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# Climate shocks, dynastic cycles and nomadic conquests: evidence from historical China

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## Abstract

Nomadic conquests have helped shape world history, yet we know little about why they occurred. Using a unique climate and dynastic data set from historical China dating from 221 BCE, this study finds that the likelihood of nomadic conquest increases with less rainfall proxied by drought disasters, which drove pastoral nomads to attack agrarian Chinese for survival. Moreover, consistent with the dynastic cycle hypothesis, the likelihood of China being conquered increases with the number of years earlier that a Chinese dynasty had been established (and hence was weaker, on average) relative to a rival nomadic regime. These results survive a variety of robustness checks.

**JEL classifications:** N45, O13

## 1. Introduction

Nomadic conquests have helped shape world history. We may indulge ourselves for a moment to imagine the following counter-factuals: what if Western Europe did not fall to semi-nomadic Germanic tribes; Western Europe was conquered by the Huns, Arabs, or Mongols; Kievan Rus did not succumb to Mongolian invaders; or Ming China did not give way to the Manchu Qing? Historians have provided vivid accounts of the rise of nomadic powers and their conquests (e.g., Grousset 1970), yet little is known about why nomadic conquests occurred or did not occur. In this article, I use a unique dynastic and climate data set from historical China dating back to 221 BCE to study the determinants of nomadic conquests, including both complete and partial conquests as proxied by the shifting Sino-nomadic border. The main conclusions are twofold. First, the likelihood of nomadic conquest increases with less rainfall proxied by drought disasters, which drove pastoral nomads to attack agrarian Chinese for survival. Second, consistent with the dynastic cycle hypothesis, the likelihood of China being conquered increases with the number of years earlier that a Chinese dynasty had been established (and hence was weaker, on average) relative to a rival nomadic regime.

Historical China provides an interesting case for studying the determinants of nomadic conquests: Sino-nomadic conflict endured for over two millennia, and the Chinese people are known for their obsession with meticulous recording of historical events, including droughts, floods, snow, frost, and low-temperature disasters. It is well known that the nomadic way of life, notably keeping livestock, depended heavily on climate (Barth, 1964; Khazanov, 1994; Graff and Higham, 2002). Thus, even a small negative climate shock could upset the delicate nomadic equilibrium and prompt nomads to act against their sedentary neighbours for survival, a possibility known as the climate pulsation hypothesis (Huntington, 1907; Toynbee, 1972). Bai and Kung (2011) find that less rainfall, proxied by a 'decadal share of years with recorded drought disasters', was associated with more frequent nomadic attacks of China proper, and more rainfall, proxied by a 'decadal share of years with a levee breach of the Yellow River', reduced the frequency of nomadic attacks. Zhao (2012) reports similar findings, using different data sources.

Moreover, according to the dynastic cycle hypothesis (Spengler, 1926; Toynbee, 1972; Olson, 1986; Kennedy, 1987), all historical regimes had life cycles that included rises and falls and passed through inevitable stages of growth, maturity, and decline. Usually, a dynasty reached its height of power during and shortly after the reign of its founder. As time passed, vested interests became increasingly entrenched, with the ruling class growing more corrupt and inefficient, inevitably diminishing the dynasty's political and military power. An implication of the dynastic cycle hypothesis is that if a Chinese dynasty was established much earlier than a competing nomadic regime, then China faced an awkward situation in which an aging dynasty was confronted by a rising nomadic regime, resulting in heightened risk of the country being conquered.

To the best of my knowledge, this article is the first systematic study of the determinants of nomadic conquests. Thus, it contributes to the understanding of the epic struggles and interactions between nomadic and settled peoples that have occurred throughout world history. It also contributes to the dynastic cycle literature by explicitly testing one of its implications, that older regimes are weaker, on average, than younger regimes and that the former are therefore prone to conquest by the latter. Moreover, this article adds to the growing literature on the effects of climate on human conflict and society (e.g., Miguel *et al.*, 2004; Bai and Kung, 2011; Bruckner and Ciccone, 2011) by observing that climate shocks affect not only the frequency of human conflict but also its outcomes.

This article is most closely related to the pioneering work of Bai and Kung (2011) (hereafter BK) relating climate shocks to Sino-nomadic conflict. However, it differs from this work in the following important respects. First, whilst BK focus on the incidence of conflicts between agricultural and nomadic regimes, the present article focusses on conquests—one possible outcome of conflicts. Many studies examine the determinants of war, but few focus on the outcomes of war. Second, whilst climate shocks predict the incidence of conflicts, they may fail to explain the outcomes. Because climate shocks may also decrease the military power of nomads, the net effect of climate shocks on the outcomes of conflicts is unclear. Third, whilst BK focus exclusively on the effects of climate shocks, the present article, to the best of my knowledge, is the first to quantify the effects of dynastic cycles. Finally, this study employs a richer set of variables and higher data quality than are used in BK.[1]

1 For example, whilst BK derive drought data from only one source and do not use flood data, the present study uses both drought and flood data from two sources to cross-check reported events

The remainder of this article is organized as follows. Section 2 provides background information on nomadic conflict, climate shocks, and dynastic cycles. Section 3 describes the data employed in the analysis. Section 4 focusses on the determinants of the Sino-nomadic border as a proxy for partial nomadic conquest. Section 5 focusses on the determinants of complete nomadic conquest. Section 6 concludes.

## 2. Background

### 2.1 Nomads and Sino-nomadic conflict

Not all nomads are alike. According to Barfield (1993), there are five types of nomads in Afro-Eurasia: cattle nomads of East Africa; camel nomads of Arabia, North Africa, and the Levant; sheep nomads of Anatolia, Persia, and Afghanistan; yak nomads of Tibet; and horse nomads of East Asia. It is notable that horse nomads in Mongolia, which neighbours China, had much greater mobility than other, slower-moving nomads and thus posed a greater threat to settled Chinese. Turchin (2009, p.196) nicely summarizes two conditions that underlie the historical struggle between nomadic and agricultural peoples: ‘First, there is a steep gradient in average rainfall. The well-watered side of the ecological frontier is inhabited by settled agriculturalists, while pastoral nomads occupy the arid zone. Second, pastoralist nomads have both the incentive and ability to take agricultural products away from farmers by force.’ Although nomads were regarded as barbaric and backwards, their skills in horsemanship and archery gave them considerable advantages in military organization and rapid movement over the settled Chinese, setting the stage for Sino-nomadic conflict over 2,000 years along the ‘perilous frontier’ (Barfield, 1989).

Pastoral nomads had become a credible threat to settled agriculturists since horses were domesticated by herders in Ukraine in approximately 4000 BCE, notably after the two-wheeled chariot was invented in Kazakhstan in approximately 2000 BCE (Morris, 2010, p.196). In the Chinese context, at least from the time of the Shang dynasty (1766–1122 BCE) and perhaps from the Xia dynasty as well, Chinese dynasties were in sporadic conflict with nomadic peoples to the north (Bentley and Ziegler, 2003, p.131). In the worst situations, Chinese dynasties were conquered to the point where they ceased to exist as polities. The earliest such nomadic conquest occurred in 771 BCE, when Western Zhou (1046–771 BCE) crumbled under a nomadic invasion aided by disgruntled Zhou allies and subordinates, and the final such conquest occurred in 1644, when the Ming dynasty (1368–1644) was toppled by the semi-nomadic Qing (Manchu).

The epic struggle and interactions between settled Chinese and nomadic rivals from the central Asian steppes (the Xiongnu, the Turks, the Mongols, etc.) have shaped the history of China as well as that of her grassland neighbours.[2] As the Chinese empire grew in size, neighbouring nomads may have needed to co-operate on a larger scale to continue successful raiding, leading to nomadic confederations known as ‘shadow empires’ (Barfield, 2001) that mirrored China in size. Turchin (2009) proposes that this social scaling-up process

and reduce measurement errors. BK’s measurement of temperature takes only a few discrete values in the past two millennia, whereas this article derives historical temperatures that are continuous and more reliable, based on more recent studies.

2 The importance of the steppe frontier in Chinese history has been examined by Lattimore (1940 [1989]), Barfield (1989), Cosmo (2002), and Turchin (2009).

actually occurred on both sides of the steppe frontier and that agrarian empires grew in response to increasing pressure from the steppes.

## 2.2 Climate shocks

It is well known that historical nomadic economies depended heavily on climatic conditions, such as rainfall, snowfall, and temperature (Barth, 1964; Khazanov, 1994; Graff and Higham, 2002). Climate shocks could affect nomadic cattle either directly (e.g., extremely cold temperatures or heavy snowfall could kill animals) or indirectly by affecting the availability of fodder. When the fragile nomadic equilibrium was upset by negative weather shocks, nomads either migrated to places with more water and grass (an essential feature of the nomadic way of life) or, when the latter was not an option, raided agricultural peoples for survival. Consequently, historians have long suspected that nomadic incursions into settled Han territory were partly responses to adverse climate changes (Huntington, 1907; Toynbee, 1972),[3] a view known as the climate pulsation hypothesis.

Recently, economists and climatologists have undertaken quantitative studies of the effects of climate shocks on human conflict. In a pioneering work, Miguel *et al.* (2004) use rainfall variation as an instrumental variable to estimate a significantly negative effect of economic growth (caused by favourable rainfall in economies relying on rain-fed agriculture) on the likelihood of civil conflict in 41 African countries during the 1981–1999 period. Using reconstructed paleo-temperature records, Zhang *et al.* (2006, 2007) show that a colder climate was associated with more frequent wars in China over the past millennium, but no distinction is made between Chinese civil wars and Sino-nomadic conflict. BK provide the first quantitative evidence that lower precipitation is significantly associated with more frequent nomadic attacks on China proper by using the 'decadal share of years with recorded drought disasters' and the 'decadal share of years with a levee breach of the Yellow River' to proxy for lower and higher precipitation, respectively. Using different data sources, Zhao (2012) finds that lower temperature and more snowfall increased the number of China's external wars, but paradoxically that more drought and flood disasters reduced the number of China's external wars.[4]

## 2.3 Dynastic cycles

Climate change by itself is not the only driver of nomadic conquests. Two issues stand out. First, there is the question of why China was conquered by some nomadic regimes but not others that were subjected to the same climate shocks; for example, why was the Northern Song dynasty (960–1127) conquered by the Jin (Jurchens) but not the Liao (Khitan) or the Western Xia (Xianbei), all of which co-existed for some period of time? Second, the frequency and the outcomes of nomadic attacks varied; the outcomes of attacks also depended on the relative strengths of nomadic and sedentary peoples, which are linked to their relative positions in dynastic cycles.

The dynastic cycle hypothesis proposes that historical regimes had life cycles that included rises and falls and that all regimes inevitably declined over time (Spengler, 1926;

3 This view is echoed by Chinese scholars, for example, Zhang (1991, p.27–28).

4 A potential issue is data quality; the climate data of Chen (1939) used by Zhao (2012) are less complete than the climate data of Zhang *et al.* (1994) used by BK. See Section 3 for a discussion of these two data sources.

Toynbee, 1972; Olson, 1986; Kennedy, 1987).[5] Therefore, abstracting from the initial rise of a dynasty, the power of a dynasty is a decreasing function of its age: when two rival regimes meet, the younger dynasty is in a more advantageous position, on average, than the older dynasty. Consequently, an aging China was more likely to be conquered by rising nomadic powers. Indeed, the typical nomadic strategy towards agricultural peoples was 'hit and run', with no intention of conquest. Planned conquests could be costly and uncertain, and nomads had no prior experience in administering sedentary societies following successful conquests. Quite often, nomadic conquests occurred only after nomads had observed the extraordinary weakness of aging Chinese dynasties, which aroused their ambitions for conquest.

Various mechanisms have been proposed in the literature to explain the causes of dynastic cycles. For Fairbank and Reischauer (1989), one of these mechanisms was the degeneration of royal families, whose offspring were often raised in isolated courts rife with temptations or who were heavily shielded from the outside world. For Wang and Gou (1985), Usher (1989), Sun (1994), and Chu and Lee (1994), the Malthusian effects of population growth inevitably led to declining cultivated land per capita and presaged the downfall of a dynasty. For Lattimore (1940 [1989]) and Fairbank and Goldman (2006, p.48), tax evasion by the gentry, whose vested interests grew too powerful for the state to resist, led to dynastic fiscal crises and eventual demise. Liu (1962) and Shao (2007) blame dynastic cycles on administrative cycles, whereas Wang and Ma (2005) suggest spiritual factors. Still others, such as Jin and Liu (1984) and Du and Li (2007), use system theory and control theory to explain the periodic destruction and self-recovery process of ancient Chinese societies. Turchin (2007) argues that empires rose because of society's capacity for collective action, but as the rich got richer and the poor got poorer, conflict replaced co-operation, and empires inevitably fell apart. In a new best-selling book, Morris (2010) emphasizes the 'paradox of social development', the tendency of development to generate the very forces that undermine it, as society creates threats to itself when it becomes more complex. The question of which mechanism is most prominent in the context of historical China is beyond the scope of this study. Regardless of the mechanisms at work, empirical data can be used to examine one of its implications: as agricultural dynasties age, they become increasingly likely to be conquered by younger nomadic regimes.

To fix ideas, assume that the power of a nomadic regime evolves according to the following formula:[6]

$$P_{1t} = \alpha_1 - \gamma t + \mathbf{x}'_{1t}\boldsymbol{\beta}_1 + \varepsilon_{1t} \tag{1}$$

where $P_{1t}$ is the power of a nomadic regime at time $t$, $\gamma > 0$ is the rate of decline due to dynastic cycles, $\mathbf{x}_{1t}$ includes other covariates affecting nomadic power, and $\varepsilon_{1t}$ is an unobserved random shock. The founding year of the nomadic regime is normalized to time 0. Similarly, the power of a Chinese dynasty evolves according to:

$$P_{2t} = \alpha_2 - (\gamma + \delta)(t + \mathit{diff}) + \mathbf{x}'_{2t}\boldsymbol{\beta}_2 + \varepsilon_{2t} \tag{2}$$

where $P_{2t}$ is the power of a Chinese dynasty at time $t$, $(\gamma + \delta) > 0$ is the rate of decline of China, *diff* is the number of years earlier the Chinese dynasty was established than its

5 Chen (2014) shows that dynastic age was positively correlated with peasant uprisings in north China during 25–1911 CE, which is consistent with the dynastic cycle hypothesis.

6 I thank an anonymous referee for this suggestion. Empirically, we may add a squared term to capture possible nonlinearities, which turn out to be insignificant.

nomadic rival; and $\mathbf{x}_{2t}$ and $\varepsilon_{2t}$ are defined similarly as above. If $\delta \neq 0$, then the Chinese dynasty and the nomadic regime decline at different rates. Because a nomadic regime was typically more personalized and less institutionalized than a Chinese dynasty, we might expect that $\delta < 0$, so that Chinese dynasties declined at relatively slower rates on average than nomadic regimes.

Furthermore, assume that the outcome of a Sino-nomadic conflict depends on the relative power of a Chinese dynasty and its nomadic rival:

$$P_{1t} - P_{2t} = (\alpha_1 - \alpha_2) + \gamma diff + \delta age_t + (\mathbf{x}'_{1t}\boldsymbol{\beta}_1 - \mathbf{x}'_{2t}\boldsymbol{\beta}_2) + (\varepsilon_{1t} - \varepsilon_{2t}) \tag{3}$$

where $age_t \equiv t + diff$ is the absolute age of the Chinese dynasty. From eq. (3), it is clear that, as *diff* increases, a Chinese dynasty becomes weaker and easier to conquer. However, if $\delta < 0$, then, as a Chinese dynasty ages, it becomes relatively more powerful and thus harder to conquer.

## 3. Data

### 3.1 Nomadic conquest data

The sample consists of time series data covering the 221 BCE–1911 CE period, with each decade constituting an observational unit. One dependent variable is a dummy variable that indicates whether China was conquered by a nomadic regime (*conquered*). All dynastic data, including the founding and ending years of Chinese and nomadic regimes and whether China was conquered, are taken from Bai (1999), a multi-volume, comprehensive general history of China, unless otherwise indicated.

During the sample period, China was conquered seven times: the Western Jin was conquered by the Former Zhao (Xiongnu) in 316; the Southern Dynasty Chen was conquered by the Sui in 589; the Later Tang and Later Jin were conquered by the Liao (Khitan) in 936 and 947, respectively; the Northern Song were extinguished by the Jin (Jurchens) in 1127; the Southern Song were wiped out by the Yuan (Mongols) in 1279; and the Ming were toppled by the Qing (Manchu) in 1644.

As complete conquest occurred only seven times over 2,000 years, there is less variation in the dependent variable than we would like. In fact, nomadic invasions often resulted in shifts of the Sino-nomadic border rather than complete conquest. Because the Sino-nomadic border mostly ran in the east–west direction, it is appropriate to measure its location by latitude as a proxy for partial nomadic conquest.

Data for the location of the Sino-nomadic border over the past two millennia are derived from Tan (1982), an eight-volume authoritative atlas of historical China. Tan (1982) provides one or more territorial maps for each Chinese dynasty. For each map, I measure the latitudes of the southernmost tip of the Sino-nomadic border (labelled *border_min*) and the northernmost tip of the Sino-nomadic border (labelled *border_max*). Because *border_min* and *border_max* were likely subject to idiosyncratic shocks, for robustness, I also compute their average (labelled *border_mean*). I first assign these latitude data to each relevant decade and then fill in missing data through linear interpolation.[7] For the Yuan and the Qing dynasties, established after successful nomadic conquests, I use the southernmost tip of continental China to measure the Sino-nomadic boundary.

7 If only one territorial map is available for a dynasty, I use the same data throughout the dynasty.

An alternative measure is China's territorial size. However, measurement of a two-dimensional area is subject to greater measurement errors than measurement of a one-dimensional line. Additionally, such a measure involves confounding factors other than nomadic powers north of China, such as China's changing southern and western borders. For example, the territory of some Chinese dynasties once stretched as far south as present-day Vietnam. Therefore, I focus on the latitude of China's northern border.

### 3.2 Dynastic cycle data

A key explanatory variable capturing the dynastic cycle effect is the number of years earlier that a Chinese dynasty was founded relative to a competing nomadic regime (*diff*), a variable generated simply by subtracting the nomadic founding year from the founding year of a rival Chinese dynasty. Because *diff* remained fixed after two competing regimes were founded, it is a pre-determined regressor free of endogeneity concerns. According to eq. (3), the absolute age of a Chinese dynasty may also matter; thus, I define *age* as the number of decades that a Chinese dynasty had been established.

The founding and ending years of Chinese dynasties are well established,[8] whereas the dating of nomadic regimes, which were usually organized as loose confederations of tribes, is less clear. The founding of a nomadic regime is typically dated as the year a tribal leader unified his tribes (often including closely related neighbouring tribes) and declared himself king, chanyu, or khan. As such, the leeway for dating nomadic regimes is minimal in most cases. An additional issue is that because almost all dynastic data are from Chinese instead of nomadic sources, there is a possibility of selection bias. However, this is unlikely because if a nomadic regime is not mentioned or is mentioned only in passing in mainstream Chinese historiography, then it most likely did not pose a threat to China and need not be included in the study. A historical narrative of China's nomadic rivals is provided in the Online Appendix A, and I discuss how China can be distinguished from its nomadic competitors in Online Appendix B.

When there was only one significant nomadic rival facing a Chinese dynasty, the computation of *diff* is straightforward. However, sometimes multiple nomadic competitors confronted a single dynasty. In such cases, I handpick the most threatening nomad for each decade, using historical data from Bai (1999), a determination that is often less ambiguous than may appear. For example, it is well known that until the Jin appeared, the most lethal challenger of the Northern Song was the Liao.

As an alternative measure, I define *diff_mean* as China's average dynastic age relative to that of all nomadic groups, with results that are robust to whether *diff* or *diff_mean* is used.[9] Moreover, I define *rival* as the number of significant nomadic rivals that a Chinese dynasty simultaneously confronted in each decade.

### 3.3 Historical climate data

Ideally, one should use historical climate data for the nomadic region to model nomads' incursions into China. Unfortunately, such information is not available. However, because

8 Although the founding year of the Cao Wei is traditionally set at 220, when Cao Pi (son of Cao Cao) seized the throne, I set its founding date at 196, when Cao Cao forced the last emperor of the Eastern Han to move the capital to Xuchang and became the Eastern Han's de facto regent. The results are robust to this treatment.

9 I thank an anonymous referee for suggesting the use of *diff_mean* as a robustness check.

the Mongolian steppe and north China share the monsoon characteristics of northeast Asia (Zhang and Lin, 1992), climate conditions in north China's agricultural zone could be used as a proxy for the neighbouring nomadic zone to the north. North China is defined as the combination of present-day Shandong, Shanxi, Henan, Hebei, and Shaanxi provinces as well as the Beijing and Tianjin municipalities, which are roughly located south of the Great Wall and north of the Qinling Mountain–Huai River line.[10] BK, using modern precipitation data from 1957 to 1990, report high correlations in the climatic conditions of these two regions. All climate data in this article pertain to north China.

Following BK, I use the decadal share of years with recorded drought disasters (*drought*) to proxy for less rainfall and the decadal share of years with a levee breach or flooding of the Yellow River (*levee*) to proxy for more rainfall. An alternative proxy for more rainfall is the decadal share of years with recorded flood disasters (*flood*). Other climate variables include the decadal share of years with snow disasters (*snow*) and the decadal share of years with frost or low temperature disasters (*frost*). Three sources are used to obtain the climate data. The data for *levee* are from *A Concise Narrative of Irrigation History of the Yellow River* (Editorial Committee of the Irrigation History of the Yellow River, 1982).[11] The data for *snow* and *frost* are from Zhang *et al.* (1994). Both Zhang *et al.* (1994) and Chen (1939) provide annual records of drought and flooding disasters, including the years and locations of relevant natural disasters.[12] Ultimately, all of these historical climate data come from voluminous official Chinese history books, such as *The Official History of the Twenty-five Dynasties*. The quantity of relevant information is so vast that the primary form of measurement error is presumably omission.[13] Having two separate data sources provides an opportunity not only for cross-checking but also to create a single, more complete data set. There is a substantial overlap between these data sources, and the coefficients of correlation for *drought* and *flood* at annual frequencies from these two data sources are both 0.68, indicating high-quality data. I combine these two data sources to generate a single data set for *drought* and *flood*. Any year for which either Zhang *et al.* (1994) or Chen (1939) record a drought or flooding disaster is counted as a year with a drought or flooding disaster. In general, Zhang *et al.* (1994) is more complete than Chen (1939), but the latter provides valuable complementary information.

In addition, I use two temperature anomaly series provided by paleoclimatologists to proxy for historical temperature variations. Tan *et al.* (2003) report temperature anomaly reconstructions derived from a correlation (with a correlation coefficient of 0.55) between thickness variations in annual layers of a 2,650-year-old stalagmite from Shihua Cave, Beijing, and instrumental meteorological records. Zhang *et al.* (2008) report another temperature reconstruction derived from a correlation (with a correlation coefficient of 0.8) between modern instrumental temperature records and oxygen isotope signals of a

10 This is the same as region 1 in Bai and Kung (2011).

11 I have excluded three instances of levee breaches of the Yellow River (years 1128, 1232, and 1234), breaches that were intentionally engineered for military purposes.

12 Care must be exercised in determining the locations of disasters and to include only disasters in north China. Chen (1939) and Zhang *et al.* (1994) include all disasters throughout China. I use Ci Hai Editorial Committee (1982) to determine the current locations of ancient places.

13 According to Deng (2000, p.7), '*The official history of the twenty-five dynasties* contains over 33 million words in classical Chinese. It takes at least 10 years' linguistic and historical training for a student to be able to understand the material'.

1,810-year-old stalagmite from Wanxiang Cave, Wudu County, Gansu Province between the Chinese Loess Plateau and the Qinghai-Tibetan Plateau.[14] I take a simple average of these two temperature series over each decade to proxy for temperature anomalies in north China (*temp*) in the past two millennia.[15]

### 3.4 Other data

In ancient times, country size arguably played a significant role in the outcomes of national warfare. As a rough measure, I define a dummy variable that indicates whether China was unified (*unified*), with China deemed a unified country whenever the Chinese regime controlled the majority of China proper, defined for simplicity as the combination of the Yellow River valley and the Yangzi River valley. This definition makes historical sense because these valleys constitute the historical core of Chinese civilization.

Another factor related to the outcomes of Sino-nomadic conflicts is the fact that the Great Wall was built as early as the Qin dynasty (221–207 BCE) to defend against nomadic invasions. However, China's boundary sometimes was to the south of the Great Wall (e.g., Western Jin, Eastern Jin, Northern Song, Southern Song), making the Great Wall irrelevant. Hence, I include another dummy variable to indicate whether China was under the effective protection of the Great Wall (*wall*). In determining whether China was unified or under the Great Wall's effective protection, I refer to Tan (1982).

## 4. Determinants of the Sino-nomadic border

In recent path-breaking work, exogenous variations in climate have been used as instrumental variables to estimate the causal effects of economic shocks on civil conflict (Miguel *et al.*, 2004; Ciccone, 2011; Miguel and Satyanath, 2011). Due to data availability and the fact that we are unclear about the intermediate channels through which historical climate shocks influenced Sino-nomadic conflict,[16] I employ reduced-form estimations in this study.

In this section, I study the determinants of the Sino-nomadic border as a proxy for partial nomadic conquest. The latitude data are highly persistent, and the first-order autocorrelation coefficients for three latitude variables all exceed 0.98. Thus, I take the first difference of these variables (labelled *D.border*) and model the increment of latitudes as follows:

$$D.border_t = \beta_0 + \beta_1 diff_t + \beta_2 age_t + \beta_3 rival_t + \beta_4 wall_t + \beta_5 unified_t + \boldsymbol{\beta}_6 L.\mathbf{climate}_t + \varepsilon_t \tag{4}$$

where *D.* is the difference operator, *L.* is the lag operator, and **climate** = (*drought flood levee snow frost temp*) is the climate vector. Both the Akaike and Bayesian information

14 Strictly speaking, Wanxiang Cave lies outside north China, as defined above. However, it is located in the south of Gansu Province, very near Shaanxi Province in north China.

15 Tan *et al.*'s (2003) data are available as annual temperature anomalies in Celsius with respect to the long-term mean for 665 BCE–1985 CE, whereas Zhang *et al.*'s (2008) oxygen isotope data are available for every 2–3-year period for 190–2003 CE. I first linearly interpolate the Zhang *et al.* (2008) data and then linearly transform these data to obtain the same magnitude of variations (minimum and maximum) as the Tan *et al.* (2003) data.

16 For example, although drought could motivate nomads to attack settled Chinese, it could also weaken the Chinese dynasty economically and militarily by instigating peasant riots, rendering China more vulnerable to invasion.

**Table 1.** Determinants of the Sino-nomadic border: a difference approach

| | (1) dborder_mean | (2) dborder_mean | (3) dborder_min | (4) dborder_min | (5) dborder_max | (6) dborder_max |
|---|---|---|---|---|---|---|
| *diff* | −0.00914*** | | −0.00855*** | | −0.00974*** | |
| | (0.00269) | | (0.00249) | | (0.00298) | |
| *diff_mean* | | −0.0131*** | | −0.0120*** | | −0.0142*** |
| | | (0.00406) | | (0.00381) | | (0.00457) |
| *age* | −0.0316 | −0.0289 | −0.0242 | −0.0222 | −0.0389 | −0.0356 |
| | (0.0247) | (0.0227) | (0.0220) | (0.0200) | (0.0282) | (0.0261) |
| *rival* | 0.502** | 0.523*** | 0.487** | 0.502** | 0.517** | 0.544*** |
| | (0.213) | (0.190) | (0.206) | (0.196) | (0.233) | (0.202) |
| *wall* | 1.018*** | 0.885** | 0.947*** | 0.817** | 1.089*** | 0.952** |
| | (0.371) | (0.358) | (0.359) | (0.341) | (0.405) | (0.398) |
| *unified* | 0.352 | 0.368 | 0.373 | 0.391 | 0.331 | 0.344 |
| | (0.272) | (0.284) | (0.323) | (0.320) | (0.263) | (0.292) |
| *L.drought* | −1.031** | −1.009** | −0.932** | −0.909** | −1.129** | −1.108** |
| | (0.439) | (0.438) | (0.416) | (0.413) | (0.495) | (0.497) |
| *L.levee* | −0.127 | −0.0684 | −0.150 | −0.0907 | −0.103 | −0.0461 |
| | (0.534) | (0.579) | (0.467) | (0.519) | (0.628) | (0.668) |
| *L.flood* | 0.659* | 0.545 | 0.667* | 0.559 | 0.651 | 0.530 |
| | (0.397) | (0.399) | (0.348) | (0.351) | (0.464) | (0.465) |
| *L.snow* | −1.159 | −1.418 | −0.731 | −0.981 | −1.588 | −1.856 |
| | (1.806) | (1.817) | (1.606) | (1.613) | (2.036) | (2.052) |
| *L.frost* | 0.123 | 0.376 | 0.0935 | 0.323 | 0.153 | 0.430 |
| | (0.589) | (0.591) | (0.567) | (0.560) | (0.642) | (0.658) |
| *L.temp* | 0.220 | 0.409 | 0.211 | 0.381 | 0.229 | 0.437 |
| | (0.273) | (0.290) | (0.247) | (0.256) | (0.313) | (0.337) |
| *_cons* | −0.961** | −0.835** | −1.059** | −0.935** | −0.863* | −0.735* |
| | (0.452) | (0.384) | (0.445) | (0.394) | (0.493) | (0.411) |
| *T* | 212 | 212 | 212 | 212 | 212 | 212 |
| $R^2$ | 0.217 | 0.230 | 0.210 | 0.220 | 0.206 | 0.220 |

*Notes:* Newey-West standard errors in parentheses. The truncation parameter is set to 5, using the formula $0.75T^{1/3}$. $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

criteria favour the first-period lag.[17] Because *D.border* is still serially correlated (albeit to a lesser extent), I estimate eq. (4) using OLS with Newey-West standard errors robust to heteroscedasticity and autocorrelation. The results are reported in Table 1.

Column (1) in Table 1 reports the results for *D.border_mean* with all regressors. The coefficient for *diff* is negatively significant at the 1% level, suggesting that the earlier a Chinese dynasty was established relative to a nomadic rival, the more effectively the nomads were able to push the Sino-nomadic frontier to the south. The coefficient for *L.drought* is negatively significant at the 5% level, indicating that less rainfall is associated with nomadic pushes into the Chinese heartland. The coefficient for *wall* is positively significant at the 1% level, confirming the defensive value of the Great Wall. Paradoxically,

17 Current values of climate variables performed rather poorly, so I do not include them in the regression.

the coefficient for *rival* is positively significant at the 5% level, implying that larger numbers of nomadic rivals were associated with placement of the Sino-nomadic border further to the north. A possible interpretation of this finding is that, because nomads also competed with one another (sometimes fiercely), the presence of multiple nomadic rivals might relieve pressure on the Chinese frontier. In contrast, a single nomadic rival, such as the Mongols and the Manchu Qing, could prove lethal to China. The coefficients for *age*, *unified*, and other climate controls are insignificant.

Column (2) of Table 1 replaces *diff* with *diff_mean*, yielding similar results. Columns (3) and (4) report regression results for the dependent variable *D.border_min*, whereas columns (5) and (6) report regression results for the dependent variable *D.border_max*. The results are qualitatively similar.

Overall, the effects of climate shocks, dynastic cycles, the presence of the Great Wall, and the number of nomadic rivals are found to be significant in determining the shifting Sino-nomadic border. Nevertheless, the $R$ squares of these regressions, as reported in Table 1, are typically only slightly above 0.2. Figure 1 plots predicted versus actual border shifts, according to column (1) of Table 1. Evidently, the predicted shifts mimic the directions of actual shifts fairly closely but often miss the magnitudes of the shifts (the correlation coefficient is 0.47). Many random factors (including personal factors, such as heroes or bunglers) were involved in determining how far nomads could push into the Chinese heartland.

Alternatively, I use the following autoregressive distributed lag (ADL) framework to model the serial dependence of the Sino-nomadic border:

$$\begin{aligned} border_t = \beta_0 + \gamma_1 border_{t-1} + \gamma_2 border_{t-2} + \beta_1 diff_t + \beta_2 age_t + \beta_3 rival_t \\ + \beta_4 wall_t + \beta_5 unified_t + \boldsymbol{\beta}_6 L.\mathbf{climate}_t + \varepsilon_t \end{aligned} \tag{5}$$

The lag orders of ADL (2,1) are determined by both the Akaike and Bayesian information criteria. In an ADL model with a sufficient number of lag orders included, serial

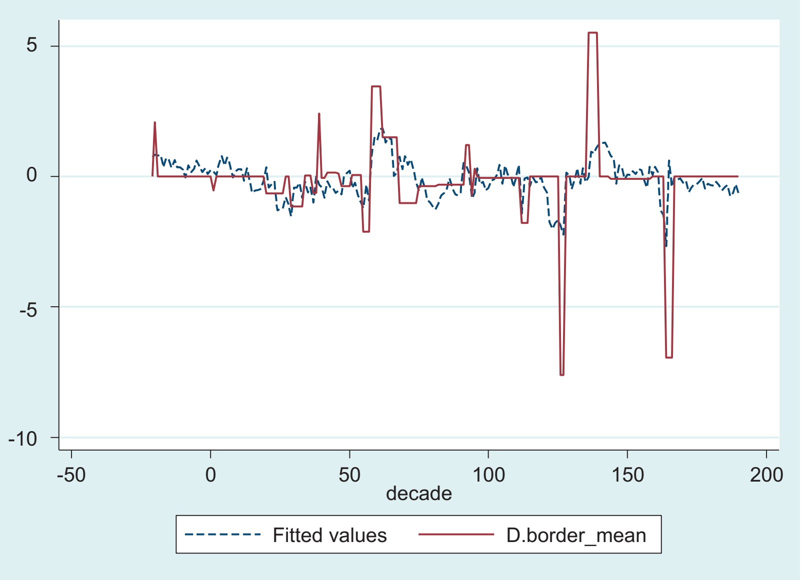


**Fig. 1.** Predicted border shifts versus actual border shifts

**Table 2.** Determinants of the Sino-nomadic border: an ADL approach

| | (1) border_mean | (2) border_mean | (3) border_min | (4) border_min | (5) border_max | (6) border_max |
|---|---|---|---|---|---|---|
| *L.border* | 1.514*** | 1.518*** | 1.461*** | 1.466*** | 1.536*** | 1.549*** |
| | (0.133) | (0.133) | (0.135) | (0.135) | (0.132) | (0.130) |
| *L2.border* | −0.559*** | −0.559*** | −0.512*** | −0.512*** | −0.579*** | −0.585*** |
| | (0.127) | (0.128) | (0.126) | (0.127) | (0.127) | (0.126) |
| *diff* | −0.00720** | −0.00697** | −0.00703** | −0.00671** | −0.00759** | −0.00758** |
| | (0.00298) | (0.00282) | (0.00274) | (0.00259) | (0.00329) | (0.00315) |
| *age* | −0.0273** | −0.0264** | −0.0224** | −0.0217** | −0.0315** | −0.0279** |
| | (0.0128) | (0.0124) | (0.0113) | (0.0107) | (0.0150) | (0.0135) |
| *rival* | 0.367** | 0.341** | 0.380** | 0.350* | 0.378*** | 0.342*** |
| | (0.152) | (0.146) | (0.186) | (0.185) | (0.136) | (0.121) |
| *wall* | 0.657*** | 0.734*** | 0.556** | 0.632*** | 0.754*** | 1.034*** |
| | (0.245) | (0.220) | (0.245) | (0.215) | (0.257) | (0.323) |
| *unified* | 0.465** | 0.408* | 0.550** | 0.495** | 0.415* | |
| | (0.230) | (0.223) | (0.255) | (0.233) | (0.245) | |
| *L.drought* | −0.453 | −0.633** | −0.459 | −0.637** | −0.478 | −0.562* |
| | (0.440) | (0.301) | (0.399) | (0.317) | (0.506) | (0.313) |
| *L.levee* | −0.561 | | −0.538 | | −0.587 | |
| | (0.582) | | (0.501) | | (0.668) | |
| *L.flood* | 0.179 | | 0.141 | | 0.189 | |
| | (0.541) | | (0.519) | | (0.588) | |
| *L.snow* | −0.0651 | | 0.0519 | | −0.159 | |
| | (1.092) | | (1.025) | | (1.211) | |
| *L.frost* | −0.679 | | −0.649 | | −0.748 | |
| | (0.620) | | (0.576) | | (0.704) | |
| *L.temp* | 0.102 | | 0.135 | | 0.0782 | |
| | (0.189) | | (0.174) | | (0.222) | |
| *_cons* | 1.032* | 0.819* | 1.102 | 0.850 | 1.079* | 0.841* |
| | (0.607) | (0.473) | (0.705) | (0.519) | (0.603) | (0.487) |
| *T* | 211 | 211 | 211 | 211 | 211 | 211 |
| $R^2$ | 0.986 | 0.985 | 0.982 | 0.981 | 0.986 | 0.986 |

*Notes:* Robust standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

correlation is no longer a concern, and only heteroscedasticity-robust standard errors are needed.[18] The regression results, presented in Table 2, largely parallel the corresponding results in Table 1.

Column (1) of Table 2 presents the estimation of eq. (2) with all regressors included and *border_mean* as the dependent variable. In column (2) of Table 2, insignificant regressors in column (1) are dropped sequentially until all regressors are at least significant at

18 For all ADL models in this study, I confirm residual whiteness by conducting $Q$ tests on the residuals. In addition, I confirm model stability by verifying that all roots of the characteristic equations fall outside the unit circle. I thank an anonymous referee for suggesting these diagnostic checks.

**Table 3.** Determinants of the Sino-nomadic border: an ADL approach with *diff_mean*

| | (1) border_mean | (2) border_mean | (3) border_min | (4) border_min | (5) border_max | (6) border_max |
|---|---|---|---|---|---|---|
| *L.border* | 1.502*** | 1.512*** | 1.450*** | 1.461*** | 1.524*** | 1.544*** |
| | (0.134) | (0.134) | (0.136) | (0.136) | (0.133) | (0.131) |
| *L2.border* | −0.548*** | −0.553*** | −0.502*** | −0.507*** | −0.568*** | −0.581*** |
| | (0.129) | (0.129) | (0.128) | (0.128) | (0.129) | (0.127) |
| *diff_mean* | −0.00965*** | −0.00878*** | −0.00932*** | −0.00832** | −0.0103*** | −0.00963*** |
| | (0.00365) | (0.00326) | (0.00357) | (0.00326) | (0.00390) | (0.00351) |
| *age* | −0.0267** | −0.0271** | −0.0220** | −0.0226** | −0.0308** | −0.0282** |
| | (0.0128) | (0.0128) | (0.0110) | (0.0109) | (0.0152) | (0.0142) |
| *rival* | 0.378** | 0.327** | 0.388** | 0.331* | 0.392*** | 0.327*** |
| | (0.160) | (0.147) | (0.196) | (0.188) | (0.143) | (0.118) |
| *wall* | 0.539** | 0.624*** | 0.439* | 0.524** | 0.634** | 0.941*** |
| | (0.235) | (0.204) | (0.236) | (0.204) | (0.246) | (0.297) |
| *unified* | 0.501** | 0.445* | 0.583** | 0.529** | 0.452* | |
| | (0.242) | (0.239) | (0.262) | (0.245) | (0.261) | |
| *L.drought* | −0.441 | −0.655** | −0.445 | −0.650** | −0.466 | −0.575* |
| | (0.439) | (0.300) | (0.397) | (0.316) | (0.504) | (0.305) |
| *L.levee* | −0.495 | | −0.472 | | −0.522 | |
| | (0.547) | | (0.473) | | (0.626) | |
| *L.flood* | 0.0745 | | 0.0404 | | 0.0769 | |
| | (0.530) | | (0.515) | | (0.572) | |
| *L.snow* | −0.305 | | −0.180 | | −0.412 | |
| | (1.173) | | (1.086) | | (1.306) | |
| *L.frost* | −0.508 | | −0.485 | | −0.563 | |
| | (0.630) | | (0.579) | | (0.716) | |
| *L.temp* | 0.232 | | 0.260 | | 0.218 | |
| | (0.215) | | (0.192) | | (0.254) | |
| *_cons* | 1.172** | 0.948** | 1.238* | 0.964* | 1.224** | 0.983** |
| | (0.582) | (0.475) | (0.687) | (0.521) | (0.574) | (0.487) |
| *T* | 211 | 211 | 211 | 211 | 211 | 211 |
| $R^2$ | 0.986 | 0.985 | 0.982 | 0.981 | 0.987 | 0.986 |

*Notes:* Robust standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

the 10% level. In columns (3) and (4), the dependent variable is *border_min*, whereas in columns (5) and (6), the dependent variable is *border_max*.

For a dynamic regression such as eq. (5), it is straightforward to calculate the long-term effects. For example, according to column (2) of Table 2, the long-term effect of a one-year increase in *diff* on the latitude of the Sino-nomadic border is (–0.00697)/$(1-1.518+0.559)=0.17$ degrees, whereas the long-term effect of a one-unit increase in *drought* (i.e., an increase in the decadal frequency of drought from 0 to 1) on the latitude of the Sino-nomadic border is (–0.663)/$(1-1.518+0.559)=15.44$ degrees, which is a large effect.

In Table 3, all columns of Table 2 are reestimated by replacing *diff* with *diff_mean*, with results that are again qualitatively similar. There are, however, two notable differences between the results of the ADL approach in Tables 2 and 3 and the difference approach

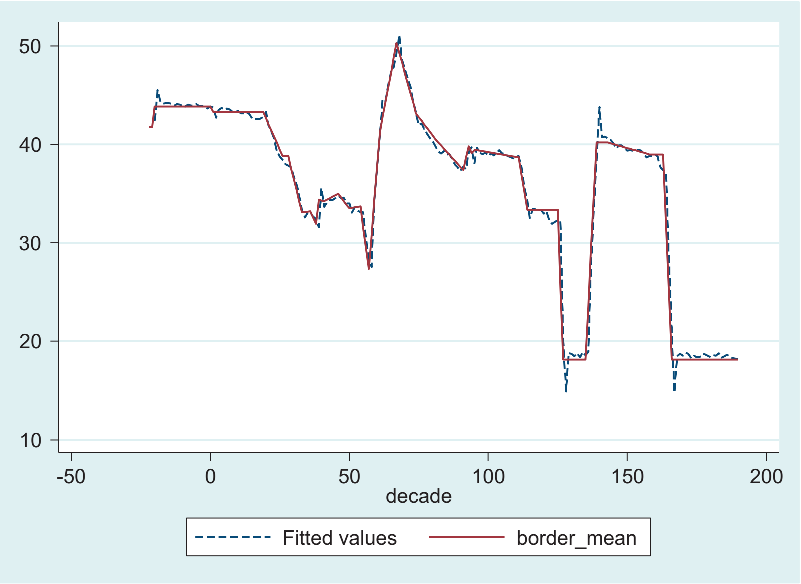


**Fig. 2.** Predicted border versus actual border

in Table 1. First, the model fit increases dramatically to over 0.98. Figure 2 plots the predicted versus actual *border_mean*, according to column (1) of Table 2. Second, the coefficient for *age* (absolute dynastic age) becomes negatively significant at the 5% level. The coefficient for *unified* also gains significance and has a positive sign. Apparently, older Chinese dynasties were more likely than younger dynasties to lose ground to northern nomads (contrary to the hypothesis that the power of Chinese dynasties declined at a slower rate than that of their nomadic counterparts), whereas a unified China was better able to hold its ground.

## 5. Determinants of nomadic conquests

In this section, I study the determinants of complete nomadic conquests, using the dummy variable *conquered* as the dependent variable:

$$conquered_t = \beta_0 + \beta_1 diff_t + \beta_2 age_t + \beta_3 rival_t + \beta_4 wall_t + \beta_5 unified_t + \boldsymbol{\beta}_6 L.\mathbf{climate}_t + \varepsilon_t \tag{6}$$

where *L*. denotes a one-decade lag. In choosing the lag order, both the Akaike and Bayesian information criteria favour the use of only one lag. It is natural to estimate eq. (6) using a logit model.[19] The results are reported in Table 4.

Column (1) of Table 4 reports the results when all regressors are included. The coefficient for *diff* is again positively significant at the 5% level, the coefficient for *L.drought* is positively significant at the 1% level, and all other variables are insignificant.

19 Results of probit regressions are similar, so I only report logit results throughout this article, to conserve space.

**Table 4.** Determinants of nomadic conquest (dependent variable: *conquered*)

| | Logit (1) | Logit (2) | Marginal effects (3) | Logit (4) |
|---|---|---|---|---|
| *diff* | 0.0388** | 0.0386*** | 0.00103** | |
| | (0.0178) | (0.00916) | (0.000428) | |
| *diff_mean* | | | | 0.0206** |
| | | | | (0.00842) |
| *age* | −0.338 | −0.263*** | −0.00700* | −0.0304 |
| | (0.251) | (0.0962) | (0.00407) | (0.0753) |
| *rival* | 0.800 | | | |
| | (0.806) | | | |
| *wall* | −2.182 | −2.486* | −0.0661** | −1.796 |
| | (2.351) | (1.282) | (0.0331) | (1.096) |
| *unified* | −0.0216 | | | |
| | (2.393) | | | |
| *L.drought* | 6.659*** | 3.915*** | 0.104** | 3.029** |
| | (2.517) | (1.375) | (0.0459) | (1.374) |
| *L.levee* | −1.603 | | | |
| | (2.857) | | | |
| *L.flood* | −0.839 | | | |
| | (2.568) | | | |
| *L.snow* | 5.553 | | | |
| | (6.790) | | | |
| *L.frost* | −5.089 | | | |
| | (4.705) | | | |
| *L.temp* | 0.357 | | | |
| | (1.535) | | | |
| *_cons* | −4.818*** | −3.361*** | | −4.181*** |
| | (1.445) | (1.039) | | (1.100) |
| *T* | 212 | 212 | 212 | 212 |
| Pseudo $R^2$ | 0.399 | 0.303 | 0.303 | 0.145 |

*Notes:* Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

After insignificant regressors have been sequentially dropped, the variable *age* is found to be negatively significant at the 1% level in column (2) of Table 4. Thus, given relative dynastic age *diff*, an older China was more difficult to conquer, which is consistent with the hypothesis that the power of nomadic regimes declined at a faster rate than that of agricultural regimes. Figure 3 graphs the predicted probability of conquest from column (2) of Table 4 against actual conquests. Evidently, most actual conquests coincided with peak values of the predicted probability of conquest.

To facilitate interpretation, column (3) of Table 4 reports average marginal effects for column (2). For example, when *diff* increases by one year, the likelihood of China being conquered increases by 0.1% on average. However, when *drought* increases by one unit (i.e., the decadal frequency of droughts increases from 0 to 1), the probability of China being conquered increases by 10.4% on average, which is a large effect. As a robustness check, column (2) is re-estimated in column (4) by replacing *diff* with *diff_mean*, with similar results.

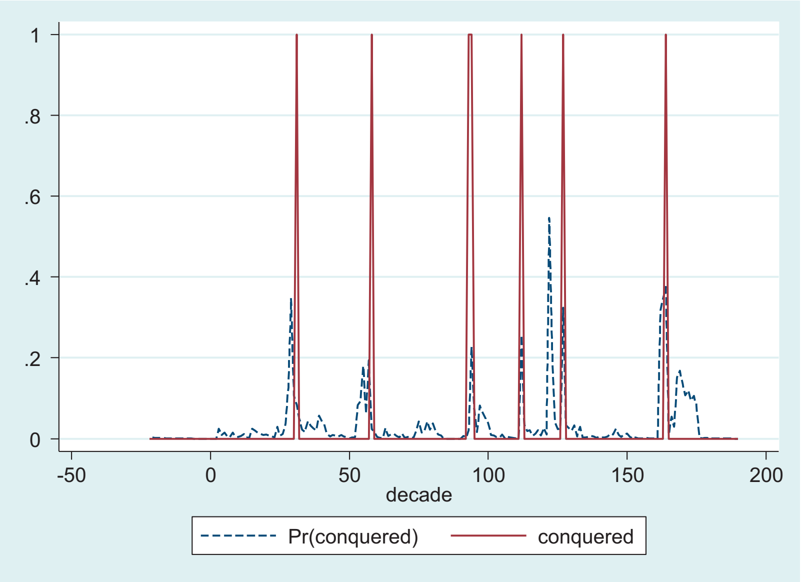


**Fig. 3.** Predicted probability of conquest versus actual conquests under the decadal approach

**Table 5.** Robustness checks (dependent variable: *conquered*)

| | Logit (drop Yuan, Qing) (1) | Heckman selection (2) | Logit (rare events) (3) | Complementary log-log (4) |
|---|---|---|---|---|
| *diff* | 0.0516*** | 0.0283*** | 0.0312*** | 0.0343*** |
| | (0.0142) | (.00808) | (0.00895) | (0.00808) |
| *age* | −0.445** | −0.244*** | −0.201** | −0.226** |
| | (0.174) | (0.0880) | (0.0940) | (0.0984) |
| *wall* | −1.413 | −0.701 | −2.136* | −2.282** |
| | (1.329) | (0.540) | (1.253) | (1.136) |
| *L.drought* | 5.501*** | 2.542*** | 3.431** | 3.508*** |
| | (2.103) | (0.728) | (1.344) | (1.315) |
| *_cons* | −3.449*** | −1.826*** | −3.041*** | −3.412*** |
| | (1.259) | (0.499) | (1.015) | (1.070) |
| *T* | 177 | 212 | 212 | 212 |
| Pseudo $R^2$ | 0.357 | 0.103 | | 0.299 |

*Notes:* Robust standard errors in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

Additional robustness checks are reported in Table 5. Column (1) of Table 5 drops the Yuan and Qing dynasties, both of which were ruled by nomads, which may have reduced their likelihood of being conquered by nomads still active in the central Asian steppes. The results are qualitatively similar.

However, nomadic control of agricultural land is likely to be endogenous. Following BK, I use a Heckman-style probit model with sample selection to address potential sample selection bias.[20] The results, reported in column (2) of Table 5, are qualitatively similar. However, the $p$-value for testing the null hypothesis, $\rho = 0$, is 0.33. Thus, sample selection bias is minimal, and the sample selection model is unnecessary.

As there were only seven nomadic conquests among 213 decadal observations, conquests may be deemed rare events. Hence, the data may suffer from rare event bias, with small-sample results distorted. I address possible rare event bias in two ways. First, I use a corrected logit model, proposed by King and Zeng (2001a,b), that specifically corrects for rare event bias. The results, presented in column (3), are qualitatively similar to those obtained above. Second, for rare events, it is common to use the asymmetric complementary log-log model in which the probability approaches 1 faster than it approaches 0. The results, presented in column (4), again resemble those obtained above.

## 6. Conclusion

To the best of my knowledge, this article is the first systematic study of the determinants of nomadic conquest. Hence, it complements current literature, which focusses on the incidence of conflicts rather than the outcomes. The effects of nomadic conquests are arguably more substantial and durable than the incidence of conflicts, and the former may play a much more decisive role in economic development in the long term. Moreover, whilst climate shocks might help explain the incidence of conflicts, their net effect on outcomes is ambiguous (e.g., climate shocks might also reduce the military strength of nomads). The present study, however, drawing on empirical data, finds a positive effect. Additionally, this article, to the best of my knowledge, is the first study to quantify the significant effects of dynastic cycles on conflicts.

Using a unique dynastic and climate data set from historical China covering the past two millennia, the main conclusions of this study are twofold. First, consistent with the dynastic cycle hypothesis, the likelihood of China being conquered was significantly and positively related to the number of years earlier that a Chinese dynasty was founded relative to its nomadic rival. To a degree, whether a Chinese dynasty was conquered by a nomadic regime depended on a timing mismatch between the Chinese dynasty and its nomadic counterpart. That is, a growing new Chinese dynasty could usually defend itself, whereas an aging Chinese dynasty often could not resist a rising nomadic power. Second, climate shocks played a significant role in nomadic conquests, as the likelihood of conquest increased with less rainfall as proxied by drought disasters. These results contribute to our understanding of the perennial conflict between settled and nomadic peoples in ancient China and throughout world history.

## Supplementary material

Supplementary material is available online at the OEP website

20 The variables in the selection equation are *diff*, *age*, and *L.drought* (including *wall* in the selection equation would make convergence more difficult).

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