive Margin			Intensive Margin		
	Territorial	Cadastral^1	Cadastral^2	Territorial	Cadastral^1	Cadastral^2
	(1)	(2)	(3)	(4)	(5)	(6)
Distance to Erlitou	-0.15***	-0.21***	-0.23***	-0.26***	-1.72***	-0.26***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.07)	(0.02)
Isolation Index	-0.07***	0.19***	0.52***	0.92***	4.63***	1.00***
	(0.03)	(0.03)	(0.06)	(0.12)	(0.37)	(0.12)
Distance to Major Rivers	-0.03***	-0.04***	-0.00	-0.08***	-0.11**	-0.07***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.05)	(0.02)
Years since Agricultural Adoption	0.02***	0.04***	0.03***	0.09***	0.12**	0.11***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.06)	(0.02)
Hotspot Millet	0.03	0.13***	0.10***	0.02	1.03***	0.14*
	(0.02)	(0.02)	(0.03)	(0.07)	(0.21)	(0.07)
Hotspot Rice	-0.01	0.04*	0.12***	0.02	0.76**	-0.01
	(0.02)	(0.02)	(0.05)	(0.11)	(0.33)	(0.11)
Millet Caloric Suitability	-0.05***	0.06***	0.08***	-0.01	0.55***	-0.00
	(0.01)	(0.01)	(0.01)	(0.03)	(0.08)	(0.03)
Rice Caloric Suitability	-0.06***	-0.12***	-0.17***	-0.36***	-1.21***	-0.43***
	(0.01)	(0.01)	(0.02)	(0.04)	(0.12)	(0.04)
Plate Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo-R^2	0.75	0.68	0.72	0.79	0.80	0.80
Observations	2779	2779	2037	2037	2037	2037

Notes: The extensive measure of stickiness to China is a dummy, while the intensive measure is the inverse sine transformation of this variable. All independent variables except dummies are standardized to have mean 0 and standard deviation 1. Main controls include longitude, latitude, land size, elevation, temperature, precipitation, ruggedness, 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. ^{1} Column (2) is administrative dummy given full sample, ^{2} Column (3) is administrative dummy given territorial dummy equals to 1.

In columns (4)-(6), we analyze the intensive margin of stickiness to China using our three stickiness measures, i.e., territorial and cadastral China, and their combination. The results across these columns are strikingly similar, which lends further support to our hypothesized role of proximity to Erlitou and timing of agricultural adoption. To begin with, greater distance from the early proto-state at Erlitou increases the costs of conquest and ruling, which lowers the stickiness to China. Similarly, isolation



(a) Predicted Map

(b) Predicted vs. Actual

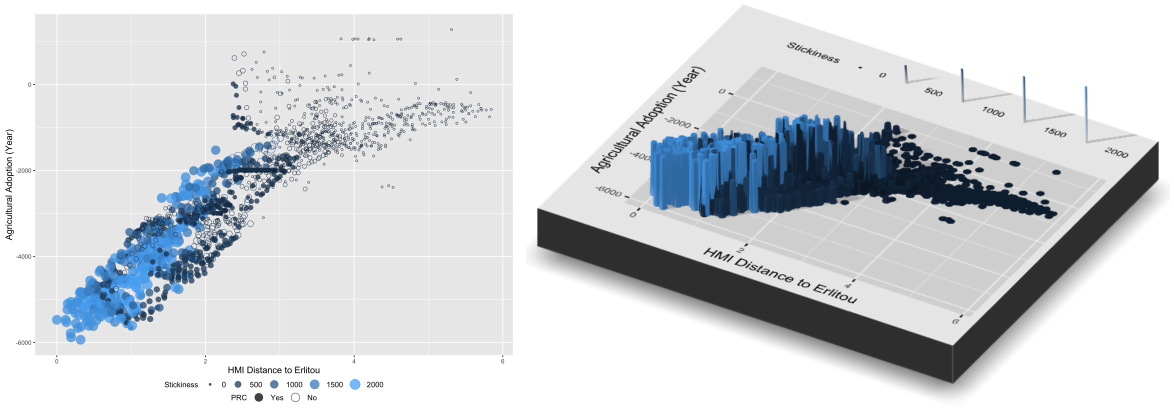
Figure 9: Predicted Stickiness to China

from the rest of Eurasia increased stickiness to China, as it prevented invasions by emerging states from the West Eurasian, European, and South Asian core areas. These conditions thus reduced regional competition, facilitating China to emerge as the first large-scale state within its isolated neighborhood. The same applies to the timing of agricultural adoption. As hypothesized, early adoption of agriculture similarly increased stickiness to China as it facilitated the emergence of social complexity in areas close to Erlitou. Consistent with this logic, millet hot-spots and high caloric suitability of millet have a significant positive effect on stickiness as they reinforce the pivotally historical role of millet in Chinese agriculture as well as being the key determinant of the location of China's political center. Additionally, proximity to navigable rivers, which played an important role in transportation for conquest, trade, and taxation, and the potential for taxation and population growth, also increased stickiness.

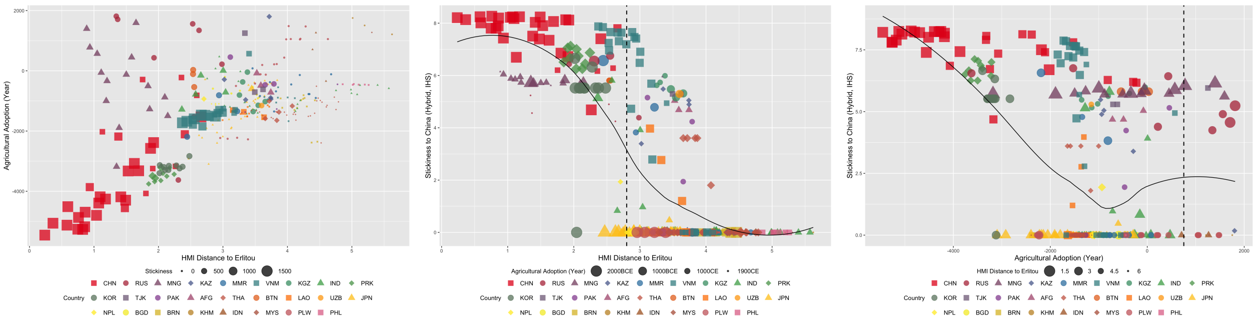
In terms of magnitude, the estimates in columns (4)-(6) imply that a one standard deviation increase in the distance to Erlitou decreases stickiness to China between 25-169 percent, while a one standard deviation increase in a cell's isolation increases its stickiness to China between 90-472 percent. With respect to the years since agricultural adoption, a one standard deviation increase in this measure is associated with a 12-28 percent increase in stickiness to China, while millet hot-spots increase stickiness by a substantially larger 102 percent. Given the size of the pseudo-R2 (which is above 79%), our model has large predictive power. One concern, however, is the potential bias generated by the large number of regions that were never a part of China. To address this concern, we estimate a two-part model that jointly fits a logit model to determine a cell's probability of ever being part of China, and an OLS to fit the level of stickiness for those cells that became part of it. Reported in Table A2, the results of this two-part analysis are qualitatively similar to those in Table 3. Figure 9 shows that the prediction based on our two-part model of which cells remain for long periods under

China's control (stickiness in short) is robust.

Our results are robust to various alternative estimation strategies. First, they are robust to the distance cutoff employed in the spatial error model in Appendix B.3.1. Second, they are also robust to using alternative specifications to account for spatial auto-correlation (Appendix B.3.2). Specifically, our results remain qualitatively unchanged if instead we use OLS and adjust standard errors following Colella et al. (2019). Third, given the potential for measurement error in our continuous measure of the years since agricultural adoption, we replace it with an ordered categorical measure. Specifically, we code this alternative measure as 0 if years since agriculture is less than 2000, 1 if it is between 2000 and 4000 years, and 2 if it's greater than 4000 years. This alternative coding also overcomes potential issues caused by our adjustment of the original measure using habitat suitability. Reassuringly, our results do not change in this case either (Appendix B.3.3).



(a) Cell-level (b) Cell-level



(c) Region-Level (d) Region-Level (e) Region-Level

Figure 10: Distance, Agricultural Adoption, and Stickiness to China

5.2 Heterogeneous effects of early agricultural adoption and the distance to Erlitou on Stickiness

The previous section provided evidence regarding the central role that agriculture and proximity to the early proto-states played in affecting the stickiness to China. We now turn to examine their heterogeneous effect by including in equation (1) the interaction of these two factors, which we expect to be negative and significant.

$$Stickiness_i = \beta_0 + \beta_m' DIST_i + \beta_n' AGRI_i + \beta_1 Adoption_i \times distErlitou_i + \beta_k' C_i + \varepsilon_i \tag{4}$$

Figure 10 foreshadows this main result. Figure 10(a) shows the relationship at the cell level. We depict the level of stickiness using circle sizes and a color gradient to highlight differences, and distinguish cells in the current PRC (solid) from foreign ones (hollow). Note stickiness to China is well predicted by these factors. Most of the PRC cells are within 2.8 weeks distance and have agricultural adoption dates before 1,000 BCE. This relation may be observed better in the 3-D graph (Figure 10(b)) with stickiness depicted by the heights of the bars.[34] Figures 10(d) and 10(e) depict the same relation from different perspectives, measuring stickiness on the vertical axis and the two factors on the horizontal ones separately. This perspective allows viewing the drop in stickiness more clearly (the dashed line).[35]

Table 4: Heterogeneous Effects of Distance and Agriculture on *Stickiness* to China

	Territorial			Cadastral			Hybrid		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Distance to Erlitou × Agr Adoption	-0.17***			-0.41***			-0.16***		
	(0.01)			(0.05)			(0.02)		
Distance to Erlitou × Millet Hotspot		-0.27***			-1.13***			-0.45***	
		(0.05)			(0.15)			(0.05)	
Distance to Erlitou × Rice Hotspot		-0.76***			-1.62***			-0.99***	
		(0.05)			(0.17)			(0.05)	
Distance to Erlitou × Millet CSI			-0.16***			-0.51***			-0.20***
			(0.01)			(0.05)			(0.01)
Distance to Erlitou × Rice CSI			-0.24***			-0.55***			-0.31***
			(0.02)			(0.05)			(0.02)
Distance Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Agriculture Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plate Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo-R^2	0.81	0.81	0.83	0.81	0.81	0.82	0.81	0.83	0.85
Observations	2037	2037	2037	2037	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, 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.

Table 4 presents the results of this analysis. Columns (1), (4), and (7) show the estimates of the interaction between the timing of agricultural adoption and distance to Erlitou, and confirm the

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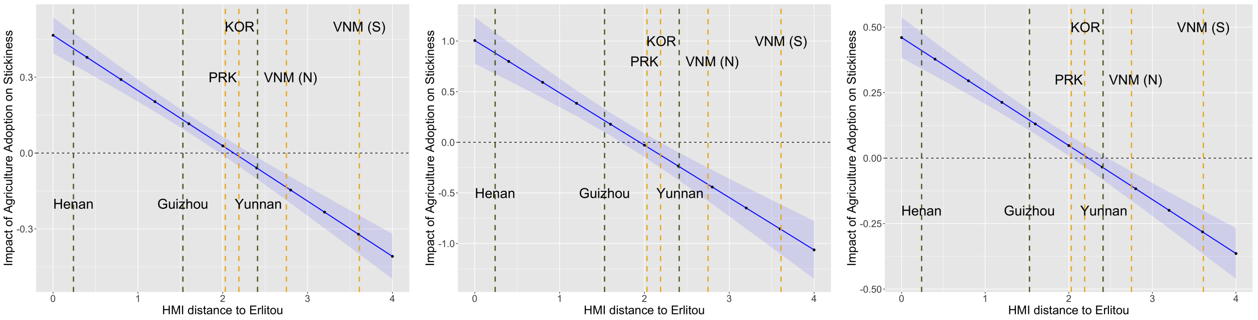
[34] Figure 10(c) replicates the analysis using administrative level-1 units across countries in East Asia.

[35] Figure 10(d) also shows that the range between 2-4 weeks distance is where most variation appears: a substantial number of regions within this range were a part of historical China, yet became independent countries. Figure 10 (e) shows that all regions with an adoption date earlier than 4000 BCE belong to China, while later adoption dates have more variation in outcomes.

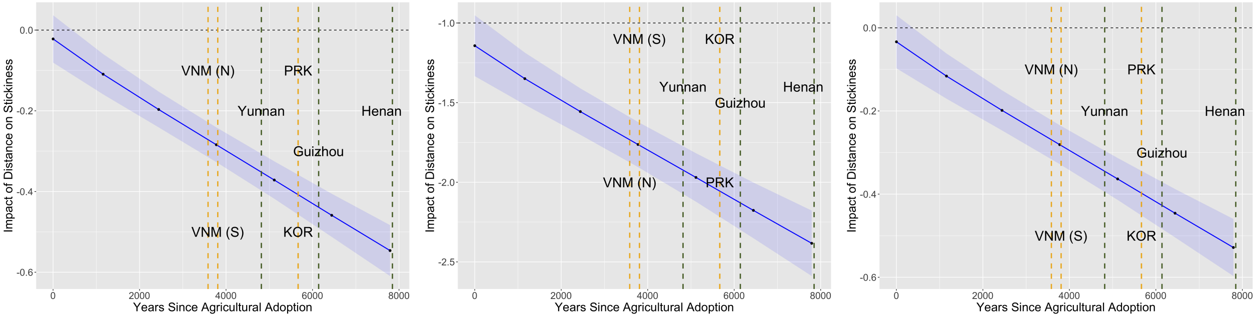
predicted significant and negative coefficient. This result implies that, conditional on their distance to Erlitou, cells that adopted agriculture relatively early (late) have a lower (higher) chance of being absorbed into China. Holding constant the timing of agricultural adoption, cells located relatively close to (far from) Erlitou have a larger (lower) chance of being incorporated into China.

Agriculture Adoption



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

Distance to Erlitou



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

Figure 11: Heterogeneous Effects of Agricultural Adoption and Distance on Stickiness

We further show the marginal effect of the timing of agricultural adoption on stickiness in Figure 11. Conditional on a cell's proximity to Erlitou, an earlier adoption of agriculture increased the stickiness to China. But as one moves farther away from it, the impact of agriculture on stickiness turns negative. In terms of magnitude, for cells located closer to Erlitou by one standard deviation (compared to the average location), the impact of a one standard deviation increase in the timing of agricultural adoption increases stickiness by about 0.2 standard deviations. However, stickiness decreases by 0.15 standard deviations for cells located farther from Erlitou by one standard deviation above the average. More specifically, the positive impact of early agricultural adoption on stickiness vanishes and becomes negative at precisely the distances at which other East Asian states - South Korea, Vietnam, Myanmar and Japan, and all of Cambodia, Laos, and Thailand - emerged. This result provides prima facie evidence in support of our hypothesis that reflects the emergence of agrarian societies on China's peripheries, which started their own state-building processes and eventually resisted Chinese incursions.[36]

While these results support our hypothesis, they may be confounded by environmental conditions that affect the incentive to adopt agriculture. To ensure that our estimates do not suffer from this possible omitted variable bias, we interact the distance to Erlitou with other more exogenous agricultural variables such as the hot-spots for millet and rice. Reported in columns (2), (5), and (8) of Table 4, we similarly find significant negative effects on stickiness. Consistently, we find the same negative (and significant) results for columns (3), (6), and (9), in which we interact distance to Erlitou with respectively the caloric suitability for millet and rice. On the whole, these results provide support for the race between agriculture and statehood, suggesting the beneficial effect of agriculture for autochthonous non-Sinitic state-formation in its competition with the Chinese state.

Table 5: Historical Stickiness to China and the Extent of the P.R.C.

	Full Sample					Non-Core				
	Territorial			Cadastral	Hybrid	Territorial			Cadastral	Hybrid
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Historical Stickiness	0.10*** (0.00)	0.07*** (0.00)	0.05*** (0.00)	0.04*** (0.00)	0.05*** (0.00)	0.08*** (0.00)	0.06*** (0.00)	0.04*** (0.00)	0.04*** (0.00)	0.04*** (0.00)
Distance Variables	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Agriculture Variables	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Plate Fixed-Effects	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Main Controls	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Pseudo-R^2	0.38	0.64	0.68	0.67	0.68	0.27	0.56	0.61	0.60	0.61
Observations	2779	2779	2779	2779	2779	2480	2480	2480	2480	2480

Notes: The independent 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, 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.

5.3 Persistent Effects of Stickiness on Contemporary China and East Asia

While these deep roots explain the persistent stickiness to China until 1911 CE, it is conceivable that the historical presence of the Chinese state may itself affect the evolution of borders and culture in East Asia. We examine the association between a cell's stickiness to China and its probability of belonging to the PRC in Table 5 both for cells in our full sample as well as those located outside of China's historical core. Columns (1) and (6) show a strong positive association between current and historical territories of China. Specifically, historical stickiness to China alone accounts for 38 percent of the variation in the full sample and 27 percent for cells located outside of China's core.

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[36] Note that the distance in kilometers associated with an HMI distance in days or weeks depends upon the terrain and climate. The distance from Erlitou to the nearest cell of today's North Korea is 1,326 km and 1.85 HMI weeks. From Erlitou to the nearest border of today's Vietnam is 1,453 km. and 2.37 HMI weeks. The distance to the nearest border of today's Myanmar is 1626.69 km and 2.15 HMI weeks, and to the nearest border of today's Afghanistan is 3,683 km and 3.74 HMI weeks.

This significant association remains even after controlling for other variables in Table 3. The estimates imply that increasing historical stickiness by 1 percent increases the probability of being in China by around 5 percentage points. The consistency of our framework with what became the borders of late Qing Dynasty China and today's P.R.C. is discussed systematically in Kung et al. (in progress).

We then examine the relative importance of each major dynasty in accounting for the contemporary extension of the PRC in Table 6. For each dynasty, we measure the level of historical stickiness during its existence, as well as its respective share of the overall historical stickiness.[37] The results show that dynasties ruled by the ethnic Han – the Han, Tang, Ming, and Qing dynasties – have significant positive persistent effects, while the effects of the non-Han dynasties – Yuan and Liao – are significantly negative.

Table 6: Historical Stickiness to China and the Extent of the P.R.C.
Persistence of Dynastic Power

	Level		Share	
	(1)	(2)	(3)	(4)
Stickiness Han	-0.00	-0.01	0.66***	0.41***
	(0.01)	(0.01)	(0.07)	(0.06)
Stickiness Tang	0.10***	0.09***	0.05	-0.14***
	(0.01)	(0.01)	(0.04)	(0.04)
Stickiness N.Song and Liao	-0.02*	-0.04***	-0.56***	-1.02***
	(0.01)	(0.01)	(0.11)	(0.11)
Stickiness Yuan	-0.02**	-0.03***	-0.01	-0.09***
	(0.01)	(0.01)	(0.03)	(0.03)
Stickiness Ming	0.03***	0.06***	0.05	0.05
	(0.01)	(0.01)	(0.04)	(0.04)
Stickiness Qing	0.15***	0.14***	0.21***	0.06
	(0.01)	(0.01)	(0.05)	(0.05)
Distance Variables	No	Yes	No	Yes
Agriculture Variables	No	Yes	No	Yes
Plate Fixed-Effects	Yes	Yes	Yes	Yes
Main Controls	Yes	Yes	Yes	Yes
Pseudo-R^2	0.64	0.67	0.55	0.62
Observations	2480	2480	2480	2480

Notes: The independent variables are inverse sine transformations of stickiness to China for each dynasty. 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, 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.

The existence of persistent effects gives rise to the question regarding the channels through which state presence affects stickiness in the long run. Cultural familiarity is a likely candidate; for instance,

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[37] We focus on these seven dynasties since they remained in power for long periods, representing about 70% of all years in our sample.

by using the same language, regions controlled by the Chinese state for longer periods are expected to become culturally more similar to China.[38] To test for this channel, we examine the effect of historical stickiness on the linguistic distance to Mandarin of the languages (dialects) spoken by the population inhabiting a cell. Reported in Table 7, we find that historical stickiness to China has a significant negative association with the linguistic distance to Mandarin. Stickiness alone accounts for 25 percent of the variation in linguistic distances in East Asia (column (1)), and 13 percent if we exclude areas in China's core (column (6)). This relationship remains significant after controlling for the geographical characteristics of the cell, which include the determinants of historical stickiness (columns (2)-(3) and (7)-(8)). Overall, our estimates suggest that a 1 percent increase in historical stickiness decreases the average linguistic distance of the languages spoken in a cell by 0.1 standard deviations;[39] implying that the continued historical presence of the Chinese state significantly changed East Asia's linguistic landscape. In light of the strong association between language and culture, we may expect more general cultural adaptation processes to have taken place too.

Table 7: Historical Stickiness to China and East Asia's Contemporary Cultural Landscape

	Full Sample					Non-Core				
	Territorial			Cadastral	Hybrid	Territorial			Cadastral	Hybrid
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Historical Stickiness	-0.16***	-0.14***	-0.07***	-0.11***	-0.08***	-0.12***	-0.10***	-0.08***	-0.10***	-0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Distance Variables	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Agriculture Variables	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Plate Fixed-Effects	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Main Controls	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Pseudo-R^2	0.25	0.48	0.58	0.60	0.59	0.13	0.31	0.36	0.36	0.36
Observations	2718	2718	2718	2718	2718	2419	2419	2419	2419	2419

Notes: The independent 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, 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.

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[38] For instance, Diamond and Bellwood (2003), and the sources referenced by them, suggest that the Chinese language spread from north to south. This led speakers of unrelated languages to either develop local dialects of Chinese, withdraw to ethnic enclaves, living in relative isolation from the surrounding ethnic Han majority, or migrate into Southeast Asia. The spread of a Tai language into Thailand and of the related Lao language to Laos exemplify this process. Although their reasoning emphasizes the migration of farmers, the expansion of the Chinese state may have reinforced this process. In particular, the migration of ethnic Han people to Southern, Southeastern, and Southwestern China, could have been influenced by the establishment of Chinese dynastic control over these areas. A similar process encouraged the dominance of ethnic Han Chinese speakers today in China's three northeastern provinces and Inner Mongolia.

[39] This magnitude is substantial, for example: the average linguistic distance to Mandarin is 2.95 for Vietnam, with a 10 percent increase in historical stickiness to China, Vietnam will become linguistically similar to Yunnan Province in China (whose average linguistic distance to Mandarin is 2.16).

6 Conclusion

We propose and empirically test a theory for the endogenous formation and persistence of states, using China as an example. We suggest that the relative timing of the emergence of agricultural societies and their distance to each other set off a race between autochthonous state-building projects and the expansion of neighboring (proto-)states. Using a newly constructed dataset on the historical presence of the Chinese state, timing of agricultural adoption, social complexity, climate, and geography across $1^\circ \times 1^\circ$ grid cells in East Asia, we provide empirical support for this hypothesis. Besides showing the deep rooted factors affecting the emergence and evolution of complex societies and proto-states in East Asia, which also underlie the emergence of the Chinese state, we also show the persistent effect of Chinese state presence on the contemporary cultural and political landscape in the region. Our results further confirm the importance and persistent effects of a history of statehood (Borcan et al., 2018; Depetris-Chauvin, 2015; Lowes et al., 2017).

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