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A PERSISTENT SHOCK ON POPULATION DISTRIBUTION FROM CAPITAL RELOCATION IN ANCIENT CHINA*

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With a self-constructed, unique historical data set for 240 counties that spans over centuries, this paper uses the 'quasi-natural experiment' of capital relocation in 1421, during China's Ming Dynasty, as an exogenous shock to study the relationship between political governance and urban systems. We found that after the Chinese Empire's capital was relocated from Nanjing to Beijing, the effects of the distance to Beijing on county-level population turns from positive to negative persistently till modern China. We also provide evidence to show that the impact of the capital relocation on population distribution is through three major channels of political governance, such as delivery, material support and national security. The causal relationship from capital relocation to population distribution is robust based on evidences from a variety of identification strategies, and robustness checks. ***JEL Codes:*** N95, O18, R11, R12.

Keywords: Capital Relocation; Population Distribution; Urban System; Political Governance.

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In contrast to the occident, the cities in China and throughout the orient lacked political autonomy. The oriental city was not a "polis" in the sense of Antiquity, and it was not a "commune" with political privileges of its own (p.13).

The prosperity of the Chinese city did not primarily depend upon the citizens' enterprising spirit in economic and political ventures but rather upon the imperial administration (p.16).

——*The Religion of China, Confucianism and Taoism* by Max Weber, 1951

I. Introduction

As cities develop, they form an urban system, where a core city at its center interacts and interconnects with other cities of varying traits, size and types. In countries and regions with a long history, urban systems began to form a long time ago. For example, certain areas of Europe in the Pre-Industrial Revolution era already formed urban systems (Bosker and Buringh, 2015), and China, an ancient civilization with over 5000 years of history, formed urban systems even earlier. An urban system is usually quite stable unless a shock is strong enough to change it. Although recent theories in urban economics have shown that the urban system is changeable, we still lack evidence to prove that an urban system can be altered by an exogenous and large shock, though a specific city may have been documented to expand or downsize.[1] In literature, urban system persists even after a country's industrialization and urbanization (Eaton and Eckstein, 1997), or wide-scale destruction such as American bombing in Vietnam during 1955-1975 (Miguel and Roland, 2011) and in Japan during WWII (Davis and Weinstein, 2002),[2] or relocating the upper-tail of human capital during China's planned system era (Xia and Lu, 2019).

The history of Imperial China offers an opportunity to study the influence of political governance on the evolution of urban system. The development of ancient Chinese or other orient cities relies on the imperial administration, while the western cities in ancient and medieval era are products of the development of commerce, especially overseas trade (Weber and Gerth, 1951).[3] Under the political centralization system,[4] the capital city is a potent symbol of authority, and in theory, moving the capital

1. Changes in the urban system reflect changes in the relationship between the core city and the other surrounding cities, which is different from the decline or expansion of a city's development.

2. Some studies have found that war has an effect on population distribution. Bosker et al. (2008) found that the WWII had an impact on the population distribution of German cities. Some studies have found that war may or may not impact urban systems, for example, after the Allied bombing of Japanese cities during World War II, Japanese cities returned to their relative position in the distribution of city sizes within about 15 years (Davis and Weinstein, 2002). Also, urban systems were not destroyed during the Vietnam War (Miguel and Roland, 2011). Several reasons lead to these different conclusions: First, an exogenous impact from war that is not large enough, causing different studies to reach different conclusions regarding the impact of war upon urban systems. Second, Bosker et al. (2008) only examined the evolution of the city size distribution in West-Germany, but under the post-war division of Germany, the effects of war and institutions on population distribution cannot be distinguished. Finally, Bombing or war is a short-term shock.

3. Chinese cities lack the political power and residents lack the spirit of economic and political adventurous, which are unique characteristics of Western cities (Weber and Gerth, 1951).

4. In most of the time since the Qin Dynasty (221 -201 B. C.), China has been a unified and politically centralized nation-state.

should be considered as a sufficiently large shock so as to change the existing urban system in a country. The main concern of this paper is to study how, under the political centralization system, political governance impacts population distribution, the urban system's most important metrics. We focus our research on China for multiple reasons. Firstly, under the political centralization system, the capital city has an important status which impacts the cities under its rule. The development of ancient Chinese cities relied on the manager of imperial administration (Weber and Gerth, 1951).[5] Secondly, we have long-term data on China's population across centuries. Lastly, there was a 'quasi-natural experiment' of capital relocation in Chinese history which has long-term and persistent effects, serving as a strong and random shock shifting the urban system. With a self-constructed unique data set for 240 counties over centuries, this paper uses the 'quasi-natural experiment' of capital relocation in 1421 during China's Ming Dynasty as an exogenous shock, to study the relationship between the political governance and the development of China's urban system. We found that after the Chinese empire's capital was relocated from Nanjing to Beijing, the effects of the distance to Beijing on county-level population turns from positive to negative, persistently till modern China. The causal relationship between capital relocation and population distribution is robust based on evidences from a variety of identification strategies and robustness checks. Before our work, several factors have already been known in the formation of the urban system, such as natural geography (Bosker and Buringh, 2015; Gabaix, 1999a, b), economic geography or agglomeration (Fujita and Mori, 1997; Krugman, 1993), cultural systems (Markusen and Gadwa, 2010), regional policy (Glaeser, 2011),[6] war (Bosker et al., 2008), and institutional systems (Acemoglu, Johnson and Robinson, 2005). This paper contributes another factor, political governance, to the literature of the shaping of urban systems, and also enriches the literature pioneered by Skinner (1977) on Chinese urban systems from a historical perspective. Besides, we also add evidence to existing literature by showing that the impact of political governance on population distribution is through such channels as information delivery, material support and national security.

Urban development varies based on regional differences, and the various mechanisms impacting urban development formation include: First, the natural geographic features. The first natural feature is the natural geography of a region, weather, and natural resource reserves, which will further affect the location and development of a city (Black and Henderson, 2003; Chandler, 1972; Davis and Weinstein, 2002, 2008; Ellison and Glaeser, 1999; Ellison, Glaeser and Kerr, 2010; Holmes and Lee, 2012; Hornbeck, 2012; Kim, 1999; Rappaport and Sachs, 2003). The second natural feature is the characteristics of human development, such as the presence of railroads, ports, traditional culture, laws, etc., which will determine the location choice of production and population density (Atack et al., 2010; Ciccone and Hall, 1993; Donaldson, 2015; Redfearn, 2009; Rosen, 2003). The third natural feature is the presence of potential markets or competitors, according to the "core-periphery" model of urban system, will also influence a city's development (Black

5. In China, counties are actually like cities in Europe and North America. In modern China, a prefecture-level city is actually composed of a central city and its surrounding county-level cities.

6. For example, the impact of Chicago's open ports and waterways on urban systems.

and Henderson, 2003; Bosker and Buringh, 2015; Davis and Weinstein, 2003; Krugman, 1993, 1991; Lu, 2017).[7]

Second, the delivery mechanism. Transport infrastructure plays an important role in shaping the configuration of spatial socio-economic structures and influences regional accessibility. Krugman (1993) found that higher transportation costs caused populations to be nearer to natural resources. The main roads were typically built along paths requiring the lowest cost, helping to alleviate transportation costs, and easing the disadvantages faced by cities located far from core urban areas (Bosker and Buringh, 2015; Song, Chen and Liang, 2015). Theory has suggested that major transportation innovations have exhibited profound and prolonged interdependencies with patterns of growth in national or regional urban systems (Goetz, 1992). As a result, areas with faster delivery had an easier time developing into cities.

Third, the material support mechanism. Skinner (1977) pointed out that in agricultural societies such as ancient China, labor and animal transportation costs were very expensive, populations clustered around resource-rich areas, and the interactions and communications between cities with large geographical distances were low. Since grains and cereals were the most important materials in ancient China, the areas with ample food supply have agglomerated more population, and experienced better development. Once transportation costs are reduced, the areas' development reliance on the food supply or other materials will be changed. For example, the development of water transportation in 19th century America enabled the rapid development of cities such as Detroit, New York and Chicago (Glaeser, 2011).[8]

Fourth, security protection mechanism. Cities with walls, military garrison, and larger population, are safer (Glaeser, 2011; Glaeser and Shapiro, 2002; Powell, 1962).[9] This not only influenced a city internally, but also the surrounding areas. As such, areas which could provide stronger security had higher population densities and had higher probability to be developed into cities. Another factor closely tied to the security is the impact of war or terrorism strikes upon urban development. War or terrorist strikes can have both positive and negative influences on urban infrastructure. During war or times of strife, population centers have an advantage in mounting a defense or counteroffensive, transportation costs rise and cities are the main targets of violence during such times (Glaeser and Shapiro, 2002). The first two factors have positive impact on the development of cities, while the last factor will inhibit urban development. Bosker et al. (2008), for instance, found that WWII had a profound, lasting impact on the development of German cities, yet Glaeser and Shapiro (2002) found that the impact of terrorism on cities throughout America is generally quite small.

7. Some literatures classified the second and third geographic features into the same category. Ioannides and Overman (2004, 2003) classify the second geographic feature as a result of the spatial structure of the economic system.

8. The cost of transportation via waterways is low. For example, in 1816, the cost of transporting goods overland in the United States for 30 miles was equivalent to the cost of sending them across the Atlantic Ocean (Glaeser, 2011).

9. Local military garrison was under the jurisdiction of the central government in ancient China (Weber and Gerth, 1951).

Last, other mechanisms, such as religious reform (Glaeser, 2011),[10] innovation and human capital (Glaeser, 2011; Lampard, 1955)[11], as well as political institution (Acemoglu et al., 2005; De Long and Shleifer, 1993; Glaeser, 2011),[12] have impact on the development of a city.

The remainder of this paper is organized as follows. In the next section, we describe institutional background, data and empirical strategy. In section 3, we report our estimation results, and analyze the relationship between political governance and population distribution. Section 4 examines some specific mechanisms through which the political governance affects the population distribution. In section 5, we have a further discussion on some other possible problems. Section 6 concludes.

II. Institutional Background, Data and Empirical Strategy

II.A. Institutional Background

II.A.1. Political Centralization and State Capital

Political centralization system vests all political power within the central government, weakening the power of local government. In 221 B.C., Qin Shi Huang, China's first emperor, conquered six other kingdoms and established his authoritarian rule, the political centralization system, laying the foundation of the Chinese political system during the period of dynastic rule, which extended after his reign for more than 2000 years up until 1911. After his campaign of unification, Qin Shi Huang established his capital city and county system (*Jun-Xian Zhi*), which divided cities into four levels: *Guo, Jun, Xian, Yi. "Guo"* means the country's capital city, and this category demonstrates the importance of the capital city within this system. Glaeser (2011) pointed out that, the greater concentration of political power within a country, the larger and more important its capital city will be. Although China has experienced many changes in both political dynasties and capital cities since the time of Qin Shi Huang and those areas have remained important cities up until the present time, such as Beijing, Nanjing, Luoyang, Xi'an, etc. On the other hand, although China changed capital cities quite frequently over its history, the decisive role which the central government plays in urban development has not changed, and the capital city in all dynasties was the economic, cultural and transportation center of the nation.

10. Religious competition can create more choices in church rules and doctrine, and lead to various reforms such as the abolition of usury laws, helping promote the development of global commerce.

11. Duranton and Puga (2001) found that innovative shocks are the basis for urban development; Glaeser (2011) pointed out that Boston and Milan's success lies in their constant adjustment of positioning and attracting human capital; Lampard (1955) found that cities are more productive and agglomerated larger population, if the cities allowed for greater specialization, knowledge spillovers and provided more efficient public services and facilities.

12. Glaeser (2011) found that Tokyo's success is due to its role as the political center of a politically-centralized country. Acemoglu et al. (2005) pointed out that institutions have a significant impact on a region's economic productivity. De Long and Shleifer (1993) found that in areas under authoritarian rule, urban commerce is comparatively lagging, and that areas where businessmen have the freedom of expression and voting rights have faster urban development.

In a country with centralized political system, the capital city is the location of the central government, with a high density of government bureaucrats and governing offices, etc. The capital city also serves as a reflection of political governance through the promulgation of governmental laws and regulations, and the influence of a capital upon a region cannot be ignored. However, very little of the existing literature has studied the influence of political governance on urban development and urban system.

Why does political governance affect urban systems? The centrality of the capital city is reinforced through various political events, such as paying tribute to the emperor, and large amounts of societal resources, such as material and political wealth, are concentrated in the capital city, so the closer a city lies in proximity to the capital, the more resources it can access. In addition, beginning with Qin Dynasty, China began to construct a series of roads known as *Chidao*, stretching all across the major places of the country, and also building courier stations (*Yizhan*) all along main roads, facilitating the delivery of information and providing national security (Fu, 2011). Lastly, capital city served as the headquarters for national defense and military command, accompanied by the presence of a large defensive force to defend against invaders and maintain social stability.

II.A.2. Why Analyzing Ming Dynasty in China?

This paper utilizes the event of relocating China's imperial capital city from Nanjing to Beijing during the Ming Dynasty to analyze the impact of political governance on the urban systems. Why studying capital relocation in Ming Dynasty? Firstly, each dynasty in China's imperial history will choose its capital city based on geographical and historical reasons. Most researches on capital city and urban systems have endogeneity problems, and cannot identify if the capital city or other missing factors have impact on urban systems. Secondly, once urban systems have formed, they are relatively stable, and only a fairly significant external shock can break an existing urban system. However, existing literature has not found an external event changing an urban system (Davis and Weinstein, 2002; Miguel and Roland, 2011). The reason may be that the exogenous events previously studied were not strong enough compared with the persistence of an urban system, or that the shock was purely temporary and shortly reversed. A shock that alters the urban system should have long-term and persistent effects. Under the political centralization system, the capital city plays a critical role in the overall urban system, and the capital relocation in the Ming Dynasty can serve as a large enough exogenous shock to change the overall population distribution. Thirdly, China is one of only a few nations with a long history of unification in the world, whose historical data can be collected. Moving from Nanjing to Beijing during the Ming Dynasty is the most significant and recent capital relocation in China,[13] which has long-term and persistent effects on cities. Lastly, this event occurred within Ming Dynasty governed by the same family, whose governing concepts and culture did not change drastically. During the

13. Beijing was not only the capital of the Ming Dynasty following Zhu Di's reign, but was also the capital of the Qing Dynasty, Republican China and the modern-day People's Republic of China. Although the Republic of China moved the capital to Nanjing after 1927, and to Chongqing due to the Japanese Invasion, this was only transitory. Therefore, this paper ignores that period.

reign of Hongwu era (1368-1398), Emperor Zhu Yuanzhang, the founder of the Ming Dynasty, was a decisive and authoritative ruler, who presided over the establishment of the Ming Dynasty's political, military, economic, legal and cultural systems, leaving numerous imperial edicts, statutes, and regulations for his descendants, the future rulers of the Ming Dynasty, to follow. Although Emperor Zhu Di gained his imperial throne by force, his style of governance and culture were similar to that of his father, Zhu Yuanzhang. By contrast, the governing principles and cultural differences between emperors and officials of different dynasties differ greatly, with quite different political and economic environments as well. Even though capitals had changed before in Chinese history, it is hard to separate out the influence of other factors, such as change of the dynasties, from capital relocation. Because of these reasons, the Ming Dynasty's capital relocation serves as a "quasi-natural experiment" to analyze how political governance affects urban system.

II.A.3. Set Capital in Nanjing and Capital Relocation to Beijing

In the Lunar New Year of 1368, Zhu Yuanzhang established China's Ming Dynasty, selecting Nanjing known as *YingTianFu*, as capital city, and this period came to be known as the *Hongwu* era. Zhu Yuanzhang selected Nanjing as the Ming Dynasty's first capital city for multiple reasons. Firstly, during Yuan and Song Dynasties, the cultural and economic center of China had already moved to south. Selecting Nanjing as the capital allowed the country's political, economic and cultural centers to be combined. Secondly, Zhu Yuanzhang had long used Nanjing as his military base, and he had developed the infrastructure over a long period after he established his rule over the Nanjing and surrounding areas. Finally, during the beginning of the Ming Dynasty, there were many other urgent priorities, and the cost of building a new capital city was prohibitive both from material and financial standpoint. Zhu Yuanzhang advocated frugality, and his close associates also opposed establishing a new capital in Beijing.

Although Nanjing was the country's economic center, there were also some drawbacks to establish the capital city here.[14] During the 24th year of his reign, Zhu Yuanzhang sent his Crown prince Zhu Biao to select the site of a new imperial capital, but when Zhu Biao returned from his trip, he became violently ill, and died a year later. This accidental event forever removed the idea of changing the capital from Zhu Yuanzhang's mind. Although Zhu Yuanzhang never changed the capital during his reign, he had begun taking some exploratory moves to deal with Nanjing's shortcomings as a capital. For example, in order to deal with the remnants of the former Yuan Dynasty, he organized a Northern Expedition. In order to deal with subsequent unrest from minority groups in China's north, he left several generals such as Xu Da and his son, Zhu Di, becoming Yongle Emperor later, stationed in Beijing (named Beiping at that time).

14. The drawbacks of establishing a capital in Nanjing were: first, previous dynasties based in Nanjing had not lasted for very long; second, Nanjing's imperial bearing and grace were destroyed; third, Nanjing's geographic position was towards China's southeast, presenting no military advantages.

In 1398, the 31st year of his reign, Zhu Yuanzhang passed away, leaving his grandson Zhu Yunwen to take the throne as the Hui Emperor, whose reign title was Jianwen. The new emperor soon faced strong pressure from the princes within the imperial family. The Hui Emperor and his close associates came up with a plan to revoke the power of the various princes and solidify his imperial. In particular, Zhu Yunwen was particularly fearful of his uncle Zhu Di, known as the Prince of Yan, who had many years of experience leading his army in Beijing. The Hui Emperor tried to employ a strategy of "amputation", stripping Zhu Di's five closest brothers that were born from the same mother, while transferring Zhu Di's elite troops away from Beijing in the name of border defense, and sends his own royal troops surrounding Beijing. In 1399, the Hui Emperor conspired to set a trap and tried to arrest Zhu Di, but Zhu Di anticipated this trap and led his troops to occupy Beijing. Using Zhu Yuanzhang's Imperial Admonitions (*Huang-Ming Zuxun*) as a justification,[15] Zhu Di immediately launched a campaign to "Save the Emperor from his Internal Enemies", known as the *Jingnan* Campaign. In 1403, Zhu Di got victorious and claimed the imperial throne. The final ending of *Jingnan* Campaign was an accidental event, from the viewpoint of military strength or moral standing. In the first two years of the *Jingnan* Campaign, Huidi held an advantage over Zhu Di. At the end of the third year of *Jingnan* Campaign, Zhu Di received a secret report that the capital city was empty, and Zhu Di led his troops to attack Nanjing directly. In June of 1402, Zhu Di's troops occupied the capital city and killed his political enemies. Zhu Di won the imperial throne, and he set his reign title as Yongle. This accidental success was the first time in Chinese history that a rebellion by an imperial prince within the same dynasty overthrew the current emperor.

Choosing Beijing as the new capital was also a result from Zhu Di's accidental success. In 1405, Zhu Di renamed the city of Beiping to Beijing, and began to establish his government bureaucracy in Beijing, starting with the Imperial Academy (*Guozijian*). By 1416, Zhu Di announced his plans to move the capital city, and in the next year he began wide-scale construction to develop Beijing. In 1420, the construction was completed, and Zhu Di move the capital city from Nanjing to Beijing in 1421. During this time, he emulated Zhu Yuanzhang's policy of "moving the rich", transferring wealthy households from wealthy regions, particularly south of the Yangtze river, to the areas around Beijing, developing the local economy there. Besides, Zhu Di organized clearing the Grand Canal for transportation, ensuring Beijing's food and material supply.

For the reasons outlined below, Zhu Di's decision to move the capital from Nanjing to Beijing is an exogenous event to population distribution in ancient China. Firstly, Zhu Di's ascension to the throne was essentially the work of a coup d'état, and the ending of the conflict was a contingent event. Beijing served as the residence place of Zhu Di during his time as the Prince of Yan, and had he not taken the Imperial throne, Beijing would not necessarily become the capital of China. Secondly, after the *Jingnan* Campaign, Zhu Di moved all the princes originally responsible for border defenses into the hinterland, which almost

15. Zhu Yuanzhang designed "*Huang-Ming Zuxun*" in his late reign: if there are disloyal officials in the imperial court, the princes and imperial guards have duty to train troops for the emperor and leading these troops to eliminate traitors. However, these regulations provide pretense for the princes to fight against the central government.

hollowed out the Ming Dynasty's northern defenses, while Mongol tribes began to launch harassing raids in northern China. On one hand, the political risk of leaving northern China's defenses under the defense of powerful generals far from imperial power was too great. On the other hand, in the early Ming Dynasty, the government was limited by economic capacity, and certainly could not simultaneously support two large armies: one to defend the northern border and one to ensure domestic national security. Living through these turbulent times prompted Zhu Di to move his capital. On the strength of the above, especially the first reason, and the rapid completion of the move, we can assume that the capital relocation to Beijing is an exogenous shock.

II.B. Data and Empirical Strategy

II.B.1. Data

Population Distribution Population distribution is one of the most important measurement for urban systems. Cities grow along with their populations' development, and the number and scale of cities also increases as populations grow (Black and Henderson, 1999; Fujita and Mori, 1997). Although regional populations in history have included "urban" and "non-urban" populations, before the modern society, given the agricultural and transportation technology, the number of urban population in a city is determined by the surrounding agricultural population and their products (Zhao, 2006). China's cities were small and few in number, and they were inextricably linked in agriculture and rural areas around them, and cities often contained farmland and farmers mixed amongst their residents (Davis, 1955; Van Werveke, 1963). On the other hand, population movements were strictly controlled and mainly guided by government officials and bureaucrats during Ming and Qing Dynasties.[16] Therefore movements and changes in the population brought about by capital relocation were mostly from the "urban population". As such, this paper assumes that in places with a large population, the urban population is also high. In other words, the total population of a region is positively related to the urban population. The past population sizes will have impact on modern-day population as well. Pearson correlation coefficient shows that the county-level population during the Ming Dynasty after capital relocation and the county-level population in 1964 are highly correlated, with a correlation coefficient reaching as high as 0.41.[17] Another measurement for urban system is population density. The correlation coefficient between population density in 1820 (Qing Dynasty) and population scale in 1820 is as high as 0.62. Since we only have population data over centuries, we did not use population density to study the change in urban system. (Data resource: Cao Shuji (2001), "The History

16. The Ming Dynasty established strict rules to control peasants. Various forms of household registrations, once established, were passed from one generation to the next, and cannot change without government's permission. People who left their hometowns without permission would be strictly punished.

17. The county-level population during the Ming Dynasty after capital relocation and the county-level population in 1820 in Qing Dynasty are also highly correlated, and we have similar conclusions when we measure county-level population using China's census data in 1982, 1990.

of China's Population (Volume V) (*Zhong Guo Ren Kou Shi*)") As we know, there is no other reference having collected the population density data at county level in the Ming Dynasty.

This paper uses local county-level gazetteers (*Xianzhi*) to construct the data of population size.[18] The county data used in this paper come from the "China Local Chronicle (*Fangzhi*) Series", which contains 876 counties from 20 different provinces. Of these, there are 240 counties and cities which have population data dating back to the Ming Dynasty. In order to establish its rule over the country, the Ming Dynasty established 15 provincial-level entities, known as "Two cities and Thirteen executive secretariats (*Liang Jing Shi San Bu Zheng Si*)".[19] In China, counties are the lowest level administrative units, similar to European cities, so studying urban systems from the county-level perspective helps to analyze the impact of political governance on population distribution from a grassroot level.

Before the founding of the People's Republic of China, both the time gap between each census and the time span within each census were quite long, and furthermore, the number of censuses conducted in each region differed, with some areas conducting multiple censuses, while others only had one or no census completed within a given time span. So, when measuring the population of a county, we used the latest available census data within each analysis period. For instance, although Anlu county (in present-day Hubei province) conducted censuses both in year 10 of the Hongwu era (1377) and in year 24 of the Hongwu era (1391), we used the 1391 data to represent Anlu's population during Zhu Yuanzhang's reign (See Appendix Table B2 for more details). Although time span after the capital relocation from Nanjing to Beijing (hereafter referred to as the post capital relocation) was long, this paper utilized Pearson correlation coefficients to find that, before and after relocating the capital to Beijing, the surveyed population from different period[20] are highly correlated within each era, which means that the city size remained relatively stable in each era. For instance, in Hongwu era,[21] each county had a correlation coefficient between population sizes of different censuses which was higher than 0.95. The correlation coefficient between the city sizes in 1377 (Hongwu year 10) and the city sizes in 1391 (Hongwu year 24) is 0.97.

Data Representativeness At the beginning of the Ming Dynasty, a reunification campaign was waged throughout different parts of the country, but the areas that were ravaged worst by this reunification campaign were not included in our data set. Overall, the Ming Dynasty ruled over northeastern, eastern, southern, and central China, and certain parts of modern-day northern and southwestern China. The regions of our dataset are concentrated mostly in central, eastern, southern and northern China. The dataset covers

18. *Xian Zhi* is a kind of local archives, recording the general history of a county. Similarly, De Long and Shleifer (1993) use population data from local archives to characterize the size of a city's population.

19. This bureaucracy has formed a structure containing both "four-layer" provincial governance system *Sheng-Fu-Zhou-Xi*an and "three-layer" provincial governance system *Sheng-Zhou-Xian*. *Sheng* is provincial governance system consisting of the provincial administrative government, which is controlled by the central government directly; *Fu* is prefecture administrative government under *Sheng*; *Zhou* is regional administrative government, controlled by *Fu* or *Sheng*; and *Xian* is county administrative government under *Zhou*.

20. The period can be a short time of 10 years or an era signifying an emperor's rule, or a long time after the capital relocation.

21. In this paper, era in the Ming dynasty refers to the period that reign by an emperor. For example, we record Hongwu era as an era, Yongle era as the other one.

240 county samples which spread across 112 prefecture cities of modern China (see Figure I-Figure II). In China's gazetteers, there are 876 counties, out of which only 240 have the Ming Dynasty's population data, the other 636 did not. Using data from China's 1964 census, we compared these 240 counties that have data in the Ming Dynasty with the rest 636 counties. The t-test for mean difference showed that, the population size of our 240 sample counties is not significantly different from that of the other 636 counties in 1964, showing that our samples are representative for those 876 counties.

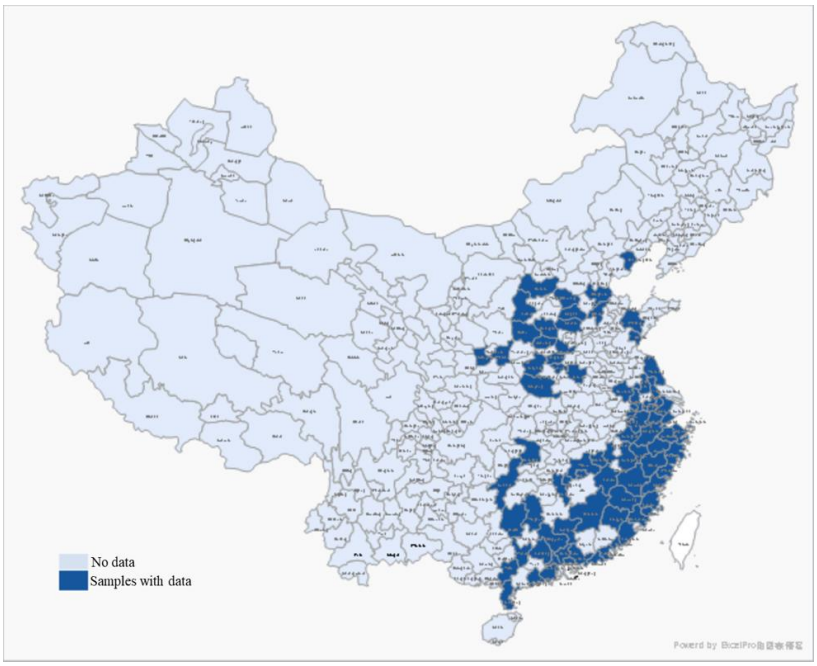

Figure I Distribution of Samples in Hongwu Era

Note: The samples presented in dark color have been matched with the prefecture-level cities in modern China.

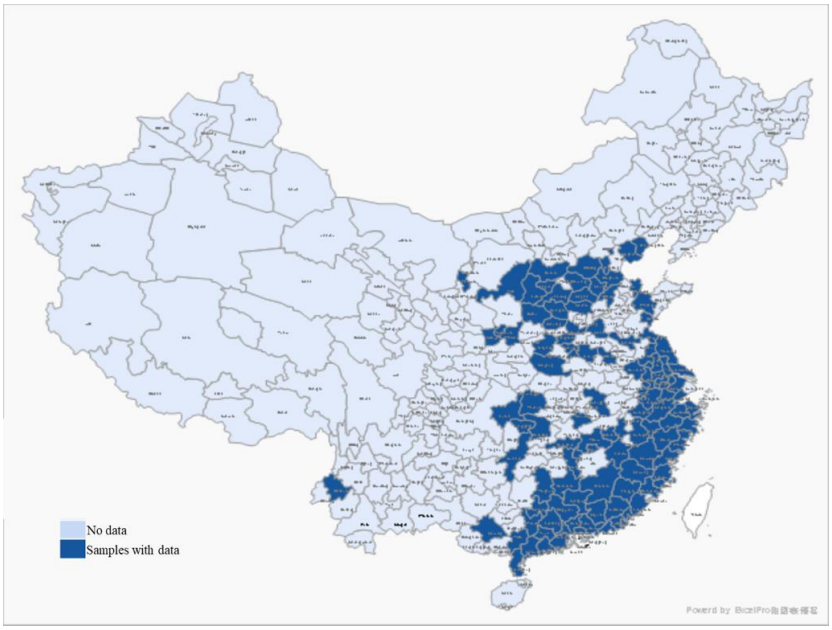

Figure II Distribution of Samples in Post-Capital-Relocation Period

Note: The samples presented in dark color have been matched with the prefecture-level cities in modern China.

II.B.2. Distance to the Capital and Political Governance

The "core-periphery" theory of urban system provides a theoretical tool for this paper to study the effect of political governance on urban systems. According to Fujita and Krugman (1995); Fujita, Krugman and Mori (1999), agglomerated development can enjoy economies of scale and lower transaction costs. Lu (2017)'s research on contemporary Chinese urban systems confirms that cities lying in geographic proximity will tend to form an urban system revolving around a core city. In a politically centralized nation-state, the capital serves as the core city, and other cities form a periphery. The effects of political governance are reflected in each region's respective distance from the capital city. Therefore, this paper uses distances between counties to the capital to quantify the impact of political governance. When they lie in close to the capital, there is a strong political governance effect, but when being more distant to the capital, the effects of political governance become smaller. As such, changing the capital city will alter the distance between cities and the capital, causing changes in the population distribution as well.

In order to calculate distances between counties and the capital, this paper uses the location of the local government (*Zhisuo*) in the Ming Dynasty matching with the current location of the local government, according to 2012 administrative delineations from China's National Bureau of Statistics, and uses longitudinal and latitudinal coordinates to calculate the corresponding distances to both Beijing and Nanjing. Since our sample includes some regions located within Beijing or Nanjing, we take this into consideration for our calculation by adding 1 before taking logarithm.

II.B.3. Empirical Strategy

Since this paper is studying how political governance change causes in population redistribution, the data is handled as follows: Firstly, segmenting Ming Dynasty into two distinct periods – the Hongwu period before the capital was relocated to Beijing (1368-1398, hereafter referred to as the Hongwu era)[22], and the period following the capital relocation to Beijing (1403-1644, the post-capital-relocation era hereafter)[23]. Secondly, since there are 14 eras in post-capital-relocation period, we further divided the post-capital-relocation period into three, every five emperors' eras combined into one period, to further ascertain any differences in population distribution that the change of capital brought about in earlier, middle and later

22. The Hongwu era, before the capital was relocated includes: the Hongwu Emperor Zhu Yuanzhang (1368-1398), and the Hui Emperor Zhu Yunwen (1399-1402), since the samples for this paper do not include samples from the reign of Zhu Yunwen, we ignore this brief period. Strictly speaking, it was not until the 14th year of Zhu Di's reign that the capital was established in Beijing. In the benchmark regression, this paper classifies these 14 years as post-relocation, but in the robustness test, this paper moves this period into the pre-capital relocation period.

23. Including: the Yongle Emperor Zhu Di (1403-1424), the Hongxi Emperor Zhu Gaochi (1424-1425), the Xuande Emperor Zhu Zhanji (1425-1435), the Zhengtong Emperor Zhu Qizhen (1435-1449), the Jingtai Emperor Zhu Qiyu(1450-1457), the Tianshun Emperor Zhu Qizhen (1457-1464), the Chenghua Emperor Zhu Jianshen (1464-1487), the Hongzhi Emperor Zhu Youcheng (1487-1505), the Zhengde Emperor Zhu Houzhao (1505-1521), the Jiajing Emperor Zhu Houcong, (1521-1566), the Longqing Emperor Zhu Zaiji (1566-1572), the Wanli Emperor Zhu Yijun (1572-1620), the Tianqi Emperor Zhu Youxiao (1620-1627), and the Chongzhen Emperor Zhu Youjian (1627-1644).

periods.[24] Thirdly, segmenting each emperor era of post capital relocation as a period, we conduct robustness checks. Finally, considering some variations may exist within the same emperor era, we construct a time effect variable, ν_t, which is a dummy variable in every 10 years, to measure these trends over time. Thus, the following linear model is estimated:

$$Population_{it} = \beta_0 + \beta_1 Distance_{it} + \beta_2 stop_{it} + \boldsymbol{X'\gamma} + \lambda_i + \nu_t + \varepsilon_{it} \quad (1)$$

where, $Population_{it}$ reflects the population size of region i during period t, and is measured by the population of counties in logarithm form; $Distance_{it}$ represents the distance of region i during period t to the capital (Beijing or Nanjing), whose unit is thousand of kilometers. Distance is the main variable of concern. In general, the greater the distance from the capital, the smaller the effect of political governance, so it can be expected that the coefficient β_1 will have a negative value. Since the capital relocation to Beijing, if the existing urban systems had changed between these two periods, the coefficients of the distance to Beijing will also change. Considering that one of the main historical functions of courier stations (*Yi Zhan*) in ancient China was to facilitate the central government's control over local areas, this regression model also considers the influence that courier stations had on the population distribution. $Stop_{it}$ represents whether or not region i during period t served as a main courier station (yes＝1, otherwise 0).

$\boldsymbol{X}$ serves as a series of control variables taking geographic features into account. Bosker and Buringh (2015) pointed out that geographic features are an important determinant for a city's regional development. First, we consider whether a main road passed through the county. We use a dummy variable to represent the historical location of China's main thoroughfares, with 1 representing the presence of a main road passing through a given county during the Yuan Dynasty, and 0 if not,[25] and another dummy variable to define whether or not main roads passed through these counties during the Hongwu era (1=yes and 0=not). We also controlled a dummy variable for *zhisuo* of *Fu*, the local political center (1=yes and 0=not). Lastly, the transportation of the Ming Dynasty's food supply primarily relied upon canals or overland routes, with the Grand Canal and Yangtze Rivers serving as the main arteries.[26] We further constructed two dummy variables, one for counties where the Grand Canal passed through, and the other for Yangtze River (1=yes and 0=not).[27]

λ_i is a group of fixed effect variables for the eastern, central and western regions of China. ν_t is time fixed effect. In the agricultural society, circulation costs such as the delivery of information and

24. The early period includes Yongle, Hongxi, Xuande, Zhengton and Jingtai Emperors; the middle period includes Tianshun, Chenghua, Hongzhi, Zhengde, and Jiajing Emperors; the later period includes the Longqing, Wanli, Tianqi and Chongzhen Emperors. When we used 80 years to split early, middle and later periods, we could obtain similar conclusions.

25. We did robustness checks using the road networks from earlier Chinese dynasties which did not change the conclusions.

26. The main rivers in China also include the Yellow River etc., but they did not serve as the main canals in Ming Dynasty, so they are not controlled in this paper. Actually, controlling for the Yellow River and other rivers' variables did not change the conclusions.

27. In modern society, the primary method of conducting international trade is via shipping, but the Ming Dynasty implemented a ban on seafaring voyages, therefore we did not control seaports variable. Actually, eastern, central and western dummy variables somehow capture the distance to the coast.

transportation were relatively high, therefore the regional population size cannot be tabulated frequently. For instance, during the Hongwu era, Anlu county and Anji county's census were conducted in 1377 (year 10 of the Hongwu era) and 1382 (year 15 of the Hongwu era), respectively. As a result, this paper treats the Hongwu era and the post-capital-relocation period as two distinct periods. In order to take time trend into consideration, ν_t is constructed for every 10 years. As an example, we set 1368-1377 of the Hongwu era as the first group ν_1, the years 1378-1387 as the second group ν_2, and so on.[28]

Considering the impact of Nanjing Although Nanjing's political status and importance declined after Zhu Di moved the capital to Beijing, Nanjing still exercised influence over its surrounding region. On one hand, even after the capital was moved, Nanjing remained the *de jure* capital (*Peidu*) of the Ming Dynasty, so any institutions established in Beijing were also established in Nanjing during the Ming Dynasty. Towards the middle of the Ming Dynasty, Nanjing became a sort of retirement home of government bureaucrats; on the other hand, in comparison with the relative stability and peace experienced in southern China, northern China were ravaged by constant warfare. Indeed, during the Song Dynasty, China's economic center has completely moved to the south, and Nanjing became one of China's economic hubs at that time. During the Ming and Qing Dynasty, southern China further cemented its position as the nation's economic hub. Since the economic center has impact on transportation, trade, and population distribution, Nanjing's influence should not be ignored. Model (1) can be expanded as:

$$Population_{it} = \beta_0 + \beta_1 Distance_{it} + \beta'_1 Distance'_{it} + \beta_2 Stop_{it} + \boldsymbol{X'\gamma} + \lambda_i + \nu_t + \varepsilon_{it} \quad (2)$$

where $Distance'_{it}$ represents the distance between region *i* to Nanjing during period *t*, and all other variables are the same as in model (1).

It is necessary to explain that, this paper mainly employs linear regression models. In the most common core-periphery theoretical model, the impact of distance to the core city on economic development is a nonlinear and cubic function. But for this paper, we focus on how political governance changes during the capital relocation affects urban system, which is captured by the interaction coefficient of the dummy variable for before and after the capital relocation. To simplify the analysis, we made a linear assumption about the effect of the distance variable.

Table I shows the descriptive statistics of the main variables used in models (1) and (2).

Table I Description and Statistical of the Main Variables

Period	Variable (unit)	Samples	Mean	sd.	Min	Max
Hongwu Era	Ln (Population) (Person)	141	11.07	1.289	7.921	13.85
	Ln (Households)	148	9.483	1.402	5.737	12.60
	Ln (Distance_Nanjing) (Thousand KM)	141	0.441	0.229	0.0159	1.011
	Ln (Distance_Beijing) (Thousand KM)	141	0.740	0.237	0.166	1.160
	Courier Station	141	0.553	0.499	0	1
	Ming Road	141	0.369	0.484	0	1
	Amount of Courier Stations	141	1.170	1.331	0	5
	Jun	141	0.0213	0.145	0	1

28. Using 5 or 15 years as time interval to construct the time trend dummies does not alter the findings.

	Zhisuo	141	0.0496	0.218	0	1
	Yuan Road	141	0.390	0.490	0	1
	Grand Canal City	141	0.326	0.471	0	1
	Yangtze River City	141	0.298	0.459	0	1
Post Capital Relocation	Ln (Population_all) (Person)	224	10.72	1.152	7.606	13.81
	Ln (Population_early) (Person)	113	11.11	1.177	7.647	13.67
	Ln (Population_middle) (Person)	191	10.89	1.105	8.249	13.81
	Ln (Population_later) (Person)	158	10.58	1.181	7.606	13.17
	Ln (Distance_Nanjing) (Thousand KM)	224	0.459	0.240	0.0159	1.120
	Ln (Distance_Beijing) (Thousand KM)	224	0.733	0.249	0.0488	1.194
	Courier Station	224	0.509	0.501	0	1
	Ming Road	224	0.344	0.476	0	1
	Amount of Courier Stations	224	1.076	1.359	0	6
	Jun	224	0.0179	0.133	0	1
	Zhisuo	224	0.0357	0.186	0	1
	Yuan Road	224	0.353	0.479	0	1
	Grand Canal City	224	0.281	0.451	0	1
	Yangtze River City	224	0.295	0.457	0	1

II.C. Statistical Results

Figure III shows the relationship between regional population during the Hongwu era and the distance to Beijing. As is evident from the chart, regions closer to Beijing have smaller population.

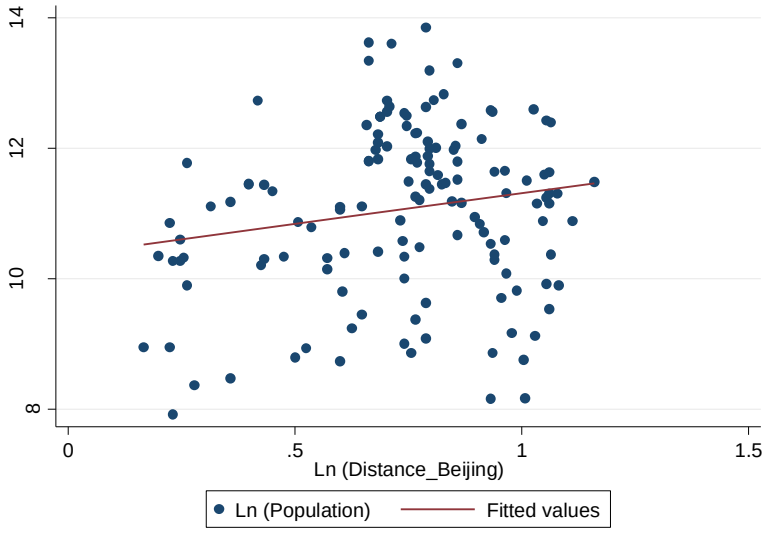

Figure III Population Distribution and Distance to Beijing in Hongwu Era

Note: The relationship between distance to Beijing and regions' population: $\text{Ln}\,(Population) = 10.364^{***} + 0.948^{**} \cdot \text{Ln (Distnace\_Beijing)}$.

Figure IV shows the relationship between regional population and distance to Beijing after the capital was moved to Beijing. Now, counties farther from Beijing have smaller population. Figure III and Figure IV show that the population distribution has changed before and after the capital moved.

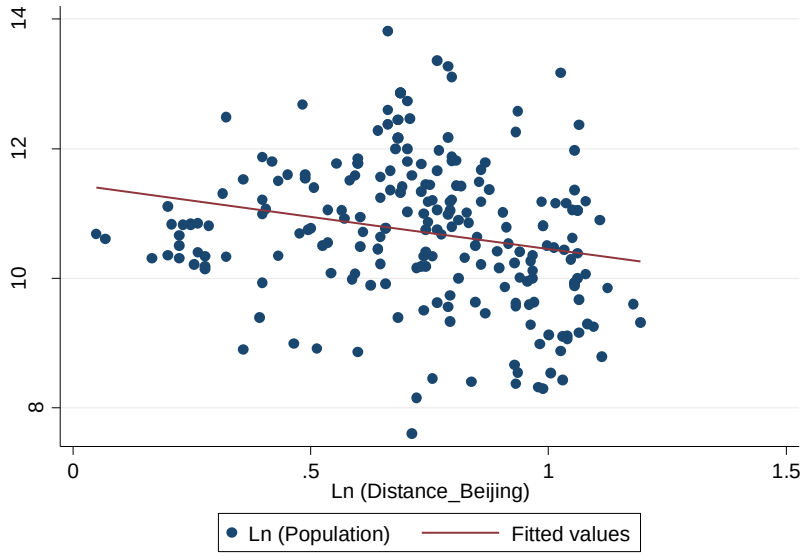

Figure IV Population Distribution and Distance to Beijing in Post-Capital-Relocation Period
Note: The relationship between distance to Beijing and regions' population: $\text{Ln}(Population) = 11.445^{***} - 0.994^{***} \cdot \text{Ln (Distnace\_Beijing)}$.

III. Empirical Results

III.A. Distance to Beijing and Population Size before Capital Relocation

Table II reports the regression results of the relationship between regional population sizes and respective distances to Beijing and Nanjing during the Hongwu era. Column (1) shows that, while the capital was in Nanjing, the size of counties farther away from Beijing was greater. Column (2) shows that the size of counties farther away from Nanjing was smaller. Column (3) considers the impact of a county's distance to both Beijing and Nanjing on its size. The finding in column (4) is similar to column (3) after more variables are controlled for. The results suggest that, during the Hongwu era, the size of a region's population was influenced by its distance from the capital. The closer a region is to the capital, the greater the size of its population.

Considering that Zhu Di had renamed Beiping as Beijing in 1405, announced his intention to move the capital to Beijing in 1416, and the capital relocation was completed in 1421, columns (5) and (6) consider 1368-1405 and 1368-1421 as pre-capital-relocation period, respectively, and show that the coefficients of the distances to Nanjing and Beijing are similar to column (4), although the coefficient size and significance

are weaker than in column (4). The reason is that Zhu Di renamed Beiping to Beijing in 1405, and had established the Imperial Academy (*Guozijian*) and other bureaucratic institutions, such that Beijing's status was improved, and some bureaucratic functions were transferred out of Nanjing towards Beijing.

It is necessary to note that, constrained by the data availability, the data of courier stations in this paper is mainly collected for the period after the capital relocation and used as a proxy of courier stations for the Hongwu era. Column (7) reports the result that does not control for the courier stations, and the coefficients and significance of the distances to both Beijing and Nanjing are similar to those in column (4).[29]

It is doubted that population data in ancient China are not accurate, because people underreported the numbers of family members to evade taxes. In columns (8) - (10) of Table II, we use the number of households in each region, which is less likely to be underreported, to measure the city size as robustness checks. The results are similar to columns (4) - (6). Due to differences in household size between regions, this paper mainly uses the reported population to measure population size.

29. The p value for distance to Nanjing is 0.106.

Table II Population Distribution and Political Governance in Hongwu Era

Dependent Variable	Ln (Population)							Ln (Households)		
Model Type	Benchmark Regression						Without Courier Stations	Robustness Checks		
Model Classification	Hongwu Era (1368-1398)				1368-1405	1368-1421	Hongwu Era	Hongwu Era	1368-1405	1368-1421
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ln (Distance_Beijing)	0.853*		1.366***	0.912*	0.981*	0.644#	1.009*	1.946***	1.987***	1.754***
	(0.460)		(0.446)	(0.507)	(0.504)	(0.438)	(0.529)	(0.511)	(0.497)	(0.467)
Ln (Distance_Nanjing)		-1.428***	-1.847***	-1.183*	-1.023#	-0.756	-1.101#	-1.631**	-1.731**	-1.448**
		(0.492)	(0.504)	(0.693)	(0.684)	(0.630)	(0.677)	(0.754)	(0.742)	(0.702)
Courier Station	0.385*	0.464**	0.431**	0.379*	0.443**	0.340		0.190	0.226	0.145
	(0.208)	(0.201)	(0.199)	(0.206)	(0.204)	(0.219)		(0.212)	(0.208)	(0.222)
Ming Road				0.151	0.158	0.162	0.183	0.050	0.028	0.054
				(0.230)	(0.231)	(0.220)	(0.244)	(0.253)	(0.251)	(0.232)
Ming Zhisuo				0.291	0.358	0.457	0.213	0.179	0.211	0.339
				(0.394)	(0.396)	(0.476)	(0.462)	(0.437)	(0.433)	(0.512)
Yuan Road				0.189	0.137	-0.015	0.282	0.431*	0.486**	0.293
				(0.226)	(0.223)	(0.233)	(0.246)	(0.242)	(0.241)	(0.232)
Grand Canal City				-0.414	-0.409	-0.109	-0.333	-0.247	-0.288	0.026
				(0.316)	(0.312)	(0.265)	(0.327)	(0.352)	(0.347)	(0.311)
Yangtze River City				0.609	0.658*	0.687**	0.583	0.449	0.382	0.441
				(0.396)	(0.391)	(0.323)	(0.386)	(0.471)	(0.466)	(0.404)
Regional Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	10.896***	11.748***	11.134***	11.128***	10.995***	10.040***	11.049***	8.966***	9.038***	7.939***
	(0.732)	(0.598)	(0.567)	(0.696)	(0.677)	(0.883)	(0.685)	(0.714)	(0.705)	(0.935)
Number of Obs.	141	141	141	141	142	150	141	148	149	156
R^2	0.158	0.192	0.244	0.275	0.287	0.243	0.258	0.319	0.335	0.304

Note: The values in parentheses are robust standard errors, $^{\#}\ p < 0.15$, $^{*}\ p < 0.1$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$.

III.B.Distance to Beijing and Population Size after Capital Relocation

As expected, the effect of a county's distance to Beijing on population size changed after the capital moved, reflecting the influence of political governance on population distribution. Columns (1) and (5) in Table III show that after the capital moved to Beijing, there was a significant negative correlation between the county's population size and its distance to Beijing. Column (1) shows that the city's distance to Beijing has a negative impact on the city's size; Column (5), on the basis of column (1), simultaneously takes the distances from Beijing and the distances from Nanjing into account, and the result shows that, distances between regions and Beijing or Nanjing has a significant negative impact on population size. The aforementioned findings show that, after relocating the capital to Beijing, the effect of distance between a region to Beijing on the size of the city in Table III is opposite to Table II. This indicates that changing the capital city has also changed the population distribution.

Although certain institutional factors can experience rapid change after the capital was relocated, the construction and development of an urban system, however, is not a simple task. The impact of political governance on population distribution cannot be changed immediately, but need to take a considerable length of time to develop. For instance, urban construction, forming a military garrison, resettling the population, etc. are gradual and may require 1-2 generations of effort. Therefore, this paper divides the post capital relocation period into three shorter periods: early, middle, and later stages.[35] Columns (2) - (4) of Table III provide a detailed breakdown of the data in Column 1. Column (2) is the early period, the impact of distance to the capital has begun but is not fully evident, and the distance to Beijing shows a non-significant but negative effect. Column (3) shows the middle period, when the negative effect of distance to Beijing on population began to appear. Column (4) shows the later period, when regions farther from Beijing had smaller populations. Columns (6) - (8) provide a detailed breakdown of column (5), delivering a similar result to columns (2) to (4). When comparing coefficients of capital relocation in the early, middle, and later periods, we found that as time goes by, the influence of the capital upon regional population becomes increasingly significant, and the value of the coefficient increases as well. This means the capital relocation in the Ming Dynasty has persistent effect on urban system.

This paper conducted other robustness checks as well. First, samples before the year 1420 were removed from Table III. Second, this paper attempted to control for more variables, including dummies for cities along the Yellow River basin in China's North, the number of courier stations, variables representing major roads during historical dynastic periods etc. Third, since data in this paper includes current county level as well as city level regions, we removed current city-level regions from the sample. All these checks did not change the results. Considering that this paper selected a sample of county-level data from the Ming Dynasty, later sections of this paper will still use the full sample. Please refer to Appendix Table A1 for these robustness regression results.

35. Every 5 emperor's eras combined into a shorter period. Please refer to footnote 29 for more details.

Table III Population Distribution and Political Governance in Post Capital Relocation

Dep. Variable	Ln (Population)							
Impact effect	Considering distance to Beijing				Considering distances to Beijing and Nanjing			
Period	All	Early	Middle	Later	All	Early	Middle	Later
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln	-0.772***	-0.233	-0.895***	-1.066***	-0.574*	0.107	-0.634**	-0.834**
(Distance_Beijing)	(0.286)	(0.662)	(0.300)	(0.368)	(0.294)	(0.670)	(0.317)	(0.373)
Ln					-0.958*	-0.814	-0.807#	-1.069*
(Distance_Nanjing)					(0.530)	(0.714)	(0.531)	(0.620)
Courier Station	0.155	0.319	0.291*	0.164	0.198	0.351	0.325**	0.218
	(0.147)	(0.261)	(0.160)	(0.177)	(0.147)	(0.270)	(0.162)	(0.177)
Ming Road	0.307**	0.185	0.280	0.349*	0.316**	0.230	0.280	0.333*
	(0.145)	(0.262)	(0.176)	(0.181)	(0.143)	(0.265)	(0.175)	(0.183)
Ming Zhisuo	0.761**	0.591	0.463	0.716*	0.771**	0.575	0.434	0.720*
	(0.310)	(0.550)	(0.443)	(0.367)	(0.308)	(0.554)	(0.452)	(0.371)
Yuan Road	0.114	-0.243	0.126	0.186	0.096	-0.277	0.102	0.156
	(0.180)	(0.287)	(0.208)	(0.207)	(0.179)	(0.296)	(0.211)	(0.208)
Grand Canal City	0.396**	0.120	0.064	0.390	0.374**	0.129	0.068	0.361
	(0.185)	(0.265)	(0.181)	(0.239)	(0.184)	(0.261)	(0.183)	(0.235)
Yangtze River City	0.525***	0.828***	0.641***	0.609**	0.229	0.612**	0.385	0.293
	(0.198)	(0.204)	(0.160)	(0.244)	(0.283)	(0.240)	(0.249)	(0.323)
Regional FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	13.302***	11.128***	11.057***	11.245***	13.860***	11.106***	11.297***	11.722***
	(0.318)	(0.842)	(0.459)	(0.462)	(0.415)	(0.837)	(0.492)	(0.510)
Number of Obs.	224	113	191	158	224	113	191	158
R^2	0.377	0.243	0.314	0.331	0.395	0.245	0.322	0.353

Note: The values in parentheses are robust standard errors, # $p < 0.15$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In order to better analyze the impact of political governance on population distribution over time, Table IV segments the data by era (*Nian Hao*). Column (1) shows the Yongle era, when there is no influence from a county's distance to Beijing on population size. The coefficient is negative, and the t value is less than 0.5. Column (2) shows during the Xuande era, for counties farther from Beijing, the population is smaller. The coefficient is not significant, but t value is close to 1, greater than that in Yongle era. Due to the fact that the capital relocation was only completed in 1421, the 19th year of the Yongle period, the effects of distance to Beijing on regional population sizes was not sufficiently significant in Yongle and Xuande eras, though the coefficients are negative. Columns (3) - (10) report results for other eras, all showing that, the farther from Beijing, the smaller the size of the county. The p values of columns (4) and (9) are close to 10% significance level.[36]

Table IV Population Distribution and Political Governance in Different Eras

Dependent Variable	Ln (Population)				
Model Time Period	**Yongle Era**	**Xuande Era**	**Zhengtong Era**	**Jingtai Era**	**Chenghua Era**
Year	1403-1424	1425-1435	1435-1449	1450-1457	1464-1487
Model	(1)	(2)	(3)	(4)	(5)
Ln (Distance_Beijing)	-0.394	-1.705	-5.660***	-1.719#	-2.090***
	(0.736)	(1.565)	(1.511)	(1.113)	(0.654)
Courier Station	0.328	0.945*	0.453	0.469	0.624**
	(0.263)	(0.522)	(0.759)	(0.514)	(0.307)
Other control variables	Yes	Yes	Yes	Yes	Yes
Number of Obs.	100	48	38	41	85

36. In column (3), a war (*Tu Mu Bao Zhi Bian*) in the 14th year of the Zhengtong era, after which Yingzong failed and was arrested by his enemies, lead to the coefficient in this era far greater than others periods.

R^2	0.242	0.439	0.428	0.274	0.433
Model Time Period	**Hongzhi Era**	**Zhengde Era**	**Jiajing Era**	**Wanli Era**	**Tianqi Era**
Year	1488-1505	1505-1521	1521-1566	1573-1620	1620-1627
Model	(6)	(7)	(8)	(9)	(10)
Ln (Distance_Beijing)	-1.600***	-1.377**	-1.541***	-0.499#	-2.025*
	(0.559)	(0.636)	(0.556)	(0.440)	(1.161)
Courier Station	0.544**	0.087	0.284	0.111	0.886**
	(0.209)	(0.306)	(0.267)	(0.185)	(0.358)
Other Control Variables	Yes	Yes	Yes	Yes	Yes
Number of Obs.	99	81	64	128	37
R^2	0.315	0.247	0.307	0.287	0.560

Note: The values in parentheses are robust standard errors, # $p < 0.15$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III. Hongxi and Tianshun eras do not have statistical samples, Chongzhen era is the end of the Ming Dynasty and samples from this period were not considered in this paper.

This paper reported other robustness checks in the Appendix as well. First, previous sections of this paper treat the relationship between distance and population distribution as a pre and post capital relocation analysis, which at its core is an asymptotic DID analysis. The principle of using an interaction term of post relocation dummy and distance to Beijing is the same in the subsample analysis. In Appendix A.2, we combine samples from before and after the capital relocation, and construct panel data for DID analysis. Please refer to Appendix Table A2 for these regression results. Second, in Appendix A.3, we controlled more regional fixed effects, such as southern and northern fixed effects, province fixed effect, etc. Please refer to Appendix Table A3 for these results. Third, historians believe that there are some errors in the measurements of urban population sizes in the Ming Dynasty. In Appendix A.4 and A.5, we use different dependent variables to measure urban system. All the major findings did not change much in these robustness checks.

III.C.Persistent Effect of Capital Relocation

Since the Ming Dynasty, Beijing has become China's principal capital city. Urban economics emphasizes that urban development and urban systems have a strong path dependence that means, once urban systems have formed, they are stable until a large and persistent shock arises. After the Ming Dynasty moved its capital, the influence of political governance on population distribution continued, because there was no other large and persistent shock. We use demographic data from the Qing Dynasty, the Republic of China period, and the early days of the People's Republic of China to test the persistent effects of capital change. First, during the early period of the Qing Dynasty, the Imperial government has instituted a series of policies to reduce taxation in order to appease its ethnic-majority subjects and establish Manchu-minority rule, and the prior system of taxation by headcount was reformed at the end of Kangxi's reign of Qing Dynasty. In the first year of the Yongzheng era (1723), tax reform had been gradually implemented across provinces, and slowly replaced the previous system based on headcount. Qianlong Emperor and his successors completely cancelled the old system of taxes based on headcount, eliminating the incentives for

regions to falsify or underreport their local populations.[37] Second, demographic census data from the Republic of China and the People's Republic of China (PRC) have smaller measurement errors and a larger sample size. Thirdly, during these periods, there were no other large and persistent shock events such as the Ming Dynasty's capital relocation to change the urban system, and the impact of capital relocation to Beijing on urban population sizes can be viewed as continuous.

Based on the natural experiment provided by the Qing Dynasty's tax reform, columns (1)-(3) in Table V report the effects of distance to the capital on population distributions during the Qing Dynasty's Kangxi, Qianlong and Daoguang eras. Kangxi's reign is considered to be pre-tax reform, so the demographic statistical results are similar to those of the Ming Dynasty during the post capital relocation period. Qianlong's reign is considered to be the end of the headcount tax system, and Daoguang's reign is used as a robustness check of column (2). The results show that counties farther from Beijing have a significantly smaller population in the Qing Dynasty. Columns (4)-(6) in Table V show the impact of a county's distance from Beijing on population distribution during the Republic of China period and the early PRC period. Again, the counties farther from Beijing have a significantly smaller population.

In a nutshell, the capital relocation to Beijing had persistent effects on the urban system until contemporary China.

Table V Persistent Effect of Political Governance

Dependent Variable	Ln (Population)					
Model Type	Qing Dynasty			Republican and Modern China		
Period	Kangxi era (pre-reform)	Qianlong (post-reform)	Daoguang (post-reform)	Republican	1953	1964
Model	(1)	(2)	(3)	(4)	(5)	(6)
Ln (Distance_Beijing)	-1.502*	-1.223#	-1.556*	-0.817***	-0.773***	-0.774***
	(0.815)	(0.758)	(0.810)	(0.174)	(0.139)	(0.118)
Ln (Distance_Nanjing)	-1.052	-2.868*	0.998	-0.602**	-0.657***	-0.564***
	(1.196)	(1.464)	(1.917)	(0.290)	(0.180)	(0.162)
Courier Station	-0.106	-0.487	0.281	0.156***	0.151***	0.139***
	(0.379)	(0.485)	(0.292)	(0.060)	(0.048)	(0.044)
Other Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	91	109	51	654	791	792
R^2	0.291	0.219	0.226	0.365	0.234	0.298

Note: The values in parentheses are robust standard errors, $^{\#}\ p < 0.15$, $^{*}\ p < 0.1$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$. Other control variables are the same as column (1) in Table III.

IV. Mechanisms

The urban system is dependent on urban development, therefore the mechanisms affecting urban development will have an impact upon the urban system. In this section, we will use self-collected data to

37. During year 51 of the Kangxi era in 1712, the Qing Dynasty decided to set the headcount tax at a fixed level, such that additional taxes would not be collected for additional people. This was called "Encouraging Childbearing during Prosperous Times, No New Taxes for Prosperity". This fixed the amount of taxes to be paid and integrated tax collection for property and headcounts. This method was first utilized during the later years of the Kangxi era in Guangdong, Sichuan, and other provinces.

prove that political governance mainly impacts the urban system through the delivery mechanism, material supply mechanism and national security mechanism.

IV.A. Delivery Mechanism

Under a centralized political system, cities that are far from the capital or political center cannot access the various kinds of capital, technology and talent spillovers. Counties closer to the capital can enjoy lower information delivery costs, and can receive more central signals and gain access to all kinds of resources, and costs of informational and transportation to and from the capital are lower. Michalopoulos and Papaioannou (2013) used data from Africa and found that the impact of institutions on economic development is mainly within the vicinity area of the capital city. Since the Qin Dynasty, China's imperial dynasties have all placed great emphasis on the building of infrastructure, building a series of "main roads" extending from the capital to the various provinces, and constructing many courier stations along these routes, to facilitate information delivery and maintain national security (Fu, 2011). Although some areas are far from the capital, they have main roads passing through or be the site of a courier station (*Yi Zhan*), so they enjoy more rapid and a greater quantity of information delivery due to the convenience and availability of information, etc. Information delivery is the major function of those courier stations. All else being equal, these areas will have larger populations, and provide these courier stations with supporting services and urban functions. As a result, the construction of a major road and courier stations through an area will help to narrow the geographic disadvantage of being located far from the capital, and help to make up for the negative effect of distance to the capital on the population size.

IV.A.1. Channel of Main Road

Generally speaking, main roads are built on the paths that require the lowest construction costs (Bosker and Buringh, 2015), counties along the main roads will gain more information from the central government, and the development of overland transportation routes compensates for the negative relationship between distance from the capital and urban development. Therefore, there is a discrepancy as to whether or not political governance influences population size via the channel of main road. However, we can only attain data of the main roads in the Hongwu era. After the capital moved the Beijing, it gradually became the hub of the national road network due to its status as the capital. Many of the courier stations and roads to Nanjing were abolished, due to Nanjing's loss of political status, and a lot of the main roads originally directed towards Nanjing were redirected towards Beijing. Therefore, the data to test the main road mechanism comes mainly from the Hongwu period. After the capital moved to Beijing, there are no corresponding data since the main roads were changed. Therefore, using the data of the main roads from the Hongwu period for the post capital relocation regression is actually a placebo test, where the main road should not bear a significant coefficient.

Columns (1) - (3) in Table VI show how counties lying along a main road were impacted by distance from Beijing or Nanjing before the capital moved. Of these, column (1) shows that counties lying along the main road has an insignificant relationship between an area's population size and its distances to Nanjing and Beijing. Column (2) shows counties not along main roads have a significantly negative relationship between distance to Nanjing and population size, and a significantly positive relationship between distance to Beijing and population size. Column (3) is the regression result controlling for the interaction term of whether there is a main road and distance to Nanjing. The coefficient of the interaction term is significantly positive, reflecting that the main roads weaken the negative impact of distance to the capital on population size. The coefficient of the interaction term is less than the absolute value of the coefficient of distance to Nanjing, thus the distance has a negative impact on population size.

The main influence of political governance, under the mechanism of the main road, on a region's population, can be tested using data of the main roads in Hongwu era to see if this mechanism truly exists. The logic is that the data of the main roads from Hongwu era are not fully applicable to the period after the move since the main roads have changed, and we won't get the results from columns (1) - (3) in post capital relocation period if the capital city's influence on a region's population size is indeed via a main road mechanism. Columns (4) - (6) in Table VI show the relationship between population distribution and the distance of the cities to Beijing and Nanjing after the capital relocation. Column (4) shows, for cities with a main road in Hongwu era, population size and distance to Beijing and Nanjing has an insignificantly negative relationship. Column (5) shows an insignificantly negative relationship for cities without a main road between distance to Beijing and population size. Column (6) gives the regression coefficient for the interaction term of the main road and distance to Beijing (capital), which is positive but insignificant. As a result, given that information of roads is not entirely correct, the regression results of columns (4)-(6) do not reach the conclusion that main roads weaken the negative relationship between distances to the capital and population size. The reason for the positive coefficient of the interaction term in column (6) may be that the function of some main roads remained unchanged despite the capital relocation.

Table VI Mechanism of Main Road

Dep. Variable	Ln (Population)					
Sample Time	Hongwu Era			Post Capital Relocation		
Main Road	Passes	Non-Passes	Full Sample	Passes	Non-Passes	Full Sample
Model Number	(1)	(2)	(3)	(4)	(5)	(6)
Ln (Distance_Beijing)	0.542	1.406**	1.061*	-0.305	-0.105	-0.698*
	(0.899)	(0.660)	(0.598)	(0.564)	(0.428)	(0.366)
Ln (Distance_Nanjing)	-0.173	-1.963**	-2.116**	-1.107	-1.444**	-0.945*
	(0.956)	(0.942)	(0.810)	(0.768)	(0.688)	(0.533)
Main Road* Ln (Distance_Nanjing)			2.102**			
			(0.935)			
Main Road* Ln (Distance_Beijing)						0.308
						(0.521)
Courier Station	-0.176	0.642**	0.346*	0.256	0.246	0.197
	(0.309)	(0.271)	(0.203)	(0.281)	(0.210)	(0.148)
Other Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	52	89	141	77	147	224
R^2	0.407	0.356	0.295	0.447	0.455	0.394

Note: The values in parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III.

IV.A.2. Channel of Courier Station

Courier stations served as a place for the transmission of official documents, military information, or a rest place for government officials on an official business trip. Their locations had the characteristics of convenient transportation, large volumes of passenger traffic, and flexible information delivery, which all positively impact regional development. Therefore, the Ming Dynasty placed a great deal of emphasis on the construction of courier stations, and set up courier stations along the main roads.[38] Since the construction and operation of courier stations took time, they were relatively stable after their establishment, and the courier stations mainly worked in the post capital relocation period. Therefore, the test of the courier station mechanism for the Hongwu era is actually a falsification test.

Similar to the main road mechanism, courier stations may compensate for the effect of distance to the capital on the population size. Table VII shows the regression results for the full sample and subsamples with or without courier stations. Columns (1) - (3) show that before the capital moved from Beijing, the presence of courier stations had a negative impact on the influence of distance to Nanjing (the capital) on population distribution, but a positive influence on distance to Beijing on population size. As expected, since this paper uses data of courier stations after the capital relocation to analyze the impact of Hongwu era's data, the courier stations did not significantly reduce the impact of distance to the capital on population size.

Columns (4) - (6) are used to check the impact of the courier station mechanism after the capital relocation, given that the courier station information is accurate. Among these, column (4) shows the insignificant, negative relationship between populations of regions with a courier station and distances to Beijing and Nanjing after the capital relocation. Column (5) shows the significantly negative relationship for populations of regions without a courier station and distance to Beijing and Nanjing. Column (6) shows the coefficient of the interaction term of the courier station and distance to Beijing is significantly positive. Therefore, the presence of a courier station reduces the negative impact of distance to the capital on the population size.

Table VII Mechanism of Courier Station

Dep. Variable	Ln (Population)					
Sample Time Period	Hongwu Era			Post Capita Relocation		
Model Range	With Courier	Without Courier	Full Sample	With Courier	Without	Full Sample
Model Number	(1)	(2)	(3)	(4)	(5)	(6)
Ln	0.902	1.093	0.818	-0.189	-0.902*	-1.032***
(Distance_Beijing)	(0.782)	(0.721)	(0.702)	(0.562)	(0.497)	(0.393)

38. Delivery stations were independent of courier stations, specializing in the transportation of goods. Their main task was the prepayment of military needs, tributes and rewards, managed by local garrisons. Ming Dynasty transportation was based on a series of fixed points and relays. As such, in addition to taking on responsibility for transportation over designated routes, delivery stations were responsible for sea or river transport as well. Another point worth noting is: courier stations were always based in cities or counties along a main road, but not all cities or counties along a main road had courier stations.

Ln	-1.274	-1.191	-1.212	-0.896	-1.513*	-1.087*
(Distance_Nanjing)	(0.962)	(1.195)	(0.999)	(0.907)	(0.796)	(0.552)
Courier Station* Ln			0.183			
(Distance_Nanjing)			(0.905)			
Courier Station* Ln						0.963*
(Distance_Beijing)						(0.541)
Courier Station			0.241			-0.508
			(0.781)			(0.403)
Other Variables	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	78	63	141	114	110	224
R^2	0.288	0.299	0.276	0.408	0.462	0.378

Note: The values in parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III. If columns (4)-(6) regression does not control for distance to Nanjing, the coefficient for distance to Beijing does not change.

IV.B. Material Supply Mechanism

Under the political centralization system, a country's political, material, economic wealth and other social resources are concentrated in its capital. The counties surrounding the capital can access more resources, and have access to protection from the central government. In an agricultural society, food is the most important material guarantor of the urban system. When the transportation costs for agricultural goods are high, cities will only form in areas with an adequate food supply (Bosker and Buringh, 2015; Duranton, 1999). On one hand, the government forbade any maritime commerce in the Ming Dynasty, so the transportation of foodstuffs had to be via land transport or river transport. The Grand Canal was the water route after the capital relocation that guaranteed the food and material supply to the capital city, therefore the cities along the Grand Canal would have more adequate food supply and larger population. On the other hand, the Ming Dynasty established granaries both at the central and the local level. The central granaries were concentrated around the capital,[39] and local granaries were set up and managed by the local governments. However, the Ming Dynasty set requirements for the amount of storage in local granaries, therefore the number of local granaries can be used as a measurement for the amount of food supply in a region. We hypothesize that the closer an area is to the capital, the more food supply.

IV.B.1. Channel of the Grand Canal

In agricultural societies, land transportation costs are prohibitively expensive (Skinner, 1977). A cheaper way to transport food or material is via water transportation, and canals were the principal waterway in the Ming Dynasty. In order to transport food or material from the south to Beijing, the Yuan Dynasty opened the Huitong River in Shandong province, and completed the Grand Canal's route from south to north, but due to seasonal changes in water levels, throughput of the Grand Canal was limited. At the

39. During the Hongwu era, the central granary located in Nanjing. After the Yongle era, the central granaries including Beijing's Jingcang and Tongzhou granaries. The main purposes of the granaries in the Ming Dynasty were: 1: Food supply for the military, bureaucrats and the royal family; 2: Disaster relief; 3: Adjust for food surpluses and deficits in each region through transfers.

beginning of the Hongwu era of the Ming Dynasty, the Huitong River had fallen into disrepair and was abandoned due to siltation. Also, during this period, the capital's (Nanjing) food and material supply was primarily supplied from the southern provinces, negating the need for the Grand Canal. After Zhu Di moved the capital to Beijing, he organized to dredge the Huitong River in order to ensure a stable food and material supply for the new capital. By the 13th year of Zhu Di's reign (1415), the repairing work had been completed, and the Grand Canal undertook the main responsibility of transporting food and material. In addition to alleviating the labor burdens and costs of transporting food and material by land, the Grand Canal also promoted economic exchanges between northern and southern China. Therefore, the Grand Canal should help to reduce the impact of distance to the capital on population size for cities along its banks. Cities along the Grand Canal received more materials from both the capital and other regions, and are less affected by the impact of distance on population.

Table VIII shows the regression results of impact of distance to the capital on population size for cities lying or not lying along the Grand Canal. Columns (1) - (2) show that before the capital relocation, neither the population of cities along or not along the Grand Canal was affected significantly by distance to Nanjing or Beijing. Column (3) considers the influence of the interaction term of the Grand Canal and distance to Nanjing (the capital), and the coefficient of the interaction term is negative. Columns (1) - (3) show that Grand Canal does not have effect on the impact of distance on population size in Hongwu era, due to the fact that the purpose of the Grand Canal was to ensure the security of Northern China's food and material supply which brought about development and prosperity to cities along its route. During the Hongwu era, Beijing was neither a political nor an economic center, and the Grand Canal's role of food and material transportation was not important. Columns (4) - (6) show that after the capital moved to Beijing, the relationship between a region's population and distance to Beijing for cities not along the Canal is negative and significant, while cities along the canal have an insignificant coefficient. Column (6) considers the interaction term of the Grand Canal and distance to Beijing, and its coefficient is significantly positive, indicating that being along the Grand Canal helps reduce the negative effect of distance to the capital on population size. Columns (7) - (9) show the regression results for, after the capital relocation, simultaneously controlling for distance to Beijing and Nanjing, and the results are similar to columns (4) - (6). In summary, the impact of distance to Beijing on the size of city is reversed. The interaction terms of columns (6) and (9) indicate that the Grand Canal helps to reduce the impact of distance on the population size.

Table VIII Mechanism of the Grand Canal

Dep. Variable	Ln (Population)								
Sample Time Period	Hongwu Era			Post Capital Relocation					
Model Range	Along	Not Along	Full	Along	Not Along	Full	Along	Not Along	Full
Model Number	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln	2.272	0.069	0.578	-0.140	-0.960**	-1.021***	-2.691	-0.718*	-0.794**
(Distance_Beijing)	(3.805)	(0.547)	(0.541)	(2.395)	(0.394)	(0.336)	(2.228)	(0.393)	(0.338)

Ln (Distance_Nanjing)	-1.878 (3.246)	-0.951 (0.661)	-0.903 (0.704)				-5.865*** (1.657)	-0.997* (0.585)	-0.869 (0.528)
Grand Canal *Ln (Distance_Nanjing)			-2.498 (1.733)						
Grand Canal *Ln (Distance_Beijing)						1.452* (0.771)			1.171# (0.743)
Courier Station	0.400 (0.645)	0.365 (0.517)	0.330 (0.207)	-0.067 (0.400)	0.277 (0.181)	0.368 (0.256)	-0.316 (0.421)	0.377* (0.183)	0.203 (0.149)
Other Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	46	95	141	63	161	224	63	161	224
R^2	0.405	0.314	0.303	0.433	0.284	0.377	0.573	0.317	0.396

Note: The values in parentheses are robust standard errors, # $p < 0.15$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III.

As the government continued to repair and expand the functions of the Grand Canal, the Grand Canal still serviced its transportation function during the Kangxi (1661-1722) and early of Qianlong (1736-1795) era in the Qing Dynasty. However, after that, the government was chaotic, and the officials were corrupt, and the river workers were too lazy to repair the Grand Canal which was blocked. In the early years of Daoguang (1782-1850) era, the Grand Canal was not suitable for transporting grain and material any more. Table IX shows the regression results of the influence of the Grand Canal on urban system in the Qing Dynasty and the Republic of China, and test whether the weakening effect of the Grand Canal on distance will change with the Grand Canal's role in different periods. Column (1) shows that the interaction coefficient of the Grand Canal and the distance to Beijing during the Kangxi period was significantly positive. The Grand Canal helped to weaken the negative effect of distance on urban system. Column (2) shows that the interaction coefficient of the Grand Canal and the distance from Beijing during the Qianlong period was positive but not significant, because the Grand Canal began to be abandoned in the late Qianlong period. Column (3) shows that the interaction term coefficient of the Grand Canal and distance to Beijing during the Daoguang period was negative but not significant, and column (4) shows that the interaction coefficient of the canal and distance to Beijing during the Republic of China period is negative but not significant. Columns (5)-(6) use the same samples, which got consistent findings with columns (1) and (4). In summary, as the transport capacity of the Grand Canal changes, the weakening effect of the Grand Canal on distance-population relationship also changes.

Table IX The Function of Grand Canal in Different Periods

Dep. Variable	Ln (Population)					
Sample Time Period	Kangxi era	Qianlong era	Daoguang era	Republican	Kangxi era	Republican
Year	(1661-1722)	(1736-1795)	(1782-1850)	(1912-1949)	(1661-1722)	(1912-1949)
Model Number	(1)	(2)	(3)	(4)	(5)	(6)
Ln (Distance_Beijing)	-2.183** (0.859)	-1.614** (0.800)	-0.584 (0.920)	-0.811*** (0.177)	-1.921** (0.877)	-0.854* (0.511)
Ln (Distance_Nanjing)	-0.490 (1.189)	-2.315 (1.496)	0.336 (2.048)	-0.605** (0.290)	-1.107 (1.373)	1.126* (0.604)
Grand Canal *Ln (Distance_Beijing)	4.369** (1.781)	3.384 (3.066)	-3.287 (2.021)	-0.050 (0.342)	3.479* (1.990)	0.800 (0.807)
Courier Station	-0.113 (0.376)	-0.553 (0.490)	0.352 (0.289)	0.156*** (0.060)	-0.171 (0.402)	0.347** (0.155)
Other Variables	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	91	109	51	654	79	79

R^2	0.318	0.231	0.251	0.365	0.357	0.491

Note: The values in parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III.

IV.B.2. Channel of Grain Barns

When the cost of agricultural transportation is very high, cities will form in areas with a sufficient food and material supply (Bosker and Buringh, 2015; Duranton, 1999), and the Ming Dynasty established local grain barns, setting storage requirements for each granary by central government. The local government would be punished if each granary could not reach to stipulated minimum storage. Therefore, the number of granaries can be used as an indicator to measure the adequacy of the food supply. Cities closer to the capital receive more assistance from the capital including protection, material assistance, etc., which contribute to agricultural production, ensuring a better food supply. We examined the relationship between distance to the capital and the number of granaries. In general, the larger the number of granaries in a region, the more adequate the region's food supply.

Shen (1989) has given local granary data for the Ming Dynasty's Wanli era. Due to the small number of county-level granaries,[40] local granaries are added in total to prefecture level as an indicator to measure the total number of granaries in an area (for cities within each corresponding prefecture). Table X shows the number of prefecture-level's local granaries was affected by distance to Beijing or Nanjing. Column (1) only controls the regional fixed effect and courier station variable to calculate the impact of distance to Beijing or Nanjing on the number of granaries. Column (2) adds other control variables in the regression. Columns (1) - (2) show that regions closer to the capital had a larger number of granaries.

Table X Mechanism of the Number of Local Granaries

Dependent Variable	Ln (Number of Government Granaries)	
Model Number	(1)	(2)
Ln (Distance_Beijing)	-1.336***	-1.167***
	(0.353)	(0.378)
Ln (Distance_Nanjing)	1.223***	1.289***
	(0.399)	(0.420)
Courier Station	0.020**	0.012
	(0.008)	(0.011)
Other Control Variables	Only Regional Dummy Variables	Yes
Number of Obs.	112	112
R^2	0.350	0.361

Note: The values in parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III.

IV.C. National Security Mechanism

The safety of the surrounding environment is an important factor in determining the development of the urban system. The military functions of a Chinese city were superb, and the capital served as the military command center and defense headquarters of the nation, with outstanding military functions. The political

40. Distribution of the number of granaries in most counties is between 0-1.

governance impacted population distribution by safeguarding and protecting social stability. Chinese cities were always built with a defense wall and gates, with a considerable garrison to fend off outside aggressors and maintain order. The armed forces are an important component to a nation's political power, providing public security, and protecting the interests of the people, therefore, the larger the size of the armed forces garrisoned in a city, the larger the population size (Glaeser, 2011). Generally speaking, the larger the number of regional military garrisons, the better its defensive capability, so we use the number of military garrisons (*Weisuo*) to measure a region's defensive capabilities. Due to the importance of the capital, areas closer to the capital has stronger garrisons, and this is shown through the number of troops stationed in the regions.

In order to strengthen its control and management of the country, the Ming Dynasty established a defensive system known as the *Weisuo* from the capital down to the county level.[41] The Ming Dynasty's army was under the direct control of the emperor, and no soldiers could be moved without his express order, and the capital is a key area to garrison. For instance, in year 26 of the Hongwu era (1393), there were an estimated 1.8 million soldiers in the Ming Dynasty's army. Amongst these, most of the elite forces were stationed in Nanjing, about 200,000 men, meaning that 1/9 of the entire Ming Dynasty's army stayed to defend the capital (Nan and Tang, 2003). *Weisuo* of the Ming Dynasty was set up by the imperial government according to the defense and strategic needs of each place, which is a military unit with the authority of the central governance, ensuring the safety of local materials. On the other hand, *Weisuo* compensated for the disadvantages of the courier station's geographical restrictions, and inherited the commercial functions of some cities in different regions of the urban system. This paper adds up *Weisuo* data to the prefecture level.[42]

Since most *Weisuo* garrisons were established in the mid-to-late Hongwu era or even after the emperor Yongle, this paper treats *Weisuo* garrisons established before 1391 as *Weisuo* garrisons in Hongwu era, and treats garrisons existing later than 1402 as in post capital relocation period. Columns (1) - (2) in Table XI show that the number of *Weisuo*'s increase and decreases the farther from Beijing before and after the capital relocation. Within the Ming Dynasty's army system, the *wei* represents a large presence of troops, whose protective area is large. Column (3) in Table XI is the regression result of the number of *Wei* garrisons with respect to the distance to Beijing and Nanjing in post capital relocation period, and we found that distance have significant and negative impact on the number of *Wei* garrisons. Columns (4) - (5) in Table XI, excluding areas without the number of *Weisuo*, analyzes the samples regions who have counted the number of *Weisuo*, the results show that the number of *Weisuo*'s increases with the distance to Beijing before the capital relocation, but the coefficient turns to be negative after the capital relocation.

41. Zhu Yuanzhang placed special emphasis on the management and formation of the armed forces. In strategically important areas, he first set up a military command (*wei*), followed set up *suo*. A *wei* contains roughly 5,600 commanders, and leader of *wei* is named *Zhi Hui Shi*, who oversaw five *qian hu suo*s. Each *qian hu suo* had approximately 1,120 people, and they were directly overseen by officials per one hundred hu.

42. The number of *Weisuo* is based on the total number of *Weisuo* in an area. For instance, the Tangshan city in Hebei province had six *Weisuo*: Zunhua, Zhongyizhong, Xingzhou zuotun, Xingzhou Youtun, Xingzhou Qiantun and Kuanhe. Data source: http://www.xzqh.org/old/lishi/12ming/01.htm, Ming Dynasty Administrative Division Network.

Considering that the border areas needs stronger military security, there might not have been too many *Weisuo* garrisons at the border, but the number of soldiers and elite units stationed there was considerable. Firstly, samples given in this paper do not include remote areas such as China's southwest and northwest. Secondly, we regard areas north of Beijing as border areas. Taking *zhisuo* located in Liaoning, Jilin, Heilongjiang, the Inner Mongolia Autonomous Region, and Shanxi Province as border regions, a dummy variable is assigned 1, while the rest were given a value of 0. Columns (6) - (7) in Table XI exclude the border samples, and the results in columns (1) - (5) in Table XI remain almost unchanged.

Table XI Mechanism of *Weisuo*

Dep. Variable	Number_*Weisuo*		Number_*Wei*	Number_*Weisuo*			
Model Types	Full Sample		Full Sample	Areas_*Weisuo*		Eliminating Border	
Sample Time	Hongwu	Post Capita	Post Capita	Hongwu	Post Capita	Hongwu	Post
Period	Era	Relocation	Relocation	Era	Relocation	Era	Capita
Model Number	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln	0.492***	-0.753**	-0.925***	0.495**	-1.050***	0.591**	-1.007*
(Distance_Beijing)	(0.154)	(0.382)	(0.181)	(0.206)	(0.396)	(0.246)	(0.511)
Ln	-0.178	0.463	0.325	-0.448	0.480	-0.049	0.737**
(Distance_Nanjing)	(0.317)	(0.349)	(0.263)	(0.539)	(0.533)	(0.379)	(0.356)
Courier Station	0.058***	0.158***	0.080***	0.034	0.114***	-0.006	0.115**
	(0.013)	(0.029)	(0.019)	(0.022)	(0.033)	(0.032)	(0.047)
Other Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	331	331	331	165	208	168	168
R^2	0.272	0.388	0.431	0.180	0.314	0.176	0.388

Note: The values in parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III. When we control an interaction term between distance to Beijing (the capital) and the border dummy variable in columns (1) - (2) in Table XI, results in columns (1) - (2) in Table XI remain unchanged.

V. Further Discussion

V.A. Eliminating Effects of the Wars

Previous sections found that political governance affect population distribution. However, there were many wars during the Yuan and Ming Dynasty. One may be concerned about whether it was the Ming Dynasty's re-establishment of social stability in Northern China after winning the war, which had begun at the end of Yuan Dynasty, that led to changes in the population distribution. On one hand, moving the capital to Beijing had a protective effect on the surrounding regions, and this change in the political governance led to social stability influencing population distribution. On the other hand, the Ming Dynasty imposed strict controls on the free movement of people, and migration was mainly through official arrangement. As a result, war in this case did not have a big impact on our conclusions regarding political governance and population distribution. In this section, we try to formally eliminate the effect of war.

Considering Jingnan Campaign According to the existing literatures, wars may or may not affect population distribution (Bosker et al., 2008; Davis and Weinstein, 2002; Miguel and Roland, 2011), because

war is a short-term shock. In 1399 (right before the *Jingnan* campaign), Zhu Di received secret reports[43] that the capital city Nanjing (*Yingtianfu*) was empty, and he made the decision to attack Nanjing (*Yingtianfu*) directly. This fighting mostly occurred in Hebei and Shandong provinces, and other provinces were less affected by this campaign. (Please refer to the Appendix Table B4 for more details).

The Ming Dynasty's capital relocation occurred after the *Jingnan* campaign. In order to eliminate the possibility of changes in population distribution due to the Jingnan campaign, Table XII gives the regression results after removing the areas impacted by the war. Columns (1) - (2) are regression results for samples removing the major battlefields of the *Jingnan* campaign. Excluding these areas had no effect on the findings, because only 1 region was removed in Hongwu era. Columns (3) - (4) show the regression results of removing all samples where battles occurred, including major and minor battlefields. Removing these samples did not impact the previous results either, and 2 region samples were removed from the sample. Columns (5) - (6) are the regression results that excluded all major and minor battlefields and the surrounding areas within the same city, and the results remain. Column (6) shows the p value of the coefficient of capital relocation is 0.119.

In summary, the *Jingnan* campaign had no effect on the conclusions of the previous sections.

Table XII Eliminating Effects of the *Jingnan* Campaign

Dep. Variable	Ln (Population)					
Sample Time Period	Hongwu Era	Post Capital Relocation	Hongwu Era	Post Capital Relocation	Hongwu Era	Post-Capital Relocation
Model Range	Eliminate major Battlefields		Eliminate all Battlefields		Eliminate Surrounding Areas	
Model Number	(1)	(2)	(3)	(4)	(5)	(6)
Ln	0.912*	-0.574*	0.912*	-0.570*	0.710	-0.750**
(Distance_Beijing)	(0.507)	(0.294)	(0.507)	(0.296)	(0.664)	(0.370)
Ln	-1.183*	-0.958*	-1.183*	-0.954*	-1.251*	-0.886#
(Distance_Nanjing)	(0.693)	(0.530)	(0.693)	(0.530)	(0.728)	(0.574)
Courier Station	0.379*	0.198	0.379*	0.199	0.373*	0.273*
	(0.206)	(0.147)	(0.206)	(0.147)	(0.214)	(0.155)
Other Variables	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	141	224	141	223	129	203
R^2	0.275	0.369	0.275	0.368	0.291	0.378

Note: The values in parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III. If columns (2), (4) and (6) do not control for distance to Nanjing, the coefficient for distance to Beijing does not change much.

Considering North-South Difference In order to develop the economy, both Zhu Yuanzhang and Zhu Di had implemented the policy of "moving the rich", transferring wealthy households and residents from wealthy regions to the areas around the capital. One may be concerned that this policy caused many other people, such as followers and family members, to move along with wealthy residents. Columns (1) - (3) in Table XIII removed the samples near the capital, where the distance between the county and capital is no larger than 200 kilometers. The results are similar to the baseline regressions. Since the policy of "moving the rich" can also be regarded as political governance, we kept these samples in benchmark regression.

43. The secret reports came from a eunuch who was familiar with the royal palace of *Yingtianfu*.

Since Northern China experienced the destruction of wars in Yuan and Ming Dynasty, was the population distribution affected by these wars? In comparison with northern China, southern China had relative safer and more comfortable living environment, was less affected by wars, and became one of China's economic hubs during the Ming and Qing Dynasty. In order to eliminate the effect of wars, columns (4) - (6) in Table XIII only keep the samples in southern China,[44] and show again that capital relocation changed population distribution. Column (7) offers the DID regression result that keeps the balanced panel data of southern China before and after the capital relocation. The interaction term of distance to Beijing and capital relocation has negative and significant effect on population.

Table XIII Eliminating Effects of the Wars

Dependent Variable	Ln (Population)						
Model Range	Remove the Sample near the Capital			Keep the Southern Sample			
Model Type	Hongwu	Post Capital		Hongwu	Post Capital		DID
Model Number	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln	0.773#	-0.940***	-0.719**	0.889	-2.733***	-2.607**	-0.823
(Distance_Beijing)	(0.531)	(0.304)	(0.322)	(1.335)	(0.581)	(1.056)	(1.204)
Ln	-1.750**		-0.876#	-1.097		-0.118	0.270
(Distance_Nanjing)	(0.725)		(0.533)	(0.939)		(0.858)	(0.694)
Courier Station	0.280	0.181	0.216	0.461**	0.352**	0.356**	0.213
	(0.210)	(0.151)	(0.150)	(0.225)	(0.172)	(0.176)	(0.174)
Capital Relocation							0.101
（Yes＝1）							(0.913)
Capital Relocation*							-1.912*
Ln (Dis_Beijing)							(1.051)
Other Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	118	221	221	117	182	182	210
R^2	0.279	0.361	0.373	0.274	0.434	0.434	0.384

Note: The values in parentheses are robust standard errors, # $p < 0.15$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III.

V.B. Considering Local Factors

Although China was a political centralization system, the effect of political governance on population distribution may come from local governance. Bai and Jia (2018) found that economic advantages driven by local political factors do not persist, but local capitals have enjoyed better economic development measured by population density and urbanization. In order to exclude the effect of the local political governance, we controlled the distance from the nearest provincial capital to rule out the effect of local governance in model (1) and (2). Columns (1) - (3) in Table XIV controlled the distance to the nearest provincial government, and the results are similar to the baseline models.

Furthermore, we use the number of successful candidates in the highest imperial examinations (*Jinshi*) as an indicator to reflect the human capital development of a region. In order to rule out the effects of local development instead of political governance, we controlled for the scholars of a region in model (1) and (2). "*Ming Qing Jin Shi Ti Ming Bei Lu*" has enumerated information of each *Jinshi* in Ming and Qing Dynasty.

44. One of the dividing lines between southern and northern China is the Qinling Mountain - Huai River Line.

Columns (4) - (6) in Table XIV show the regression results which do not differ significantly from the baseline results.

Table XIV Eliminating Effects of the Local Factors

Dependent Variable	Ln (Population)					
	Ruling out Local Capital			Ruling out *Jinshi*		
Model Type	Hongwu Era	Post Capital Relocation		Hongwu Era	Post Capital Relocation	
Model Number	(1)	(2)	(3)	(4)	(5)	(6)
Ln (Distance_Beijing)	0.776#	-0.857***	-0.657**	0.875*	-0.723**	-0.544*
	(0.514)	(0.283)	(0.293)	(0.494)	(0.293)	(0.298)
Ln (Distance_Nanjing)	-0.995#		-0.903*	-0.545		-0.889*
	(0.702)		(0.537)	(0.646)		(0.515)
Ln (Province_Nearest)	0.048	-0.017	-0.031			
	(0.125)	(0.089)	(0.100)			
Ln (Jinshi)				0.356***	0.130*	0.120*
				(0.129)	(0.073)	(0.072)
Courier Station	0.350*	0.146	0.188	0.441**	0.193	0.230
	(0.207)	(0.148)	(0.148)	(0.209)	(0.151)	(0.151)
Other Variables	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	139	222	222	141	223	223
R^2	0.257	0.350	0.362	0.334	0.366	0.378

Note: The values in parentheses are robust standard errors, # $p < 0.15$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III.

V.C. Political governance? A Placebo Test

This section uses a placebo test to argue for the causality impact of political governance on population distribution. One may doubt that the effects of the distance to the capital are simply because of economic factors, i.e. the distance to central market. Notice that former dynasty's capitals are also important core cities in China, such as Tang Dynasty's capital city, Xi'an, which is far from both Beijing and Nanjing. If the effects of the distance to the capital are only economic, the distance of counties to Xi'an should also have effect on population distribution. Actually, Xi'an was the capital city of China during the Zhou, Qin, Han, Sui and Tang Dynasties. Zhu Yuanzhang also considered Xi'an as a potential capital city in late Hongwu era, and he sent the Crown prince to inspect this city. But due to the Crown prince's death shortly after his visit and inspection to Xi'an, he shelved his proposal to move the capital. Therefore, we considered Xi'an for a placebo test. Columns (1) - (2) in Table XV set Xi'an as a central city, and show the regression results for the impact of distance from Xi'an on population sizes. The conclusions show no significant impacts. In other words, the distances to Beijing after capital relocation and Nanjing before the capital relocation really capture the effects of political governance.

In 1271, Yuan Dynasty set capital in Beijing, named *Dadu*, and adopted the political centralization system. Although the early Yuan Dynasty continued its external expansion war, and the middle and late period experienced frequent coups, political corruption, ethnic contradictions, Yuan Dynasty's political governance should also have effect on population distribution. Columns (3) - (4) in Table XV show the regression results that used Yuan Dynasty's data at *Lu* (similar to prefecture) level. Column (3) controlled time and regional fixed effects and shows that the distance to Beijing has significantly negative effect on

population size, while distance to Nanjing does not. Column (4) controlled all control variables, and the result is similar to column (3). Combining the results from Table XV and Table II - Table III, the effects of distances to Beijing and Nanjing on population size really changed with the capital relocation.

Table XV Placebo Test

Dependent Variable	Ln (Population)		Ln (Household)	
Test Type	Distance to Historical Capital		Political Governance in Yuan Dynasty	
Time Period	Hongwu Era	Post Capital Relocation	Yuan Dynasty	Yuan Dynasty
Model Number	(1)	(2)	(3)	(4)
Ln (Distance to Xi'an)	0.153	0.112		
	(0.252)	(0.193)		
Courier Station	0.324	0.054		
	(0.202)	(0.149)		
Ln (Distance_Beijing)			-3.781***	-3.809***
			(1.216)	(1.302)
Ln (Distance_Nanjing)			-1.530	-0.955
			(1.081)	(1.343)
Other Control Variables	Yes	Yes	Only Fixed Effect	Yes
Number of Obs.	139	222	52	52
R^2	0.240	0.331	0.425	0.449

Note: 1. The values in parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables in columns (1) - (2) are the same as column (1) in Table III, and other control variables in columns (3) - (4) include Yuan Road dummy variable, Grand Canal dummy variable, Yangtze Rivers dummy variable, Time Fixed Effects and Region Fixed Effects. 2. Household data in columns (3) - (4) come from Wu Songdi, 2000, "The History of China's Population (Volume III, *Zhong Guo Ren Kou Shi*)", which was collected from "Yuan history, Geography" and other variables are the same as model (1) - (2). 3. Yuan Dynasty adopted provincial system and only 52 *Lu*, which is a local government unit controlled by province. We don't have population data for Yuan Dynasty, but use the number of households reported in Wu (2000)'s book.

VI. Conclusion

As people have already known, urban systems are stable, even after experiencing a serious shock. However, theories tell us that a "serious enough" shock can alter urban systems. This paper shows that in a united country with long history, China, the relocation of the capital may be a "serious enough" shock on its urban system. With a self-constructed unique data set for 240 counties over centuries, this paper uses the 'quasi-natural experiment' of capital relocation in 1421 in Ming Dynasty as an exogenous shock to study the relationship between political governance and urban systems. The evidence of this paper also adds to the literature showing another factor that shapes the urban system in ancient China, a politically centralized country. We found that after the Chinese Empire's capital was relocated from Nanjing to Beijing, the effects of the distance to Beijing on county-level population turned from positive to negative persistently until the founding of modern China. The causal relationship from capital relocation to population distribution is robust based on evidence from a variety of identification strategies, and robustness checks. We also provided detailed evidences to show that the impact of the capital relocation on population distribution is through three major channels of political governance, such as delivery, material support and national security.

Appendix

Appendix A: Robustness Checks

A.1 Robustness Checks of Baseline Regression

In this appendix section, we performed other robustness checks on Section 3.2. First, columns (1) – (2) in Appendix Table A1 removed the samples before the capital relocation during 1368-1420 from Table III. The findings in Table III were unchanged. Second, we try to control for more control variables in models (1) and (2), including dummies for cities lying along the Yellow River, the number of courier stations, and more historical main roads from different dynasties, and the major findings did not change. Third, since county data in this paper in the Ming Dynasty includes current city-level administrative units, this paper excludes samples using city-level data. The above results did not change, but the samples selected for this paper were county-level data and these counties belong to the same administrative level in the Ming Dynasty, therefore, the analysis from other sections of the paper still utilized the full samples. Column (7), using the population growth as the dependent variable. The result shows that political governance has significant effect on population growth.

Note that the crops cultivated in antient China include millet, rice, wheat, mulberry, and hemp. After the 16th century, foreign grain species were introduced into China, and the growth of technologies promoted agricultural development. The foreign grain species that were introduced to China in the Ming Dynasty mainly occurred in the middle and late stages of Ming Dynasty, such as corn (1550), sweet potato (late 16th century) and potato (mid-17th century), which has changed China's food structure. Considering that the population distribution began to change in the early of the capital relocation (Please refer to Table III and Table IV for more details), and the food was mainly introduced from the southeastern and southwestern China which are far away from Beijing, the major results of this paper should be underestimated.

Appendix Table A1 Robustness Checks of Baseline Regression

Dep. Variable	Ln (Population)						Growth
Model Type	Excluding Yongle Era		More Controls		Excluding Prefecture-level Cities		
Model Number	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln	-0.772***	-0.574*	-0.656*	-0.594*	-0.967***	-0.715**	-1.191***
(Distance_Beijing)	(0.285)	(0.293)	(0.340)	(0.332)	(0.298)	(0.304)	(0.360)
Ln		-0.958*		-0.715		-1.214**	0.279
(Distance_Nanjing)		(0.529)		(0.580)		(0.569)	(0.461)
Courier Station	0.155	0.198	0.248	0.281*	0.113	0.163	-0.056
	(0.147)	(0.147)	(0.154)	(0.155)	(0.150)	(0.149)	(0.156)
Other Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	223	223	224	224	186	186	125
R^2	0.349	0.363	0.394	0.400	0.367	0.390	0.439

Note: The values in parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III. Growth in column 7 is a region's population after the capital relocation - population in Hongwu era.

A.2 DID Analysis

Previous sections of this paper treat the relationship between distance and population distribution as a pre and post capital relocation analysis, which at its core is an asymptotic DID analysis. The principle of using an interaction term of post relocation dummy and distance to Beijing is the same as the subsample analysis, and the subsamples can more clearly identify the differences in the impacts of distances to Beijing before and after the capital relocation on population size. Therefore, this paper is primarily focused on analysis of subsamples. In this section, we combine samples from before and after the capital relocation, and construct panel data for DID analysis. The regression model is as follows:

$$Population_{it} = \alpha_0 + \alpha_1 Distance_i + \alpha_2 Relocation_t + \alpha_3 Relocation_t * Distance_i + \boldsymbol{others} \quad (3)$$

where, $Distance_i$ represents the distance from region i to Beijing, $Relocation_t$ is a dummy variable for period t representing whether or not the capital was moved, post-relocation equal to 1, otherwise 0. $Relocation_t * Distance_i$ is the interaction term reflecting the change in the impact of distance to Beijing on population distribution before and after the capital relocation. The coefficient of the interaction term should be negative. All other variables $\boldsymbol{others}$ are the same as in model (1).

Columns (1) and (3) in Appendix Table A2 compare the regression results of samples from the Hongwu era to the samples from periods after the capital moved. The negative coefficient of the interaction term shows that after the capital moved, counties farther from Beijing had smaller population, and that the influence of distance from Beijing over population size changed after the capital relocation.

One may be concerned that changes in the urban system before and after the capital relocation are a result of inconsistencies in the sample used? However, columns (2) and (4) in Appendix Table A2 show consistent samples before and after the capital move, and the results are similar to columns (1) and (3).

In order to clearly compare the impact of political governance on population distributions during various emperors' eras before and after the capital relocation, columns (5) - (14) of Appendix Table A2 supplements the results of the comparison of the population distribution between the Hongwu era and various emperors' eras after the capital relocation. Similar to Table IV, the coefficient of the interaction term between the Yongle and Xuande periods is not significant, and the coefficients of the interaction terms for all other periods are significantly negative.

Appendix Table A2 Population Size and Political Governance in DID Regression

Dependent Variable	Ln (Population)						
Model Ranges	*Panel A:* Comparison of Pre and Post Capital				Panel B: Comparison of Pre and Post Capital Eras		
	Full Sample	Balanced Panel	Full Sample	Balanced Panel			
Period compared with Hongwu	Post Capital relocation				Yongle	Xuande	Zhengtong
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)

Ln	0.950**	0.710	1.228***	0.855*	0.973**	1.224**	1.054**
(Distance_Beijing)	(0.433)	(0.481)	(0.449)	(0.499)	(0.454)	(0.486)	(0.492)
Ln			-1.092***	-0.484	-0.852*	-1.593**	-1.107*
(Distance_Nanjing)			(0.420)	(0.545)	(0.510)	(0.618)	(0.635)
Relocation	0.705	-0.213	0.789	-0.162	0.518	0.971	3.238***
（Yes, 1）	(0.721)	(0.620)	(0.699)	(0.624)	(0.696)	(1.000)	(1.178)
Relocation* Ln	-1.868***	-1.540**	-1.916***	-1.571**	-1.129	-1.749	-4.385***
(Distance_Beijing)	(0.490)	(0.642)	(0.489)	(0.643)	(0.698)	(1.192)	(1.574)
Other Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	365	250	365	250	241	189	179
R^2	0.304	0.336	0.321	0.339	0.250	0.302	0.285
Model Ranges	*Panel B:* Comparison of Pre and Post Capital Eras						
Period compared with Hongwu	Jingtai	Chenghua	Hongzhi	Zhengde	Jiajing	Wanli	Tianqi
Model	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Ln	1.013**	1.111**	1.068**	1.072**	1.006**	1.178***	0.978**
(Distance_Beijing)	(0.471)	(0.459)	(0.459)	(0.466)	(0.441)	(0.452)	(0.476)
Ln	-1.145**	-1.314***	-1.170**	-0.849	-0.995**	-1.177**	-1.182**
(Distance_Nanjing)	(0.578)	(0.499)	(0.496)	(0.567)	(0.440)	(0.495)	(0.546)
Relocation	1.159	1.568**	1.337**	0.950	0.675	0.627	1.337*
（Yes, 1）	(0.763)	(0.649)	(0.663)	(0.750)	(0.639)	(0.675)	(0.741)
Relocation* Ln	-2.325***	-2.863***	-2.214***	-2.058***	-1.952***	-1.683***	-2.731***
(Distance_Beijing)	(0.765)	(0.613)	(0.616)	(0.686)	(0.495)	(0.534)	(0.650)
Other Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	182	226	240	222	282	269	178
R^2	0.271	0.330	0.283	0.243	0.287	0.288	0.321

Note: The values in parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III.

A.3 Considering More Regional Fixed Effect

In ancient China, there is large difference between the southern and northern China, such as cultural and preferences. One of the dividing lines between the southern and northern China is bounded by the Qinling Mountains - Huaihe River Line. In this section, we controlled southern and northern fixed effects, and interaction terms of southern and northern fixed effects with eastern, central and western fixed effects in model (1) and (2).

Columns (1) - (3) in Appendix Table A3 show the results of the effect of political governance on population distribution after controlling southern and northern fixed effects and interaction terms in model (1) - (2). In Hongwu era, distance to Nanjing (capital city) has significantly negative effect on population distribution, and distance to Beijing has positive effect on population distribution. After the capital moved to Beijing, distance to Beijing has significantly negative effect on population size. These results show that relocating the capital city has changed the population distribution.

The DID regression results in columns (4) - (6) control the provincial dummy variables (hereafter referred to as province FE). Column (4) shows the unbalanced panel data regression result, column (5) shows the balanced panel data regression result, and column (6) shows the southern China sample of balanced panel data regression result. The coefficient of the interaction term in columns (4) - (6) are all significantly negative, showing that after the capital moved, counties farther from Beijing had a much smaller population.

Appendix Table A3 Controlling for More Regional Fixed Effects

Dependent Variable	Ln (Population)					
Model Type	Hongwu Era	Post Capital Relocation		DID - Province FE		
Model Number	(1)	(2)	(3)	(4)	(5)	(6)
Ln (Distance_Beijing)	1.872#	-2.104***	-1.480*	4.089***	3.487*	1.881
	(1.221)	(0.574)	(0.876)	(1.214)	(1.897)	(2.555)
Ln (Distance_Nanjing)	-1.816**		-0.680	0.831	1.713*	2.749***
	(0.900)		(0.736)	(0.747)	(0.957)	(1.026)
Capital Relocation				1.061*	0.422	0.841
（Yes, 1）				(0.605)	(0.600)	(0.881)
Capital Relocation*				-1.659***	-1.424**	-1.781*
Ln (Distance_Beijing)				(0.468)	(0.626)	(1.020)
Other Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Number of Obs.	141	224	224	365	250	210
R^2	0.302	0.390	0.394	0.418	0.455	0.484

Note: The values in parentheses are robust standard errors, # $p < 0.15$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III, and we controlled Southern and Northern fixed effects and interaction term with Eastern, Central and Western fixed effects in columns (1) - (3). We controlled Province FE in columns (4) - (6).

A.4 Using Provincial-level Data

In order to stabilize areas under its rule, the Ming Dynasty set up Two cities and Thirteen executive secretariats (*Liang Jing Shi San Bu Zheng Si*), a total of fifteen provincial administrative entities. Previous sections of this paper have shown the results of the impact of distance to capital on counties' population size, this section analyzes the impact of distance to capital on provincial-level population size and population density. First, the timing of data collection and releases are more consistent over time at provincial-level. Second, there are more available indicators that can be used to characterize provincial-level urban development. For example, population density, which better reflects urban development, is easier to obtain from provincial-level data. Liang (1980) has given statistics on total population and population per square kilometer for each province during 1393 (the 26th year of the Hongwu era), and 1578 (the 6th year of the Wanli era). We use two indicators to measure the size and density of provincial-level population, respectively.

Column (1) in Appendix Table A 4 shows the influence of the distance to Beijing and Nanjing on provincial population size during year 26 of the Hongwu era (1393). The result shows that distance to the capital (Nanjing) had a negative impact on population size, however the impact of distance to Beijing was not significant, t-test much less than 0.5. Column (2) shows the influence of distance to Beijing and Nanjing on provincial-level population had a negative impact during year 6 of the Wanli era (1578). Column (3) in Appendix Table A 4 gives the regression result of distance to Beijing and Nanjing on provincial-level population density during year 26 of the Hongwu era, and it shows that a county's distance to Beijing had a negative impact on population density, but that distance from Nanjing had a significant negative impact on population density. Column (4) shows both the effects of distances to Beijing or Nanjing on population density is significantly negative during year 6 of the Wanli era. Therefore, before and after the capital moved, there was a change in population distribution regardless of the measure of population distribution.

Appendix Table A 4 Population Distribution and Political Governance at Provincial Level

Dependent Variable	Ln (Population)	Ln (Population Density)

Model Type	Hongwu Year 26 (1393)	Wanli Year 6 (1578)	Hongwu Year 26 (1393)	Wanli Year 6 (1578)
Model	(1)	(2)	(3)	(4)
Ln (Distance_Beijing)	-0.053	-0.170**	0.076	-0.156**
	(0.168)	(0.064)	(0.096)	(0.061)
Ln (Distance_Nanjing)	-0.166**	-0.227***	-0.420***	-0.153**
	(0.067)	(0.028)	(0.086)	(0.049)
Other Control Variables	Yes	Yes	Yes	Yes
Number of Obs.	14	15	14	15
R^2	0.366	0.791	0.870	0.861

Note: The values in parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables added at the provincial level including: Areas around Yuan Dynasty roads, Ming Dynasty roads, area's fixed effects, and provincial level variables. If we do not controlled distance to Nanjing variable during the Wanli era, the coefficient of distance to Beijing is similar between columns (2) and (4).

A.5 Using Different Dependent Variable

Historians believe that there are some errors in the measurements of urban population sizes in Ming Dynasty. Because taxes in ancient China were levied on a headcount basis, additional people meant additional tax levies, which plausibly leading to underreporting and false reports in demographic data (Cao, 2001). For the following reasons, false reporting or undercounting of the population do not have great effect on the conclusions above. Firstly, considering that the number of households will not be undercounted or misreported, columns (8) - (10) in Table II utilize the number of households as dependent variable, and the results are similar to columns (4) - (5) in Table II. Secondly, demographic biases are errors of the dependent variable, which should have no substantial impact on estimations, unless the false reporting factors were related to the explanatory variables of this model. In order to ensure the reliability of conclusions from earlier sections, in this section, we use different indicators to measure the urban system.

Considering Rank of the Cities Demographic statistical errors are unlikely large enough to influence the ranking of a city based on its size, therefore changes in urban rankings can be an even more accurate indicator of urban system change. This paper ranks counties by their population size and sorted rankings separately before and after the capital moved. The larger the population size the higher the ranking value. For example, the county with the smallest population is ranked as 1, the second smallest population is ranked as 2, and so on.

Columns (1) - (3) in Appendix Table A5 show the regression results of a county's distance to Beijing or Nanjing on a city's ranking before and after the capital moved. The conclusion shows, no matter before or after the capital relocation, cities farther from the capital city ranked lower, and the influence of the distance from Beijing on the ranking changed from a significantly positive relation to a significantly negative relation.

Similar to model (3), we consider the DID regression using ranking. Columns (4) - (7) in Appendix Table A5 show that the coefficient of the interaction term of the relocation dummy and distance to Beijing is significantly negative, which means regions farther from Beijing had lower rankings after the capital relocation.

Appendix Table A5 City Ranking and Political Governance

Dep. Variable	City Ranking						
Model Type	OLS Regression			DID Regression			
Sample	Hongwu Era	Post Capital Relocation	Post Capital Relocation	Full Samples	Balanced Panel	Full Sample	Balanced Panel
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln	32.893**	-43.870***	-33.244*	33.945**	24.932*	46.404***	30.306*
(Dis_Beijing)	(14.769)	(16.541)	(16.857)	(13.371)	(14.963)	(14.460)	(15.920)
Ln	-37.618*		-51.580*			-48.927***	-17.986
(Dis_Nanjing)	(20.881)		(28.084)			(18.735)	(22.023)
Relocation				89.797***	51.604*	93.576***	53.490*
				(23.746)	(30.891)	(23.309)	(31.086)
Relocation*Ln				-83.887***	-64.908**	-86.015***	-66.034**
(Dis_Beijing)				(19.407)	(29.476)	(19.320)	(29.525)
Other Var	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No of Obs.	141	224	224	365	250	365	250
R^2	0.300	0.326	0.341	0.371	0.457	0.386	0.459

Note: The values in parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III.

Considering Markets Market serves as a place to exchange goods, and is an important indicator for a region's social vitality. The presence of markets is highly correlated with the size of the population, and the larger the population, the greater the demand for the exchange of goods, and the larger the number of markets. The Ming Dynasty had various names for markets, and *shi*, *zhen*, *ji* are the most common market names. These market names vary across regions and have crossovers, and different market names could co-exist within the same province, prefecture, or county. Han (2009) has given statistics on different market types in each *Fu*, *Zhou* and County, which primarily focused after the capital relocation. We use the number of markets, including *shi*, *zhen*, and *ji*, as an indicator of social economic vitality.

Appendix Table A6 shows the regression results for a county's distance to Beijing and Nanjing and the number of markets in each county. Columns (1) - (2) only controlled east/middle/west fixed effects ; columns (3) - (4) show regression results with all control variables as column (1) in Table III; columns (5) - (6) conduct robustness checks, which use the number of *zhen* in the county. The results show that the farther from Beijing, the smaller the number of markets. The distance from Nanjing coefficient is positive, because Beijing's status strengthened, and Zhu Di mimicked Zhu Yuanzhang's policy, moving rich people from wealthy areas of China to areas around the vicinity of Beijing.

Appendix Table A6 Number of Markets and Political Governance

Dependent Variable	Number of Markets				Number of *zhen*	
Model	(1)	(2)	(3)	(4)	(5)	(6)
Ln (Distance_Beijing)	-10.662***	-13.486***	-6.193*	-10.736**	-13.803#	-17.996**
	(3.834)	(4.189)	(3.717)	(4.497)	(8.526)	(8.800)
Ln (Distance_Nanjing)		7.313**		11.097**		13.170*
		(3.370)		(4.635)		(7.281)
Courier Station	0.032	0.068	0.042	0.101	-0.073	0.016
	(0.117)	(0.111)	(0.176)	(0.158)	(0.129)	(0.104)
Other Control Variables	Only FE		Yes	Yes	Yes	Yes
Number of Obs.	266	266	266	266	117	117
R^2	0.043	0.061	0.104	0.124	0.147	0.255

Note: The values in parentheses are robust standard errors, # $p < 0.15$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Other control variables are the same as column (1) in Table III.

Appendix B Statistical Description of Data

County Distribution Distribution of sampled counties in China Local Chronicle Series throughout China's provinces.

Appendix Table B1 Sampled Counties in Each Province (No.=876)

Province	Frequency	Percent (%)	Province	Frequency	Percent (%)
Anhui	28	3.20	Jiangsu	48	5.48
Fujian	44	5.02	Jiangxi	41	4.68
Gansu	33	3.77	Ningxia	8	0.91
Guangdong	58	6.62	Shandong	72	8.22
Guangxi	43	4.91	Shanxi	44	5.02
Guizhou	20	2.28	Shaanxi	67	7.65
Hebei	90	10.27	Sichuan	32	3.65
Henan	69	7.88	Yunnan	40	4.57
Hubei	36	4.11	Zhejiang	62	7.08
Hunan	41	4.68			

Data Samples Appendix Table B2 provides the data structure for counties during the Ming Dynasty. Because chronological variables are very important, we eliminated any data with missing dates for our application. If the time period is the Jiajing era, then we only consider samples with data from that period, and do not consider data from other samples. For instance, Badong County has statistical data on the Chenghua, Zhengde, Jiajing, Longqing and Wanli era populations, but only the population data from the Jiajing period matches our conditions. For data within the same era, we only take the latest year within the same time period. For instance, Badong County has population data for year 1, 10, 20, 30 and 40, and for our statistical tabulations we used year 40 to represent the population of the Jiajing era.

Appendix Table B2 Some Example of Data Structure Diagram in Ming Dynasty

Counties (Modern)	ID(2012)	County	Era	year	Emperor	Reign	Household	Population
Hanzhong City	610700	Hanzhong City	Hongwu	Hongwu Year 17 (1384)	Zhu Yuanzhang	1368-1398		
Anlu City	420982	Anlu City	Chenghua		Zhu Jianshen	1465-1487	1263	11428
Anlu City	420982	Anlu City	Jiajing		Zhu Houcong	1522-1566	1452	22202
Anlu City	420982	Anlu City	Wanli		Zhu Yijun	1573-1620	1452	22211
Pucheng County	610526	Pucheng County	Hongwu	Hongwu Year 1 (1368)	Zhu Yuanzhang	1368-1398	7000	30000
Anxiang County	430721	Anxiang County	Chongzhen	Chongzhen Year 15 （1642）	Zhu Youjian	1628-1644	2701	14107
Badong County	422823	Badong County	Chenghua	Chenghua Year 8 (1472)	Zhu Jianshen	1465-1487	1207	9493
Badong County	422823	Badong County	Zhengde	Zhengde Year 7 (1512)	Zhu Houzhao	1506-1521	1221	8612

Badong County	422823	Badong County	Jiajing	Jiajing Year 1 (1522)	Zhu Houcong	1522-1566	1263	8643
Badong County	422823	Badong Count	Jiajing	Jiajing Year 10 (1531)	Zhu Houcong	1522-1566	1253	8863
Badong County	422823	Badong County	Jiajing	Jiajing Year 20 (1541)	Zhu Houcong	1522-1566	1252	8833
Badong County	422823	Badong County	Jiajing	Jiajing Year 30 (1551)	Zhu Houcong	1522-1566	1252	8833
Badong County	422823	Badong County	Jiajing	Jiajing Year 40 (1561)	Zhu Houcong	1522-1566	1253	8883
Badong County	422823	Badong County	Longqing	Longqing Year 6 (1572)	Zhu Zaiji	1566-1572	1253	8883
Badong County	422823	Badong County	Wanli	Wanli year 10 (1582)	Zhu Yijun	1573-1620	1253	8883
Badong County	422823	Badong County	Wanli	Wanli year 20 (1592)	Zhu Yijun	1573-1620	1169	9033
Badong County	422823	Badong County	Wanli	Wanli Year 30 (1602)	Zhu Yijun	1573-1620	1553	13328
Baishui County	610527	Baishui County	Wanli		Zhu Yijun	1573-1620	1526	
Anxiang County	430721	Anxiang County	Hongwu	Hongwu year 24 (1391)	Zhu Yuanzhang	1368-1398	3887	15210
Chaling County	430224	Chaling County	Hongwu	Hongwu Year 24 (1391)	Zhu Yuanzhang	1368-1398	12568	56563
Pucheng County	610526	Pucheng County	Jiajing		Zhu Houcong	1522-1566	9000	80000
Pucheng County	610526	Pucheng County	Chongzhen		Zhu Youjian	1628-1644	9000	110000
Anlu City	420982	Anlu City	Hongwu		Zhu Yuanzhang	1368-1398	1035	5716

Ming Dynasty's Eras There are 16 emperors in the Ming Dynasties, and their corresponding years are tabulated in Appendix Table B3.

Appendix Table B3 Reigns of the Ming Dynasty's 16 Emperors

Era	Hongwu	Jianwen	Yongle	Hongxi	Xuande	Zhengtong	Jingtai	Tianshun
Years	1368-1398	1398-1402	1402-1424	1424-1425	1425-1435	1435-1449	1450-1457	1457-1464
Emperor	Zhu Yuanzhang	Zhu Yunwen	Zhu Di	Zhu Gaochi	Zhu Zhanji	Zhu Xizhen	Zhu Xiyu	Zhu Qizhen
Temple Name	Taizu	Huizong	Chengzu	Renzong	Xuanzong	Yingzong	Daizong	Yingzong
Data	Yes	No	Yes	No	Yes	Yes	Yes	No
Era	Chenghua	Hongzhi	Zhengde	Jiajing	Longqing	Wanli	Tianqi	Chongzhen
Years	1464-1487	1487-1505	1505-1521	1521-1566	1566-1572	1572-1620	1620-1627	1627-1644
Emperor	Zhu Jianshen	Zhu Youtang	Zhu Houzhao	Zhu Houcong	Zhu Zaiji	Zhu Yijun	Zhu Youxiao	Zhu Youjian

Temple Name	Xianzong	Xiaozong	Wuzong	Shizong	Muzong	Shenzong)	Xizong	Sizong
Data	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes

Note: The "data" row refers to whether this paper uses data from this period, yes indicates there is data, No indicates there is no data.

War areas of Jingnan Campaign Main regions of war areas of the *Jingnan* campaign are listed in Appendix Table B4.

Appendix Table B4 Main Regions of War Areas of the *Jingnan* Campaign

Areas of Important Battles	Areas with any battles	Cities in those areas	Cities in those areas
Baoding		Baoding City	Baoding City
Wuji		Shijiazhuang City	Wuji County
Zhending		Shijiazhuang City	Zhengding County
Dezhou		Dezhou City	Dezhou City
Jinan		Jinan City	Jinan City
Dongchang		Liaocheng City	Liaocheng City
Lingbi		Suzhou City	Lingbi County
Xuyi		Huaian City	Xuyi County
	Daning	Linfen City	Daning County
	Baigouhe	Baoding City	Xiong County
	Jiahe	Hengshui City	Wuyi County
	Guangping	Handan City	Guangping County
	Daming		Daming County
	Yangzhou	Yangzhou City	Yangzhou City
	Gaoyou		Gaoyou City
	Nantong	Nantong City	Nantong City
	Taizhou	Taizhou City	Taizhou City

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