THE STRUGGLE FOR EXISTENCE: MIGRATION, COMPETITION, AND HUMAN CAPITAL ACCUMULATION IN HISTORIC CHINA*

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Abstract

By constructing a dataset encompassing 287 prefectures and exploiting the spatial variation in migrant settlement, I show that the 1127–30 Han migration southward in historic China had a significantly positive effect on economic prosperity in the year 2000 (as measured by GDP and nighttime lights per capita). One possible channel is that the competition between migrants and locals following the implementation of the imperial civil service examination incentivized both groups to invest in education to better compete with their rivals. The resulting human capital increase contributed to today's economic development. These results remain robust even when I address the endogeneity issue by instrumenting migration flow size by the number of northern-born officials governing southern prefectures during the migration period.

Keywords: Historic migration, competition, human capital, GDP per capita, nighttime lights
JEL Codes: O15, N35, J15.

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I Introduction

Although north China was one of the world's most prosperous regions during the first millennium, today south China is much richer than the north. For example, in 741, the south was 56 percent (0.7 standard deviation) less prosperous than the north as measured by population density (the common proxy for premodern economic prosperity), whereas in 2000, the pattern was reversed. The south was 13 percent (0.1 standard deviation) richer than the north as measured by average GDP per capita (the common proxy for modern economic prosperity) (Figure I). According to economic historians, a major factor in this equilibrium transition was the north-south migration of China's dominant ethnic group, the Han Chinese, descendants of north China's ancient tribes, who expanded into south China over the past 2,000 years (Cavalli-Sforza, Menozzi, and Piazza 1994; Cioffi-Revilla and Lai 1995; Wen et al. 2004). These southward migrants not only increased the south's labor supply but stimulated its development through the importation of human capital and advanced agricultural technology (Maddison 2007). The last and largest wave of this historic southward migration occurred in 1127-30, after conflict with the Jurchen abruptly ended the Northern Song dynasty (967–1127) with the capture of the national capital, the emperor, and most of the imperial court. Only one prince, Zhao Gou, escaped from north to south China, reestablishing the government in the 1130s as the Southern Song dynasty (1127–1279) and leaving the Jurchen Empire to rule the north (Jin dynasty, 1115–1234). As a result, during the short period between 1127 and 1130, around 5 million people, about 10 percent of southern natives, also fled from the north to the south (Wu 1997).

Figure I about here

A preliminary examination of the data (see Figure I) provides strong support for the migration hypothesis. I construct a database that includes 1,369 recorded migrants, define each southern prefecture as "with/without migrants" based on whether the prefectures have records of any of these migrants, and find that the southern prefectures in which the Han migrants settled are 34 percent (0.45 standard deviation) richer than the northern prefectures, and that the southern prefectures without migrants are 16 percent (0.20 standard deviation) poorer than the those in the north. Nonetheless, despite a seemingly positive correlation between migrants and economic prosperity – that is, the southern prefectures with migrants are 50 percent richer than those without – the possibility that migrant settlement may be endogenous (i.e., more likely in regions that were richer in 1127-30) prevents a causal interpretation.

In this paper, therefore, I seek to address the potential endogeneity issues and identify the long-term migrant effect by (1) controlling for a wide range of variables (e.g., geography, initial economic conditions, the impacts of Sino-nomadic warfare, and crop suitability) and (2) using an instrumental variable approach. First, using both GDP and nighttime lights per capita in the year 2000 as proxies for contemporary development, I show that southward migrants did indeed have a positive long-term effect on today's economic prosperity, even though the inclusion of controls moves the migrant coefficients toward zero. Then, using Oster's (2017) exercise for assessing omitted variable bias to test the influence of unobserved factors on the remaining estimated effects, I demonstrate that even the lower bound of the bias-adjusted migrant effect is still much larger than zero, implying that these effects are unlikely to be fully driven by unobservables.

Second, I employ the number of northern-born officials (hereafter, NBOs) that were governing in southern prefectures during the migration period as an instrumental variable based on the assumption that the network effect would lead NBO-governed prefectures to receive more migrants. Given that subsequent falsification tests show a significant correlation between the numbers of NBOs and migrants during the migration period and the year 2000 level of economic prosperity but no such association for the pre- and postmigration NBO numbers, the presence of these NBOs during the migration period is unlikely to have affected today's income via other channels. Moreover, whereas the pre- and postmigration numbers have no effect on population density during either the pre- or postmigration periods, the migration period NBO number, although it makes no impact on pre-1127 population density (as a proxy for economic condition), has a significant effect after 1130.

To explain the link between historic migration and today's economic prosperity empirically, I start from an investigation into two possible channels highlighted in the literature; namely, human capital (e.g., Hornung 2014) and cultural diversity (e.g., Ashraf and Galor 2013). The results confirm that migrants do indeed increase contemporary educational level as measured by the percentage of population educated to high school or above, and cultural diversity as measured by an ethnolinguistic fragmentation (ELF) index. However, their explanatory powers for migration's positive impact on today's economic development are different: once education is controlled for, this significant migration effect disappears, while inclusion of the index only explains a small part of migration's impact on today's economic development.

Why, then, does migration contribute to a rise in human capital? The extant literature's dominant hypothesis is that migrants can benefit the receiving economy by carrying talents, knowledge, and human capital to the host region (cf. Hornung 2014). Different from this traditional view, I propose a new channel, migrant-local competition, which has both negative and positive potential. That is, as commonly acknowledged, migrants can introduce intense competition between themselves and regional natives, which can generate social and political problems, especially when the two groups are similar and the resources very limited.[1] Nonetheless, this negative side of migration can have positive long-term consequences if the competition between locals and migrants is based on human capital and thus capable of incentivizing both groups to invest more in such capital to better compete with their rivals. In this case, migrants, even without carrying advanced knowledge or human capital, could in fact have a long-term beneficial effect on the host region.

[1] Borjas (1999), in an analysis of immigrants' impact on the host region labor market, shows theoretically that natives "benefit from immigration as long as immigrants and natives differ in their productive endowments" (p. 1700); however, the empirical evidence on this impact is mixed (Borjas 2014; Card and Peri 2016; Dustmann, Schonberg, and Stuhler 2016).

To provide suggestive evidence for this migrant-local competition channel, I conduct an in-depth analysis of the 1127-30 Han migration, which offers three unique advantages for its disentanglement. First, it occurred in a subsistence agricultural economy whose key input factors of production were natural resources (land) and labor, implying that if the southern premigration labor-land ratio were small, immigrants could play a complementary role by making up the labor shortage and preventing intense competition. In reality, however, the area's sharply decreasing annual population growth rate (from 0.31 percent in 741-1078 to 0.15 percent in 1078-1102) suggests a decline in the agricultural production potential, so this massive influx of migrant refugees (10 percent of the local population or 64 years of population growth) coupled with land scarcity would have made competition unavoidable. This assumption is qualitatively supported by mid-19th century conflicts (i.e., 700 hundred years after the migration) between local Cantonese natives and Hakka southward migrants, which resulted in roughly one million dead (Liu 2003).[2]

Second, China's imperial civil service examination specified a form of education-based competition that was highly unique in a premodern period during which economic agents commonly used power to seize control of the assets held by others (Piccione and Rubinstein 2007). When such power is purely physical, competition may not necessarily lead to more investment in education. Hence, prior to the examination system's introduction, both migrants and natives of a region could invest in the number of their children to increase family size and compete with rival groups. Following its implementation, however, successful candidates could be appointed as government officials and use the state to compete with rival groups. Hence, if parents found that education could, for example, help the family or its kinship group in a fight over resources, they might tend to invest more in child quality than quantity in order to gain an evolutionary advantage for their lineage. As a result, the educational level in the host region might rise, promoting economic prosperity in the long term.

Third, the importance of this civil service examination (a human capital-based competition) varied over time, implying that migrant-local competition might be differently explained in particular periods. Hence, although I hypothesize that the migrant-local competition under the civil examination system induced both groups to make more investment in human capital (the "competition hypothesis"), I allow that migrants may indeed have carried and diffused advanced technology or human capital to the host region (the "diffusion hypothesis"). Whereas the diffusion hypothesis would predict a strong migrant effect on human capital before the examination system's intense implementation, the competition hypothesis would predict no such effect. Rather, it would expect migrants to be much more educated during the early period, with a chance for the locals to catch up later. The competition hypothesis, in contrast, would expect human capital not to differ between migrants and locals and thus increase synchronously over time. Fortunately, the examination system did not become the primary selection channel for

[2]The conflict between local Cantonese and Hakka is an extreme case of between-group competition. These conflicts happened in Guangdong and Guangxi provinces, whose total population in 1820 was around 30 million, meaning a death toll of about 3.3 percent (see Section II.B for additional anecdotes).

government officials until the Ming (1368-1663) and Qing (1664-1910) dynasties, two centuries after the migration period (1127-1130), so China's historical context facilitates empirical testing of these two hypotheses' auxiliary predictions.

The results of these tests provide suggestive evidence for the local-competition channel: First, using the ratio of successful examination candidates (Jinshi) to population as a measure of human capital in each prefecture, I show empirically that the migrant effect on human capital is statistically similar to zero during the early period after migration (e.g., during the Southern Song period, 1127-1279) but gradually increases and turns significant during the Ming and Qing dynasties (1368-1904) when the civil service examination became the primary channel for selecting government officials. Conversely, the migrant effect on population density decreases over time. These observations do not support the diffusion hypothesis, which predicts a higher educational level in the regions with more migrants during the early periods after migration. Second, by comparing the civil examination performance of northern-surnamed individuals (migrants) with southern-surnamed (locals), I demonstrate that the migrants performed no better than the locals in their host region. In fact, not only is there no statistical difference between the two groups in terms of human capital, but, consistent with the migrant-local competition hypothesis when both have identical incentives to invest in education as a means to beat each other out, their human capital level increases synchronously over time.

This study makes two useful contributions to the literature on the long-term effects of historic migrations. First, whereas extant studies attribute any impacts on receiving economies to migrants as carriers of talent, knowledge, and human capital, my analysis demonstrates that migrant-native competition, by motivating the two groups to invest more in human capital, stimulates economic prosperity when institutions increase the educational returns to survival of the kinship group. Hence, even when migrants and natives are similar, migrants can bring long-term benefits to the receiving economy via the human capital channel.[3] This finding is also related to the literature on the effect of forced migration on natives (e.g. Braun and Mahmoud 2014; Card 1990) or migrants (e.g. Bauer, Braun, and Kvasnicka 2013; Nakamura, Sigurdsson, and Steinsson 2017; Sarvimäki, Uusitalo, and Jäntti 2016) at their destinations. For example, Becker et al. (2020), using the post-WWII population transfer of Poles, shows that migration can lead to a switch in immigrants' preferences from material possessions to investment in such mobile assets as human capital, a shift that resulted in Poles with a family history of forced migration being much more educated today. In the differing context of China, I find not only that migrants similarly increase their investment in human capital at their destination, but that forced migration increases the educational level of natives through migrant-local competition.

[3] Although intense group competition for scarce resources has in the past led to violent conflicts and millions of deaths (Esteban, Mayoral and Ray 2012; Ray and Esteban 2017), recent research suggests that it may be possible to mitigate such political risk by introducing intergroup complementarity (i.e. Jha 2013). My study, although focused specifically on the migrant-local schism in historical China, provides a new perspective for understanding this question in general. That is, group competition could have a largely beneficial effect if group competition is dependent on elements that benefit economic development (e.g. human capital) rather than on physical power or violence.

The insights provided by this paper can also expand our understanding of the deep roots of comparative development, especially ethnolinguistic fractionalization (i.e., Alesina et al. 2003; Alesina and La Ferrara 2005).[4] Such fragmentation, although it may adversely affect economic prosperity, can still have an important positive effect by stimulating two competing groups to invest in child quality in order to gain an evolutionary advantage, thereby promoting economic development in the long run. Whereas Ashraf and Galor (2013) propose that genetic diversity (fragmentation) may have a positive effect by enlarging the possible frontiers of production, this paper proposes that fragmentation can have a positive effect through a different channel; namely, between-group competition. The analysis also relates somewhat to the Galor and Moav (2002) investigation of competition and natural selection, even though instead of their two types of individuals in a population, each with different inherited preferences for child quality or quantity, I assume two types of populations with the same preference incentivized by between-group competition to invest in child quality.

II Historical background

II.A Migration and the Change in China's Economic Center

During three separate periods of China's history, the agricultural Han population living in the lower and middle reaches of the Yellow River (i.e., central China) suffered invasion by northern nomadic peoples (Bai and Kung 2011), who eventually conquered China proper (north China) leaving the southern region peaceful and untouched. As a result, the Han underwent three major waves of mass southward migration (Cavalli-Sforza, Menozzi, and Piazza 1994; Wen et al. 2004).[5] These migrations began during the Western Jin dynasty (265–316), when the Jin could not contain the revolt of the five barbarian tribes (in Chinese, *Wuhu Luanhua*). After the overthrow of their capital, Luoyang, and the murder of the crown prince, a host of ministers, and over 30,000 civilians; the remnants of the Western Jin court fled south and re-established their government in Jiankang, while the north remained occupied by various nomadic groups. At this time, around 0.9 million refugees fled from central China to the lower and middle reaches of the Yangtze River, where conditions were relatively stable.

The second migration wave, thought to have been even more extensive (Wu 1997), began in 755, during an era of great political upheaval between the Tang and Song Dynasties, when the nomadic leader An-Lushan conquered the northern part of China and declared himself emperor.[6] Because his attempt to expand into south China was blocked by a stalemate in the

[4] As outlined by Spolaore and Wacziarg (2013), the fundamental roots of comparative development range from geography (Diamond 1997), climatic fluctuations (Ashraf and Michalopoulos 2015), human capital (Glaeser et al. 2004), institutions (Acemoglu et al. 2001; Michalopoulos and Papaioannou, 2013), culture (Alesina et al. 2013; Nunn and Wantchekon 2011; Voigtländer and Voth 2012), and the role of the current population's ancestral composition (Putterman and Weil 2010) to genetic distance (Spolaore and Wacziarg 2009).

[5] See Wu (1997) for a summary of this southward migration and its three migration waves, which are supported by modern genetic studies (Wen et al. 2004).

[6] The first wave of migration mainly covered the Yangtze River Valley, while the second wave reached south

War of Suiyang, south China again remained relatively untouched, encouraging another mass southward migration of northern Han that continued for 200 years until the Song dynasty unified China.

The third wave took place after the abrupt downfall in 1127 of the Northern Song dynasty, when the Song's erstwhile allies the Jurchens (a northeastern ethnic group) turned against them, capturing their capital city Kaifeng, their emperor, and most of the imperial court (Ebrey 2006). The Jurchens then established their own empire in north China, which prompted around 5 million northerners to flee south between 1127 and 1130 (Wen et al. 2004; Wu 1997), leading eventually to the 1131 establishment of the Southern Song dynasty with a new capital at Hangzhou.

Historians measure the role of migrants in changing the regional center of gravity by their proportion. For instance, Wu (1997) shows that the proportion of the population living in north China decreased from 81 percent (circa AD 2) to 33.5 percent (circa 1102), with migrants, as carriers of labor, human capital, and advanced agricultural technology, playing an important role in this decrease (Durand 1974; Elvin 1973).[7] These southward migrants thus not only increased the south's labor supply but brought human capital and advanced agricultural technology to the region (Maddison 2007), which prior to the first two migration waves, practiced only primitive slash-and-burn agriculture and moving cultivation. In doing so, they stimulated development in a region with large relatively underdeveloped areas (Maddison 2007). The situation preceding the third wave of migration to south China, however, was very different: following the second migration wave, the economic center shifted from the north to the south (Maddison, 2007), so that by 1102–25, the ratio of the southern population to the total was about 66.5 percent, very similar not only to the 71.7 percent ratio of the southern to the total area (Appendix A) but also to the ratio in the late Qing dynasty (1820–1910). Given these conditional differences, the third migration wave may not have affected the economic development of the receiving region in the same way as the first two waves had done. Moreover, any strong positive causal relation may not have been created through the diffusion of human capital or technology but through other important changes assumedly brought about by the southward migration. These latter include not only a significant effect on interregional development and dramatic transformation (between 750 and 1550) of China's demographic, political, and social landscape (Hartwell, 1982), but also the other major channel introduced in this paper: the competition between migrants and natives.

China (i.e., Guangdong and Guangxi Province in today's China).

[7] At the end of the 12th century (i.e., after the third migration wave), about 60 percent of the population lived in south China (Durand 1974), a concentration that continued to grow because of the Mongol Yuan conquest until by the end of the 13th century, about 85 percent of China's inhabitants lived in the south (Elvin 1973). Although these studies compare populations in the area south of the Yangtze River rather than defining south China as the area ruled by the Southern Song dynasty (as done here following Wu, 1997), the comparison in Appendix A of north and south China populations shows a similar trend.

II.B Between-lineage Competition and Cooperation in Historical China

To better explain the competition between migrants and locals in late imperial China, I need first to outline the general pattern of interlineage relationships so as to enable a subsequent discussion of between-lineage competition and cooperation. A primary assumption underlying this discussion is that compared to the competition between two local lineages, that between locals and migrants was much more frequent, intense, and sometimes even violent. Nonetheless, migrant-local coordination, although not impossible, was very costly and unstable.

Between-lineage competition. In general, during the Malthusian epoch, lineages need to compete with their rivals for scarce resources to survive and thrive. For example, in the 1890s, in what is now Hong Kong's New Territories, after the Tang lineage established a market in Tai Po, their neighbors challenged their monopoly of the right to hold a market in the area (Freedman, 1966). The Man lineage then rallied local support to found a new market about half a mile from the older one, making this competition partly commercial. In fact, the two lineages competed to "see which of them could lay the longer line of silver dollars along the part leading north from their settlement" (Freedman 1966, p. 84). Such between-lineage disputes may also have involved litigation.[8] For example, in the central Chinese county of Hanyang, in the early 19th century, the Yao lineage "filed suit ... to guarantee access by Yao fishermen to lakeshores owned by the Yu" in a lawsuit (typically complex and costly in Imperial China) that "dragged on for more than 15 years" (Esherick and Rankin, 1990, p. 77). Likewise, in many other regions, gross malfunctions within the legal system made parties prone to quarrel and fight (Lamley 1990, p.41), a competition that had the potential to develop into an extreme form: lineage feuding.

Competition under the civil service examination. Because of centralized and autocratic monarchy in historic China, political status (power) was crucial to the fate of a lineage, even the most powerful of which were unable or unwilling to challenge government power. Rather, to compete with their rivals, kinship groups took of advantage of the state by educating their children to pass the imperial civil service examination as a path to government positions in a national system of power in which they could then further the interest of their own lineages (Freedman 1966). As a result, elite family groups could achieve outstanding academic success with a long list of Jinshi, while those with wealth were not necessarily capable of "translating that wealth to academic success" on a grand scale, forcing them into a "relatively low status within the hierarchy of families" (Zurndorfer 1989).

Between-lineage cooperation. In addition to realizing the benefits of collective actions through competition, lineages frequently formed cooperative groups, as in the alliance formed by the Man lineage with six other kinship groups in their competition with the Tang. Whereas lineage feuding was an extreme form of interlineage competition, however, interlineage marriage was the epitome of interlineage cooperation. For example, in a tradition of intermarriage between

[8]The Tang-Man dispute in Hong Kong also involved the government: the county magistrate made a decision that only the Tang had the right to build shops in the Tai Po market.

the Chang and Yao lineages that lasted from the early 17th to the late 19th century, the Qing dynasty politician Chang Ying married three of his six sons (i.e. 50%) to Yao women, a number that rose to 71% in the next generation, and remained notable in the fourth and fifth generations at 42.5% and 30%, respectively (Beattie 1979, p.104).

Migrant-local competition. The relationship between locals and migrants, in contrast, involved more competition than cooperation, as in the mid-19th conflict between the local Punti and the Hakka ("guest people") descendants of migrants, which led to one million deaths (Liu 2003). Similar incidents occurred in late 17th century Taiwan between Hokkien speakers and the Hakka-speakers who immigrated much later. When competition between the two over "available land and especially ... water resources" increased, "ethnic rivalries became frequent, intense and violent" (Pasternak 1969, p. 559). In 1721, when the Hakka rebelled against the Manchus, the two groups joined forces; however, the alliance was an uneasy one and "an inner struggle eventually led to violence ... and a massacre of Hakka soldiers" (p. 560).

III Data

To measure the overall effect of the 1127–30 southward migration on the economic prosperity of contemporary China and identify its channels, I construct a dataset that exploits spatial variation in the number of migrants. This dataset encompasses 287 prefectures, located in the former Northern Song dynasty territory (see Figure B1), which, although they account for only around 28 percent (2.7 million km^2) of China's present territory, in 2000 were home to a disproportionate 80 percent (around 998 million) of the total population.

III.A Geographic Distribution of Migrant Settlement

The dataset is a compilation of Wu's (1997) lists of recorded migrants, drawn primarily from literary prefaces or postscripts in which authors briefly describe their family histories, including accounts of ancestors who experienced the 1127-30 migration.[9] Because Wu's work accurately records these migrants' settlement locations during those four years, by coding the locations' geographic coordinates and matching them to the map of the Northern Song dynasty (CHGIS 2007), I am able to derive the total number of migrants in each prefecture (M_i) and map their geographic distribution (see Figure II). All migrants left the 109 northern prefectures of the former Northern Song territory conquered by the Jurchen Jin ($S_i = 0$), and settled in the southern region ruled by the Southern Song ($S_i = 1$), represented in Figure IIa by the dense dark and lighter regions, respectively.

Figure II about here

The dataset includes a total of 1,369 recorded migrants distributed in 101 (out of 178) southern prefectures, ranging in number from 1 to 145 (in Hangzhou, location of the Southern

[9] Personal biographies and chorography are also very important sources of Wu's list.

Song capital).[10] The regression employs the log-term of migrants, using the $m_i = \ln(M_i + 1)$ transformation to deal with observations of 0 and the inverse hyperbolic sine transformation to check robustness.[11] Table 1 lists the data sources and summary statistics.

Table I about here

Cross-validation checks. Although around 5 million inhabitants migrated from north to south in 1127-30, Wu's (1997) sample covers only 1,369 migrants. Hence, even if one migrant signifies 50–100 individuals (i.e., members of an extended family or village), the sample migrants still only cover about 1.37-2.74 percent of the total migrants, raising the major concern of how m_i correlates with the true measure of migrant settlement. Therefore, exploiting the fact that, post migration, some largely distributed surnames in the north became more prevalent in the south,[12] I check this correlation rigorously by regressing the increased share of northern surnames, the decreased share of southern surnames, and the difference between the two changes on the logged number of migrants. The significantly positive correlation and high R-squared (0.32) suggest that the migrant data are highly reliable (see Appendix B). This check, however, may not be helpful in addressing concerns about the overinclusion of migrants with more educated descendants, which nonclassical measurement error may work in favor of a positive migrant effect on economic development. As previously explained, I strive to rule out this concern using an instrumental variable.

III.B Economic Outcomes

GDP per capita in 2000. Assessing the effect of migrants on economic development requires information on the regional distribution of income across the 287 prefectures, my first measure of which is GDP per capita in 2000. Because the observation is the prefecture during the Northern Song dynasty, I base the measurement on geocoded high-resolution (1km x 1km) GDP and population measures provided by the Institute of Remote Sensing and Digital Earth at the Chinese Academy of Sciences and aggregate them at a Song prefecture level. Whereas the average GDP per capita is about 6,210 CNY, its geographic distribution shows huge spatial variations in income (see Figure C1 of Appendix C); in particular, much higher income in the coastal region and the lower and middle reaches of the Yangtze River.

Lights in 2000. To ensure that GDP per capita is a sound proxy for economic prosperity, I use the night time satellite light (per squared kilometer or per capita) as an alternative measure based on the assumption that luminosity data are more useful for countries with the lowest

[10]Because migration during the 1127–30 period was always household or village based, one recorded migrant might indicate the migration of one extended family or village.

[11]Burbidge et al. (1988) propose the $m_i = \ln(M_i + (M_i^2 + 1)^{0.5})$ transformation, which behaves like a log transformation for large values of M_i. I use this alternative form as a robustness check.

[12]The Chinese surname data are obtained from the Harvard Yenching Institute's CBDB, which contains the biographical information of 29,234 individuals spanning 916 to 1279. Based on the surnames of these inhabitants and using the geographic coordinates (latitude and longitude) of their residences, I am able to transpose them onto a map of the sample prefectures

statistical grades (Chen and Nordhaus, 2011, Henderson, Storeygard, and Weil, 2012).[13] This measure, taken from the Defense Meteorological Satellite Program's Operational Lines System, ranges from 0 to 63 for every 30-second x 30-second area. After calculating the total lights for each prefecture, I normalize the outcomes by total area or total population. Figure C1a, which graphs the geographic distribution of GDP and the average luminosity (total lights per squared-km), reveals a strong association between the two measures, while Figure C1b shows that they are significantly positively linearly correlated. The elasticity between GDP per capita and the average night time lightness is about 0.442 and significant at a 1 percent level.[14]

Population density. Because the immediate effect of migration is increased population density, I use historical data on the prefecture-level population or household numbers in the years 741, 1080, 1102, 1290, 1391, 1776, 1820, 1851, 1880, and 1910 (Ge 2000, Liang 1980) to calculate the log term of the number of households/populations per square kilometer as a measure of population density during these different periods.[15] I then use census data to calculate the population density in 2000.

Human capital. As previously mentioned, Imperial China based its education system on the civil service examination, which was administered on three levels, from the prefecture (lowest) up to the provincial (highest), and employed a regional quota system to control the number of successful candidates, with quotas for the prefecture-level examination assigned at the prefecture level and those for higher level exams assigned at the province level. Thus, when the province fixed effect is controlled for, the number of successful candidates or Jinshi at the higher level of each prefecture can proxy for educational level, while the number of Jinshi per million population can serve as a measure of human capital. The Jinshi data cover three dynasties, divided into seven periods: Southern Song, Early Ming, Mid Ming, Late Ming, Early Qing, Mid Qing, and Late Qing. To measure educational level in 2000, I calculate the percentage of the population educated to high school level or above and use it as proxy for education.[16]

III.C Basic Control Variables

Because the dependent variable takes a per capita measure, my empirical estimations include both logged prefecture size (land area) and logged number of households before migration (in 1080) to control for size effect. Because geographic characteristics might affect the number of

[13] The local GDP is calculated based on data collected by local governments. However, the local government has an incentive to skew local statistics, which leads to concerns about the reliability of local GDP numbers (Chen et al. 2019). The satellite luminosity is a common economic indicator for measuring local economic prosperity. But, this measure is still noisy, in particular for regions with different industry structures.

[14] When I regress logged GDP per capita on logged nighttime luminosity, the coefficient is 0.442 (with a standardized beta of 0.559) and the standard error is 0.039.

[15] Ge (2000) estimates the total number of population in each Qing prefecture in 1391, 1776, 1820, 1851, 1880, and 1910, which I convert for Song prefectures (see Figure C2 for method). Liang (1980) also uses historical records to determine household size at the prefecture level in 741, 1080, 1102, and 1290.

[16] The census provides the geographic information of household registrations (Hukou) at the county level. Education at the prefectural level is calculated based on all counties whose centroids were located in the prefecture.

migrants, they also include a coastal dummy and distance to major ports,[17] as well as latitude and longitude (see Figure C3). Inclusion of the coastal dummy is necessary because the northern migrants' ability to flee by sea resulted in greater numbers settling in coastal regions (see Figure II), which are coincidentally more prosperous, possibly because of an open policy since 1978.[18] The geographic coordinates then take into account the migration direction being mainly from northwest to southeast, implying a probable relation between latitude and longitude and economic development. Given the likelihood of fleeing via water, I digitize a map highlighting waterways during the Northern Song dynasty (Liu, 2015) to generate a dummy for whether a prefecture had a main waterway during the premigration period (see Figure C4). Given the important role of human capital, I proxy the premigration level of human capital by the ratio of Jinshi to population during the Northern Song dynasty and employ it as a basic control. Before conducting the empirical analysis, I first check the effects of these controls on migrant numbers (Table D.1), which, as conjectured, provides clear evidence that prefectures along the coast and/or a major river did indeed receive more migrants.

IV The migrant effect on comparative development in 2000

IV.A Baseline Results

To assess the long-term effect of migration, I regress economic prosperity y_i (i.e., the logged GDP and logged lights per squared-km of the 287 prefectures) on the logged number of recorded migrants m_i by applying OLS to the following equation:

$$y_i = \alpha + \rho_0 m_i + \rho_1 W_i + \varepsilon_i, \tag{1}$$

where ρ_0 represents the effect of the logged number of migrants on economic prosperity. Initially, W_i only includes a dummy for whether the prefecture is located in south China (i.e., in the formerly Southern Song area, $S_i = 1$). The results, presented in Table II, show a significant positive relation between the two variables, with the logged number of migrants significantly increasing both GDP per capita (column (1)) and nighttime lights (column (4)). In terms of magnitude, a 1 percent increase in migrant number leads to a 0.258 percent increase in GDP per capita (column (1)) and a 0.348 percent increase in lights per squared kilometer (column (4)). When I then add in initial population size and area, a variety of geographic factors (latitude, longitude, distance to major ports, coastal region, and waterway access), and initial human capital; the logged number of migrants remains significant, but the effects on logged GDP per capita and logged lights per squared kilometer decrease from 0.258 (column (1)) to 0.144 (column (3)) and from 0.348 (column (4)) to 0.177 (column (6)), respectively.

[17] In the empirical analysis, I use the minimum geographic distance to three major ports (Nibo, Quzhou, and Guangzhou) across China's history, with distance to coastline as an alternative measure. The main results remain robust using either measure.

[18] Since 1978, China's central government has begun establishing special economic zones in coastal areas to stimulate economic growth.

The effect of the south China dummy on per capita income, although significantly negative in the short regression, loses its significance as more controls are added, implying that once the differences in observables are accounted for, southern prefectures without migrants do not differ significantly from northern ones. Certain geographic factors also appear to have a positive effect on comparative development, including the earlier noted effect of coastal area prefectures tending to be more prosperous. As regards other controls, initial household density (logged population size with a control for logged area) is, as expected, positively correlated with current economic prosperity, while light density is lower in regions with higher latitude, albeit only at marginal significance.

Table II about here

Model specification. In the baseline analysis, I regress economic prosperity on the logged number of migrants and the south China dummy mainly to assess whether migrants could account for the north-south income difference. To check whether the results are sensitive to this model specification, I first regress economic prosperity directly on the logged number of migrants using only the southern subsample (Table D.2) and then interact the controls with the north China dummy (Table D.3). The migrant effect on per capita income and night lights remains robust across all results.

Assessing omitted variable bias. After controlling for important confounders related to geography, initial economic conditions, and province fixed effects, I find that the effect of the logged number of migrants remains significant. Nevertheless, the estimates may still be biased by omitted variables such as unobserved settlement suitability. I thus evaluate the results' robustness to the omitted variable bias using the method proposed by Oster (2017). The results imply a low likelihood that the estimated migrant effect is fully driven by unobservable variables (Table D.4).

IV.B Robustness Checks

Because the results show that the effect of the logged number of migrants on population density (columns (9), Table II) is insignificant when the basic control variables are included, I calculate a new dependent variable; namely, logged nightlights normalized by total population (see Table III). This variable allows me to interpret the coefficient of migrants as the impact on the per capita term and compare this latter with the effect on per capita GDP. According to the results, a 1 percent increase in migrant number leads to a 0.144 percent increase in GDP per capita (column (1)) and a 0.120 percent increase in lights (column (5)). Moreover, the coefficients are significant at 1% level and the results remain robust when I account for spatial correlation using the algorithm developed by Colella et al. (2019), which allows for arbitrary spatial clustering (Table D.5).

Table III about here

Measurement. In the empirical analysis above, the explanatory variable is $m_i = \ln(M_i + 1)$. To check whether the results are sensitive to this transformation, I employ the inverse hyperbolic sine transformation of migrants, $m_i = \ln(M_i + (M_i^2 + 1)^{0.5})$, to deal with the observations of 0 (Table D.6), I also employ an alternative migration measure – derived from the change in surname structure – as the explanatory variable (Table D.6). All results point to a significantly positive migrant effect on contemporary development.

South vs. north. Although a salient feature of China's contemporary economic geography is a far more prosperous south than north, in historic China, the north was the more developed region, especially before the Song dynasty. According to the results in Table III, columns (1) and (5), this long-term pattern of north-south divergence in economic activity may be attributable to the north-to-south population. Specifically, the south China dummy's lack of significance when the logged number of migrants is included (columns (1)-(8)) implies that the southern prefectures without migrants are not significantly different from the northern prefectures. These empirical findings not only suggest that the north-south economic differences are driven mainly by prefectures with migrants, they also imply that the migration episode under study hastened the equilibrium transition. I therefore test their robustness by considering first the impact of crop suitability and then that of warfare.

Crop suitability. One key explanation for southern China's rise is advancing agricultural technology, particularly the introduction during the Song Dynasty of quickly maturing, drought-resistant champa rice, which can be harvested twice per year. Likewise, beginning in 1500, China also adopted new world crops, which greatly stimulated population growth (Chen and Kung, 2014; Nunn and Qian, 2011). I therefore rule out any crop effect (i.e., agricultural shock) by controlling for crop suitability (based on soil condition differences) using the suitability index from the Food and Agriculture Organization's 2012 Global Agro-Ecological Zones database, which ranges from 1 ("not suitable") to 8 ("very high") in each 0.5-degree x 0.5-degree grid cell. I measure prefecture-level crop suitability as the average for all cells located in each prefecture with a primary focus on the suitability for wheat, rice, maize, and sweet potato (see Figure C5). Although including this crop suitability control slightly decreases the effect on economic prosperity (Table III, columns (2) and (6)), it engenders no changes in the main effect of the logged number of migrants.

Impact of warfare. In addition to the southward migration and crop suitability, historians suggest that both the change in national capital and warfare-induced destruction, especially in the north, are also main determinants of the shifted regional center of gravity (Liu, 2015). Hence, to control for such effects, my regression also includes (i) the distance to Hangzhou (the Southern Song national capital), (ii) the destruction of infrastructure measured by water transport networks, and (iii) changes in administrative unit boundaries. As regards the first, the distance to the new Southern Song capital might be related to the number of migrants received by one prefecture or even to the diffusion of development. For instance, prefectures closer to Hangzhou are also closer to the Yangtze Delta, China's most prosperous region today. I thus include the great circular distance between Hangzhou and the mass point of each prefecture calculated using the geographic coordinates from China Historical GIS (CHGIS 2007).

To proxy the impact of warfare, I choose infrastructure destruction because the Sino-nomadic warfare of 1127–1368 destroyed the water transport networks developed during the Northern Song dynasty, causing a permanent shock from which China's waterways, especially in the north, have never fully recovered. I therefore use digitized waterway maps to generate two dummies for whether a prefecture had a main waterway during the Northern Song and/or mid Ming dynasties, the absolute value of whose difference captures the shock of Sino-nomadic warfare on infrastructure (see Figure C6). Overall, 154 prefectures (88 in the south and 66 in the north) had waterways during the Northern Song dynasty, while the waterways of 16 prefectures (all located in the north) were destroyed. In the empirical analysis, together with the waterway shock dummy, I include a control (dummy) for having a main waterway during the Northern Song dynasty.

As regards changes in administrative unit boundaries, I assume that in addition to war destruction, nomadic rule might also have had a persistent effect on income today. Because a primary Jurchen dynasty strategy was to divide and rule (meaning reunification and reclassification of administrative units), I compare the prefecture-level maps of 1078 and 1200, revealing that in the northern region, only 36 prefectures (out of 110 prefectures) retained their boundaries in 1200 (see Figure C6). Although those that retained their original land might have been less affected by nomadic rule, a concern remains that other factors, such as population growth, could also have led to reclassification of administrative units. I therefore first code a dummy for whether a boundary changed from 1078 to 1200, and then interact it with the north China dummy on the assumption that boundary changes in the north were more affected by nomadic rule than boundary changes in the south.

After controlling for these factors, the logged number of migrants remains significant, although the magnitude changes slightly (Table III, columns (3)-(4) and (7)-(8)). The effect on logged GDP per capita decreases from 0.144 (column (1)) to 0.130 (column (4)), while the effect on logged lights per capita increases from 0.120 (column (5)) to 0.129 (column (8)). Not surprisingly, infrastructure destruction has a negative effect on economic prosperity, but this impact is not statistically significant. The negative effect of the Sino-nomadic war is also supported by the negative effect of the interaction term between boundary change and the north China dummy; that is, even though a boundary change is related to an increase in contemporary economic development, in north China, the boundary change effect tends to be negative.

IV.C NBOs Governing the South in 1127–30 as Instrument

To correct the possible bias from omitted variables and measurement errors,[19] I exploit the variation in the 1127-30 distribution of NBOs (northern-born government officials) in the south as the instrumental variable of migrant population size. As previously mentioned, the Northern Song dynasty ended very abruptly, ensuring that the refugees had no mature plan for migration. These officials could thus provide important support and serve as an informational network for those suddenly forced to flee the nomadic hordes in the north, which is key to determining where these migrants fled. This argument is supported by many anecdotes. For example, Li Qingzhao, China's most famous poet, recorded her retreat route during the 1127-30 period in the postface to the *Catalogue on Bronze and Stone Inscriptions* compiled by her husband. Having followed her husband to Jiangning (today's Nanjing), where her father-in-law served as a government official, only to have him pass away the next year (1128), she planned to relocate to Hongzhou (today's Nanchang) where her brother-in-law was also a government official. The plan was suspended, however, because the route to Hongzhou was blocked by the war. Hence, in 1129, she moved to Taizhou to join one of her brothers (another government official) whom she accompanied to Wenzhou in 1130 on his assignment to another jurisdiction. Not only did southward migrants tend to turn to their relatives for asylum, but so also did NBOs in the south tend to gather southward migrants in the region they governed. For instance, Zhou Shen, born in Henan but by 1128 the governor of Ji Zhou Prefecture in Jiangxi Province, surrounded himself with his relatives, as well as old friends from his hometown of Henan.

The above anecdotal evidence suggests that the southern regions with NBOs tended to receive more migrants, both the officials' relatives and hometown fellows.[20] Hence, to systematically exploit the variations in NBO distribution, I collect information from the Da Qing Yitongzhi (Ji, 1782), which lists all important historical figures by prefecture, and sum the total number of NBOs in each southern prefecture during 1127–30, denoted by g_i^0. I hypothesize that a prefecture with a higher g_i^0 received more migrants. In addition, because these officials were subject to a term limit, I derive similar sums g_i^- and g_i^+ for the pre- and postmigration periods (1101–26 and 1131-62, respectively) to enable interperiod comparison. For this instrument to be valid, however, it must be significantly correlated with migration, so I use the following specification to regress the number of recorded migrants on g_i^0:

$$m_i = \kappa^0 g_i^0 + W_i\gamma + v_i, \tag{2}$$

where W_i represents all controls used in the baseline and robustness checks. The resulting value of g_i^0 is highly significant and the effect far from trivial: one more northern-born official during

[19]Using this instrument increases the coefficient of the logged number of migrants because of the classical measurement error (a pure random error in the measurement). Moreover, there might be some non-classical measurement errors, namely, the error might be correlated with some unobservable variables. Thus, the instrument can also correct the bias due to this non-classical measurement error, if the number of NBOs is not correlated with those unobservables.

[20]Because assignment of these officials is subject to the rule of avoidance, no individuals can be appointed in their birth region, meaning that many NBOs were assigned to southern prefectures.

1127–30 increases migrant population size by about 117 percent (exp(1.53)-1; see Table D.7, column (1)).

To rule out any higher likelihood of NBO-dominated governance for one prefecture over others, I use as instrument the difference between g_i^0 (normalized by length) and g_i^- (normalized by length), denoted by Δg_i^0, which thus represents the excess number of NBOs in the 1127–30 period.[21] After noting that the eastern and middle regions of the Southern Song territory have more NBOs in 1127–30 (see Figure IIIa), I compare the spatial distribution of migrants with the excess number of NBOs to reveal very similar distributions for the two (see Figure IIIb).

Figure III about here

IV.D Instrumented results

I now use this instrumental variable to identify the effect of migration on economic development in the year 2000 using the 2SLS method expressed by Equation (3):

$$\begin{aligned} y_i &= \rho m_i + W_i\gamma + \varepsilon_i \\ m_i &= \kappa\Delta g_i^0 + W_i\varphi + \upsilon_i \end{aligned} \tag{3}$$

where W_i includes all the controls used in the baseline and robustness checks; namely, crop suitability, warfare impact, initial economic conditions, geography, province dummies, and a constant term. Not only do the results document a significantly positive migrant effect (Table IV, columns (1) and (3)), but when instrumented by the excess number of NBOs, the migrant effect increases. Specifically, the magnitude of the effects on logged GDP per capita increases from 0.131 (Table 3, column (4)) to 0.264 (of Table IV, column (1)), while that on logged lights per capita increases from 0.129 (Table III, column (8)) to 0.238 (Table IV, column (6)). Admittedly, however, this difference could be attributable to measurement error in the size of the migrant population leading to a downward bias in the baseline analysis.

Table IV about here

IV.E Validity Checks

Impact of the pre- and postmigration NBO numbers on the 1127-30 migration. The first major concern I address is the possibility that omitted variables may be driving the effect of NBOs on the 1127-30 migration, which I rule out by adding in the 1101-26 premigration term g_i^- and the 1131-62 number g_i^+ and then assessing their effects on migration. My rationale is that given an identical set of unobservables affecting NBO numbers during the premigration, migration, and postmigration periods, if omitted variables are the drivers of the significant correlation between NBO number and migration during 1127-30, then both the 1101-26 and the 1131-62 NBO numbers should also be significantly correlated with the size of the settled migrant population. The addition of this new control might even decrease the effect of g_i^0. The results, however, do not support this conjecture. Rather, as Table D.7 (columns (4)-(5)) shows, only the 1127-30

[21] These results also remain robust to directly using g_i^0 as instrument.

NBO number affects the number of migrants, with that in the pre- and postmigration periods having no significant effect at all. In terms of magnitude, before 1127, the NBO effect is 0.033, but this figure suddenly increases to 1.153 during the migration period. After the migration period, the magnitude of the coefficient is 0.123 (column (5)), which is similar to the effect of premigration g_i^- (column (4)).

Impact of the NBO number on post-1130 migration. Although Li Qingzhao's experiences confirm the frequent transfer of government officials from one region to another, which mitigates any concern about officials being an additional migration measure, I still systematically rule out this possibility by examining the relation between NBO numbers and post-1130 migrants. Because the alternative migrant measure is based on changing surname shares between the Northern Song and Southern Song dynasties, its variation comes from both the 1127-1130 and post-1130 migration. Hence, if government officials are counted as migrants, then the number of NBOs during the post-1130 period should be correlated with the alternative migrant measure. According to the results, however, such is not the case: the post-1130 NBO number (g_i^+) is insignificantly correlated with the surname-based migrant measure (see Table D.8).

Impact of the pre- and postmigration NBO numbers on today's economic prosperity. Because instrument validity depends on its satisfying the exclusion restriction of not affecting economic prosperity via alternative channels, I rule out the possibility that the migration period NBO number's effect may in fact be capturing the effect of omitted variables by checking the effects of pre- and postmigration NBO numbers. First, recognizing that some prefectures with more NBOs may be far more prosperous, I add the 1101–26 premigration NBO number g_i^- into the regression but observe no significant effect on either migrant population size or today's economic prosperity (Table IV, columns (2) and (5)). When I then add in the postmigration number g_i^+ (columns (3) and (6)), it too has no significant impact, meaning that neither the pre- nor postmigration number of NBOs governing in the south has any significant effect on contemporary economic prosperity. These findings are further supported by reduced form regressions. After first regressing the 2000 GDP per capita on the migration period NBO number to reveal a strong positive relation between the two, I then add in either the premigration (Table D.9, column (4)) or postmigration NBO number (Table D.9,column (5)), both of which show only an insignificant association.[22]

Impact on population density: pre- vs. postmigration. Although the early analyses indicate that only the number of NBOs during the 1127-30 migration period affects the number of migrants and economic development, with no impact from the premigration and postmigration NBO numbers, the question remains of whether the logic of assigning officials differs between the

[22]The 1101-26 NBO number has no significant effect on either migrant population size or today's economic prosperity even without controlling for 1127-30 NBO number (See Table D.7, D.8, and D.9). The 1131-62 NBO number is marginal significantly correlated with migrant population size and today's economic prosperity when the 1127-30 NBO number is not included. The main reason is that the post-migration NBO number is significantly correlated with the 1127-30 NBO number (Columns (6) and (7), Table D.7).

turbulent migration period and the more peaceful pre- and postmigration eras. There may, for example, be a greater likelihood of NBOs being assigned to economically prosperous regions during 1127-30.

To check for preferential assignment of NBOs during the migration period, I regress the 741–1393 (log) population density on the migration period NBO number (g_i^0):

$$p_i^\tau = \kappa^{0,\tau} g_i^0 + W_i \gamma^\tau + \upsilon_i^\tau \quad \tau = 741, 1102, 1290, 1393 \tag{4}$$

Based on the coefficients plotted in Figure IV, the number of NBOs during 1127-30 (g_i^0) has no significant effect on population density before 1127, but its impact does become significant after 1130. Then, as a falsification test, I repeat the above exercise replacing the 1127-30 NBO number with either the 1100–26 or 1131–62 NBO number as the explanatory variable, neither of which has any effect on population density. Taken together, these results suggest that NBOs were not more likely to be assigned to more prosperous regions during the turbulent times of migration.

Figure IV about here

Overidentification test. Two additional concerns are that (i) NBO assignment may have been more likely in regions with more migrants or more migrants recorded, meaning the instrument might correlate with unobservables, and (ii) the more educated may have been more likely to have surviving records and be connected with NBOs, which would introduce bias into the identification. I seek to exploit the variation within the migration period to address this concern, and find that two subperiods, 1127-28 and 1129-30 differ in the following two aspects. First, because the Southern Song dynasty's first emperor, Zhao Gou, stabilized his rule in the late period and was more likely to employ strategic NBO assignment. Two generals, Miao Fu and Liu Zhengyan, initiated a coup in March 1129 and replaced the incumbent emperor, Zhao Gou, with his son, who was only three years old. The coup was suppressed within the month, however, and the potential challengers removed, after which the rule of Zhao Gou became very stable until his death in 1187. Second, the war situation between the Song and Jin dynasties changed during the late period after the Song won several crucial battles and stabilized the front between the two dynasties. For instance, in 1130, the Song dynasty, led by Han Shizhong and Yue Fei, achieved a decisive victory along the Yangtze River, after which the Jin army never crossed the river again. Hence, as an additional check of whether the instrument satisfies the exclusion restriction, I divide the 1127-30 NBO number into two subperiods, 1127-28 and 1129-30, and then conduct an overidentification test that uses one subperiod number to instrument migrant number and assess the direct effect of the other subperiod number on economic prosperity. If these two direct effects are indeed significant, then the migration period NBO number is likely to have affected economic development through other channels. In fact, neither of these two instruments has any significant effect on today's economic prosperity, and the migrant effect remains robust (Table V).

Table V about here

V Underlying mechanisms

Having documented that historical migrants clearly matter for today's economic development as measured by GDP and nighttime lights per capita, I now examine the possible causes of this link. To do so, I first investigate two potential channels discussed in the literature; namely, human capital and cultural diversity. I then focus on why migration leads to a rise in human capital. In answering this question, rather than accepting the widely promoted view of migrants as carriers of human capital who have a persistent effect on contemporary education and economic prosperity, I expand understanding of the migration-economic development link by proposing a new channel: knowledge- and skill-based migrant-local competition. This hypothesized competition, which in historic China takes the form of an education-based tournament created by the imperial civil service examination, could induce both locals and migrants to invest more in human capital in the form of education or training, which would then impact subsequent economic development. As previously emphasized, the different predictions derived from the diffusion and competition hypotheses offer useful tools for determining whether migrant-local competition does indeed contribute to a rise in human capital.

V.A Possible Channels: Human Capital and Diversity

As regards human capital, the literature contains ample documentation of the migrant role in carrying both it and technology into south China, as well as such capital's high persistence and strong positive effect on economic prosperity (Chanda, Cook, and Putterman 2014; Glaeser et al. 2004; Maddison 2007). To confirm the latter, I first examine the significant impact of migrant population size on today's educational levels using the percentage of the 2000 population educated to high school or above as dependent variable. As Table VI shows, both the OLS and instrumented results indicate that historic migrants significantly increased 2000 educational levels, with a 1 standard deviation increase in migrant number inducing a a 3.62 percentage point increase in educational level (3.207*1.13; column (2)). Given a mean of 12.87 percent, this effect accounts for 28 percent of the educational level overall. When I then regress the level of economic prosperity on these migrants and 2000 educational levels,

$$y_i = \alpha + \rho_0 m_i + \pi edu_i + \rho_1 W_i + \varepsilon_i,$$

not only does the latter have a large significant effect on economic prosperity, but once education is controlled for, the significant effect of migration disappears (Table VI, columns (5) and (8)).

Table VI about here

Yet despite the above evidence of education being a significant driver of today's economic prosperity, it may not have been the only channel for the migration effect. For instance, migrants may have also changed the level of genetic diversity in the host region. Ashraf and Galor (2013) found that genetic diversity has a hump-shaped effect on comparative economic development because of the tradeoff between the beneficial and detrimental effects of diversity on productivity.

Specifically, a wider spectrum of traits can reduce the likelihood of cooperative or trustful behavior, but diversity has some positive aspects as well, in the context of the complementary of traits. In China's context, the migration may have increased the level of diversity in the south of China and brought it closer to the optimal level, hence positively affecting economic prosperity.

I thus test this conjecture by compiling dialect data from the Language Atlas of China (Wurm et al. 1987; Lavely 2012) and, following Alesina and La Ferrara (2005), calculating an ethnolinguistic fragmentation index (ELF), denoted by $ELF = 1 - \sum_{n=1}^{N} s_n^2$, where s_n represents the share of dialect n over the total area in a prefecture. Not only do the results show that migration increases the host region diversity level (Table VI, columns (3) and (4)), but this diversity (fragmentation) measure has a positive linear rather than hump-shaped effect on economic prosperity (Table VI, column (6) and (9)). The outcomes are also consistent with the Ashraf and Galor (2013) finding that genetic diversity has a hump-shaped effect on comparative economic development. In this case, if China's historic migration brought the diversity level of the host region closer to the optimal level, it could also have had a positive impact on today's economic development.[23]

Unfortunately, because the exogenous variation provided for migration by the excess number of northern-born government officials is not matched by any similar instrument for educational level and cultural diversity, the endogeneity of these latter means that the estimates might be biased. Hence, following Becker and Woessmann (2009), I restrict the effects of both variables to consistent estimates ($ga\bar{m}ma$) and then examine the instrumented migration effect on economic prosperity:

$$y_i - \gamma C_i = \alpha + \rho_0 m_i + \rho_1 W_i + \varepsilon_i,$$

where C_i represents the educational level and cultural diversity. When I bound the effects of the two variables to 30 percent below and above the OLS estimates, migration loses its significant association with economic prosperity net of the effects of human capital and cultural diversity (Table D.11, column (1) and (2)). The clear implication is that education and diversity are more likely to be the dominant channels explaining the link between historical migration and today's economic prosperity.

V.B Competition between Migrants and Locals

Diffusion hypothesis. In line with the migration research evidence that migrants tend to introduce talents, knowledge, and human capital into their new region, economic historians document that the large influx of Han refugees from the north infused necessary labor, human capital, and agricultural technology (e.g., irrigation facilities) into their destination locations. Not only did

[23]The finding is similar if I adopt an alternative measure of diversity. Specifically, based on the census data, I construct a measure of surname diversity, denoted by $1 - \sum_{n=1}^{N_i} sur_{i,n}^2$, where $sur_{i,n}$ represents the share of surname n in prefecture i. This diversity measure is also positively significantly correlated with today's economic prosperity (see Table D.10).

this influx shift the regional center of gravity from central China (the lower and middle reaches of the Yellow River) to the lower and middle reaches of the Yangtze River (Maddison 2007), but the human capital it brought was diffused among the locals, thereby increasing the aggregate level of human capital.

Competition hypothesis. As the anecdotal evidence in section II.B suggests, in patriarchal societies like China, migrants and natives have often needed to compete with each other over resources in order to prevent the extinction of their lineages. Hence, when northern migrants settled in south China, both migrants and natives competed over such valuable commodities as water and arable land, an endeavor greatly assisted by a higher number of children. As the "law of the jungle" prescribes, in this struggle, the superiority of brute force determined the probability of survival. Thus, during the premodern period, the size of a family defined its physical power: those with more children were more likely to win more resources and avoid extinction. However, when human capital rather than family size became more useful in the fight over resources, both migrants and natives tended to invest more in the quality of offspring rather than their quantity.[24] In this case, when human capital helped one group compete successfully with its rivals (the competition hypothesis), migrant-local competition could have induced both locals and migrants to invest more in education. If the families (both locals and migrants) failed in the competition, they would have had lower reproduction or have been forced to re-migrate to other regions. Overall, therefore, such competition increased the aggregate level of education in the host region, a conjecture that can be formalized by introducing between-group competition into a simple model of the child quantity-quality tradeoff (Appendix E). Moreover, the level of human capital is very persistent. Although the civil exam was abolished over one hundred years ago, today's educational level is still significantly higher in regions with better historical exam performance (Chen et al. 2020). Based on these observations, I derive two different sets of predictions from the two different hypotheses, which I then test empirically.

Given the qualitative evidence in Section II.B for both more and less cooperation between locals and migrants, I provide three pieces of quantitative evidence related to migrant-local competition. First, I quantify the effect of migration on the incidence of conflict between the Hakka (migrant group) and Cantonese (local group) groups in Guangdong province. As Table D.12 shows, migration has a significant impact on the incidence of such conflict. However, the analysis only bases on the 20 prefectures in Guangdong province, and then we have to be cautious to interpret this result due to the small number of observations. Second, I use intermarriage as a proxy of lineage cooperation, and hypothesize that if the two groups compete with each other, the incidence of intermarriage between them should be much lower than in the absence of such competition. As Table D.14 shows, the analysis supports this conjecture: in the region with more migrants, the intermarriage ratio between northern and non-northern

[24] Such a quantity-quality tradeoff is also consistent with extant studies on the effects of socioeconomic status on family size and child quality. For instance, Shiue (2013) finds that higher status households had relatively fewer children and relatively more educated sons.

surnames is significantly lower.[25] Next, because the role of migrant-local competition is different from that of between-lineage competition. I use surname diversity to calculate the amount of this latter. According to the results, although surname diversity is positively related to today's economic prosperity, the effect of migration changes only trivially (Table D.10), implying that the migration effect came from channels beyond normal between-lineage competition.

V.C Competition versus Diffusion Prediction 1: Changing Effects of Migration over Time

According to the competition hypothesis, the migrant effect on human capital accumulation should be larger after the civil service examination becomes the primary channel for selecting government officials during the Ming and Qing dynasties.[26] In particular, during the early postmigration period, when the examination system plays no dominant role in political selection, migration should have a larger effect on population density (the quantity of children) and a smaller effect on human capital (the quality of children). According to the diffusion hypothesis, in contrast, if the human capital brought by migrants is indeed the main channel explaining today's economic prosperity, then both population density and human capital during the early postmigration period should be higher in regions with more migrants, and this effect should persist over time.

To test the validity of these competing assumptions, I empirically assess migration's effect on human capital for seven historical postmigration periods: Southern Song (1127-1279), Early Ming (1368-1464), Mid Ming (1465-1566), Late Ming (1567-1644), Early Qing (1644-1735), Mid Qing (1735-1820), and Late Qing (1821-1904).[27] I omit the 1276-1368 period because the civil service examination was temporarily abolished during the Yuan dynasty. I then regress human capital measured by the ratio of Jinshi to population(q_i^τ) on the logged number of migrants:

$$q_i^\tau = \rho_0^\tau m_i + W_i \rho_1^\tau + \alpha^\tau + \varepsilon_i^\tau \tag{5}$$

where τ represents the seven historic periods. I standardize the Jinshi ratio by period to account for sharp differences in civil examination structure and content between the Ming and Qing and the Song dynasties that could prevent interperiod comparability. W_i includes all the same controls as the analysis of migrant impact on today's economic prosperity but allows the coefficients to vary for each period.

Figure Va, which plots the instrumented effect of migrants (ρ_0^τ) with a 95 percent confidence interval, shows that the effect of the logged number of migrants on human capital is insignificant

[25] I examine the correlation of surname distribution between post-migration period (the Southern Song dynasty) and today (2005). The results show that the correlation is strong, which implies that although various shocks happened, surname distribution remained relatively stable (Table D.13).

[26] Shiue (2019) shows that the 14th to late 17th centuries were characterized by a high earnings elasticity of human capital, both due to the removal of barriers to mobility and to the institutionalization of the civil service examination. Specifically, although some selection of government officials on the basis of formal examinations beginning in the Northern Song dynasty, sumptuary laws prevented commoners from sitting the civil examinations. The key change happened in the (latter part of) the Ming dynasty, when these sumptuary laws were abolished.

[27] For the Ming and Qing dynasties, I divide each into three roughly equal periods.

during the Southern Song (1127-1276) and Early Ming (1368-1464) periods but gradually increases and turns significant during the late periods. This evidence, which strongly suggests that the migrant effect depends on the civil service examination's importance in political selection, appears most consistent with the competition hypothesis. Although the examination plays a similar role during the Southern Song dynasty, it has not yet become the primary channel for government official selection and is abolished during the Yuan dynasty. Even when the Ming and Qing subsequently adopt it as their major channel of elite recruitment, the migrant effect remains insignificant during the early periods (shortly after the Yuan). Once both migrants and locals begin to accumulate human capital, however, its effect gradually increases and turns significant. Yet if migrants did indeed bring human capital into the host region, then human capital during the early periods should be higher in regions with more migrants, and if this effect is the main channel explaining today's economic development, it should be persistent over time. According to Figure V, such is not the case.

Figure V about here

Auxiliary competition prediction: Effect on population density. An auxiliary prediction of the competition hypothesis is a declining effect of migration on population density. That is, whereas a less important role for the civil service examination in political selection leads both migrants and locals to invest in the quantity of children to compete with the rival group, when the examination's importance increases, families have a higher incentive to increase their children's education level rather than feed more children. I thus use the same specification to assess migration's effect on population quantity:

$$Q_i^\tau = \theta_0^\tau m_i + W_i \theta_1^\tau + \alpha^\tau + \varepsilon_i^\tau \qquad (6)$$

By plotting these coefficients (θ_0^τ) in Figure Vb, I document a significant increase in population density during the Southern Song. The fact that this effect gradually decreases during the late periods and turns statistically similar to zero during the Late Qing supports the competition hypothesis.

Effect of population density on Jinshi ratio. An increase in population may have crowded some individuals out of the agricultural into the nonagricultural sector, engendering an increase in the level of human capital. Then, the increasing effect of migration on human capital may be caused by this crowding effect. When I address this concern by incorporating current population density into the regression, however, the results remain robust (see Table D.15): the effect of migration remains insignificant during the early periods but increases and turns significant during the late periods. Specifically, the migration effect on human capital is positive but not significant during the Ming dynasty but turns significant and increases in magnitude during the Qing dynasty.

Role of conflict. A related concern is that in a Malthusian economy, an increase in population density can generate positive checks such as war. If the less educated are more likely to die during such conflict, it may cause an increase in the level of human capital, a concern I rule out by including the number of battles in each prefecture during each period.[28] According to the results, conflicts do appear to positively impact human capital, implying that war-induced population loss may lead to an increase in human capital; however, the migration effect remains robust (see Table D.15).

Alternative measure of human capital. Even though migration may indeed have brought human capital into the host prefecture, this effect cannot be captured by the Jinshi ratio because taking the exams during the early period may not have been as socially beneficial. Hence, to check whether the results are sensitive to using Jinshi ratio to proxy human capital, I use the number of academies of classical learning (*Shuyuan*), a type of school in Imperial China, as an alternate measure.[29] Unlike national academies and district schools, they were usually private establishments that provided a quiet environment where scholars could engage in studies and contemplation without restrictions. They emerged in the Tang dynasty and rose in the Song dynasty. Using the number of academies as the dependent variable, the results remain very similar (see Table D.15): the effect of migration remains insignificant during the early periods but increases and turns significant during the late periods.

Civil service examination quota system. Another potential concern is that because the central government used a regional quota system to control the number of successful civil service examination candidates, migration might affect Jinshi density through these quotas rather than human capital. To rule out this possibility, I regress logged quotas of successful candidates allocated at the prefecture (lowest examination) level and normalized by total population on historic migration. Although migration has a significant effect on both quotas and total population, its impact on quotas per capita is insignificant, suggesting that historic migration did not affect opportunities to pass the government-assigned examination (see Table D.16).

V.D Competition versus Diffusion Prediction 2: Migrants vs. Locals

I further test the predictions of the two hypotheses by looking at the difference in human capital between migrants and locals. According to the diffusion hypothesis, the descendants of migrants would have a relatively higher level of education (human capital) during the early period, which would gradually become diffused among the locals. In this case, the migrants' descendants should have a higher educational level during the early postmigration period, with the locals catching up during the late period. According to the competition hypothesis, in contrast, the human capital of both groups should increase synchronously, meaning that the educational level of the migrants' descendants should not be systematically different from that of the locals during either the early or the late period.

To test these predictions by measuring migrant versus local examination performance during the Ming (1368-1644) and Qing (1644-1910) dynasties, I define the descendants of migrants

[28] The source for the historical conflict data is *A Chronology of Warfare in Dynastic China* (China's Military History Editorial Committee,2003).

[29] The data of academies of classical learning is collected from A Dictionary of Academies in China (Li 1996).

(locals) as northern surnamed (southern surnamed) according to the surnames list in Section III, and define two dummy variables for whether a prefecture has northern or southern surnamed Jinshi (denoted by e_i^N and e_i^S). Using these dummies rather than the Jinshi to population ratio for the two groups is necessary because no historical information is available on the total population with northern or southern surnames during these periods.

The instrumented migration effects on the two dummies during the Ming and Qing dynasties, reported in Table VII, support the competition hypothesis. First, during the Ming dynasty, both migrants and locals in the region with migrants have no significantly higher education than correspondingly surnamed individuals in other regions. Second, during the Qing dynasty, migration increases the human capital of both migrants and locals. Even when I assess the migration effect in terms of the educational differences between locals and migrants ($e_i^S - e_i^N$), the results support my anticipated finding that in migrant settlement regions, the descendants of both migrants and locals have invested in education, leading to no significant difference in their educational levels.

Table VII about here

Lastly, to counter the methodological shortcoming of having to use the dummies rather than the Jinshi to population ratio, I perform a robustness check by using 2005 census data on percentages of population educated to high school level or above as a proxy for education and calculating the average educational level of those with northern versus southern surnames.[30] According to the results, migration has had a similarly sized significant effect on the educational level of both migrant and local descendants (columns (7)–(9)), with the former performing no better overall than the latter.

VI Conclusions

To assess the long-term effects of the third wave of Han migration from northern to south China, the above investigation relates the spatial variation in 1127-30 migrant settlement to population density and level of human capital. According to its regression estimates, migration did indeed positively impact population density initially, but this effect gradually decreased to zero after the civil examination system became the primary channel for government official selection. The effect on human capital as measured by examination performance, on the other hand, increased over time. By also relating migration to GDP and nighttime lights per capita in 2000, the analysis further demonstrates that the migration has had a positive long-term effect on economic prosperity, a finding that remains robust to controlling for diverse variables, including geography, initial economic conditions, the impact of Sino-nomadic warfare, and crop suitability. This observation also holds when the excess number of northern-born government officials in the south during 1127–30 serves as the instrument for migrant number. Particularly important,

[30] Because the 2000 census provides no surname information, I use 2005 rather than 2000 data to test the effect of historical migration on the educational level of those with northern and southern surnames.

this positive effect of migration on today's economic prosperity occurs largely through (level of) education.

Overall, the findings of this study provide valuable insights not only into the deep roots of wealth distribution but also into how historic population flows can account for today's income differences. Its most important contribution is to suggest that any effect of migrants on future economic prosperity occurs not only through their importation of talent, knowledge, human capital, and genes but also via competition with natives, which stimulates economic growth by incentivizing both groups to make greater investments in human capital.

References

[1] Acemoglu, Daron, Simon Johnson, and James A. Robinson. 2001. "The Colonial Origins of Comparative Development: An Empirical Investigation." *American Economic Review* 91 (5): 1369- 1401.

[2] Alesina, Alberto, and Eliana La Ferrara. 2005. Ethnic Diversity and Economic Performance. *Journal of Economic Literature* 43 (3): 762-800.

[3] Alesina, Alberto, Arnaud DevleeschauIr, William Easterly, Sergio Kurlat, and Romain Wacziarg. 2003. "Fractionalization." *Journal of Economic Growth* 8(2): 155-194.

[4] Alesina, Alberto F., Paola Giuliano and Nathan Nunn. 2013. "On the Origins of Gender Roles: Women and the Plough." *Quarterly Journal of Economics* 128(2): 469-530.

[5] Ashraf, Quamrul, and Oded Galor. 2013. "The 'Out of Africa' Hypothesis, Human Genetic Diversity, and Comparative Economic Development." *American Economic Review* 103(1): 1-46.

[6] Ashraf, Quamrul, and Stelios Michalopoulos 2015. "Climatic Fluctuations and the Diffusion of Agriculture." *Review of Economics and Statistics*, 97(3): 589-609.

[7] Bai, Ying, and James Kai-sing Kung. 2011. "Climate Shocks and Sino-nomadic Conflict." *Review of Economics and Statistics* 93 (3): 970-981.

[8] Bauer, T. K., S. Braun, and M. Kvasnicka. 2013. "The Economic Integration of Forced Migrants: Evidence for Post-War Germany." *Economic Journal 123*: 998–1024.

[9] Beattie, Hilary J. 1979. *Land and Lineage in China: A Study of T'ung-Ch'eng County, AnhIi in the Ming and Ch'ing Dynasties.* Cambridge University Press.

[10] Becker, Sascha, I. Grosfeld, N. Voitländer, and E. Zhuravskaya. 2020. "Human Capital Accumulation and Forced Migration: Evidence from the Post-WWII Population Transfers." *American Economic Review* 110(5): 1430-63.

[11] Becker, Sascha and Ludger Woessmann. 2009. "Was Iber Wrong? A Human Capital Theory of Protestant Economic History." *Quarterly Journal of Economics* 124 (2): 531-596.

[12] Borjas, George J.. 1999. "The Economic Analysis of Immigration," *Handbook of Labor Economics*, Vol 3, Part A, pp. 1697-1760.

[13] Borjas, George J. 2014. *Immigration Economics.* Cambridge, MA, USA: Harvard University Press.

[14] Braun, S. and T. Mahmoud. 2014. "The Employment Effects of Immigration: Evidence from the Mass Arrival of German Expellees in Postwar Germany." *Journal of Economic History* 74(1): 69–108.

[15] Burbidge, John B., Lonnie Magee, and A. Leslie Robb. 1988. "Alternative Transformations to Handle Extreme Values of the Dependent Variable." *Journal of the American Statistical Association* 83(401): 123-127.

[16] Card, D. 1990. "The Impact of the Mariel Boatlift on the Miami Labor Market." *Industrial and Labor Relation Review* 43(2): 245–257.

[17] Card, D. and G. Peri. 2016. "Immigration Economics by George J. Borjas: A Review Essay." *Journal of Economic Literature* 54: 1333–1349.

[18] Cavalli-Sforza, Luigi L., Paolo Menozzi, and Alberto Piazza. 1994. *The History and Geography of Human Genes.* Princeton, NJ: Princeton University Press.

[19] CBDB (China Biographical Database project). 2014. https://projects.iq.harvard.edu/cbdb.

[20] Chaffee, Jonh W. 1995. *The Thorny Gates of Learning in Sung China: A Social History of Examinations.* Albany: State University of New York Press.

[21] Chanda, Areendam, C. Justin Cook, and Louis Putterman. 2014. "Persistence of Fortune: Accounting for Population Movements, There Was No Post-Columbian Reversal." *American Economic Journal: Macroeconomics* 6(3): 1-28.

[22] Chen, Shuo and James Kung. 2014. "Of Maize and Men: The Effect of a New World Crop on Population and Economic growth in China". *Journal of Economic Growth* 21(1): 71-99.

[23] Chen, Ting, James Kung, and Chicheng Ma. 2020. "Long Live Keju! The Persistent Effects of China's Imperial Examination System." *Economic Journal* 130(631): 2030-2064.

[24] Chen, Wei, Xilu Chen, Hsieh, Chang-Tai Hsieh, and Zhegn Song. 2019. "A Forensic Examination of China's National Accounts." *Brookings Papers on Economic Activity* 2019(1): 77-141.

[25] Chen, Xi, and William D. Nordhaus. 2011. "Using Luminosity Data as a Proxy for Economic Statistics" *Proceedings of the National Academy of Sciences* 108(21): 8589—8594.

[26] CHGIS, Version 4. Cambridge: Harvard Yenching Institute, January 2007.

[27] China's Military History Editorial Committee (Ed.). 2003. *A Chronology of Warfare in Dynastic China* (Zhongguo Lidai Zhanzheng Nianbiao), 2nd ed. Beijing: Jiefangjun Chubanshe.

[28] Cioffi-Revilla, Claudio and David Lai. 1995. "War and Politics in Ancient China, 2700 B.C. to 722 B.C.". *Journal of Conflict Resolution* 39 (3): 467-494.

[29] Diamond, Jared. 1997. *Guns, Germs and Steel: The Fates of Human Societies.* New York, NY: W. W. Norton & Co.

[30] Colella, Fabrizio, Rafael Lalive, Seyhun Orcan Sakalli and Mathias Thoenig. 2019. "Inference with Arbitrary Clustering." IZA Discussion Paper No. 12584.

[31] Durand, John D. 1974. *Historical Estimates of World Population: An Evaluation.* Philadelphia: University of Pennsylvania Press.

[32] Dustmann, C., U. Schönberg, and J. Stuhler 2016. "The Impact of Immigration: Why Do Studies Reach Such Different Results?" *Journal of Economic Perspectives* 30(4): 31–56

[33] Ebrey, Patricia Buckley; Walthall, Anne; Palais, James B. 2006. *East Asia: A Cultural, Social, and Political History.* Boston: Houghton Mifflin, ISBN 0-618-13384-4

[34] Elvin, Mark. 1973. *The Pattern of the Chinese Past: A Social and Economic Interpretation.* Stanford University Press.

[35] Esherick, Joseph, and Mary Backus Rankin. 1990. *Chinese Local Elites and Patterns of Dominance. Studies on China*, Vol. 11. University of California Press.

[36] Esteban, Joan, Laura Mayoral, and Debraj Ray. 2012. "Ethnicity and Conflict: An Empirical Study." *American Economic Review* 102(4): 1310-42.

[37] Fernihough, Alan. 2007. "Human capital and the quantity–quality trade-off during the demographic transition." *Journal of Economic Growth* 22(1): 35-65.

[38] Freedman, Maurice. 1966. *Chinese Lineage and Society: Fukien and Kwangtun*g. Athlone Press.

[39] GAEZ (FAO's Global AgroEcological Zones). 2012. http://www.fao.org/land-water/en/.

[40] Galor, Oded, and Omer Moav. 2002. "Natural selection and the origin of economic growth." *Quarterly Journal of Economics* 117(4): 1133-1191.

[41] Ge, Jianxiong. 2000. *History of Population in China*. Shanghai: Fudan University Press.

[42] Glaeser, Edward L., Rafael La Porta, Florencio Lopez-de-Silanes, and Andrei Shleifer. 2004. "Do Institutions Cause Growth?" *Journal of Economic Growth* 9(3): 271-303.

[43] Hartwell, Robert M. 1982. "Demographic, Political, and Social Transformation of China, 750-1550." *Harvard Journal of Asiatic Studies* 42(2): 365-442.

[44] Henderson, J. Vernon, Adam Storeygard, and David N. Weil. 2012. "Measuring Economic Growth from Outer Space." *American Economic Review* 102(2): 994-1028.

[45] Hornung, Erik. 2014. "Immigration and the diffusion of technology: The Huguenot diaspora in Prussia." *American Economic Review* 104(1): 84-122.

[46] Jha, Saumitra. 2013. "Trade, Institutions, and Ethnic Tolerance: Evidence from South Asia." *American Political Science Review* 107(4): 806-832.

[47] Ji, Yun (Eds). 1782. *Complete Library in Four Sections* [in Chinese: Siku Quanshu].

[48] Kun, Gang et al. (Ed.) 1899. *Qinding da Qing huidian shili (Imperially Established Institutes and Laws of the Great Qing Dynasty)*, Beijing: Zhonghua shu ju reprinted in 1991.

[49] Lamley, Harry J. 1990. "Lineage Feuding in Southern Fujian and Eastern Guangdong Under Qing Rule," in Lipman, Jonathan Neaman, and Stevan Harrell, eds. *Violence in China: Essays in Culture and Counterculture.* Albany: State University of New York Press.

[50] Lavely, William. 2012. *Coding Scheme for the Language Atlas of China*, version 2. CGA, Harvard University.

[51] Lazear, Edward P., and Sherwin Rosen. 1981. "Rank-order tournaments as optimum labor contracts." *Journal of political Economy* 89(5): 841-864.

[52] Li, Xiaofeng. 1996. *A Dictionary of Academies in China* (Zhongguo Shuyuan Cidian). Hangzhou: Zhejiang Education Press.

[53] Liang, Fang-zhong. 1980. *Historical Statistics on Hukou, Land and Land Tax of China (Lidai hukou, tudi,tianfu tongji)* . Shanghai: Zhonghua Book Company.

[54] Liu, Ping. 2003. *The Hakka-Punti War in Guangdong:1854-1867.* The Commercial Press (Hong Kong) Limited.

[55] Liu, William Guanglin. 2015. *The Chinese Market Economy, 1000-1500.* State University of New York Press: Albany.

[56] Maddison, A.. 2007. *Chinese Economic Performance in the Long Run.* OECD Publishing.

[57] Michalopoulos, Stelios, and Elias Papaioannou. 2013. "Pre-Colonial Ethnic Institutions and Contemporary African Development." *Econometrica* 81(1): 113-152.

[58] Nakamura, E., J. Sigurdsson, and J. Steinsson. 2017. The Gift of Moving: Intergenerational Consequences of a Mobility Shock. Working paper.

[59] NOAA (National Oceanic and Atmospheric Administration) 2014. goo.gl/tmEbcX

[60] Nunn, Nathan, and Nancy Qian. 2011. "The Potato's Contribution to Population and Urbanization: Evidence From A Historical Experiment." *Quarterly Journal of Economics* 126(2): 593-650.

[61] Nunn, Nathan, and Leonard Wantchekon. 2011. "The Slave Trade and the Origins of Mistrust in Africa." *American Economic Review* 101(7): 3221-3252.

[62] Oster, Emily. 2017. "Unobservable Selection and Coefficient Stability: Theory and Evidence." *Journal of Business and Economic Statistics*: 1-18.

[63] Pasternak, Burton. 1969. "The Role of the Frontier in Chinese Lineage Development." *Journal of Asian Studies* 28(3): 551-561.

[64] Piccione, Michele, and Ariel Rubinstein. 2007. "Equilibrium in the Jungle." *Economic Journal* 117(522): 883-896.

[65] Putterman, Louis, and David N. Weil. 2010. "Post-1500 Population Flows and the Long Run Determinants of Economic Growth and Inequality." *Quarterly Journal of Economics* 125(4): 1627-1682.

[66] RADI (The Institute of Remote Sensing and Digital Earth at Chinese Academy of Sciences). 2014. 1kmx1km Grid GDP Database. goo.gl/ui61JS

[67] Ray, Debraj, and Joan Esteban. 2017. "Conflict and development." *Annual Review of Economics* 9: 263-293.

[68] Sarvimäki, M., R. Uusitalo, and M. Jäntti. 2016. "Habit Formation and the Misallocation of Labor: Evidence from Forced Migrations." Working paper.

[69] Shiue, Carol. 2013. "Human Capital and Fertility in Chinese Clans Before Modern Growth" *Journal of Economic Growth* 22(3): 1-46.

[70] Shiue, Carol. 2019. "Social Mobility in the Long Run: A Temporal Analysis of China from 1300 to 1900." CEPR Discussion Paper No. DP13589.

[71] Spolaore, Enrico, and Romain Wacziarg. 2009. "The Diffusion of Development." *Quarterly Journal of Economics* 124(2): 469-529.

[72] Spolaore, Enrico, and Romain Wacziarg. 2013. "How deep are the roots of economic development?" *Journal of Economic Literature* 51(2): 325-69.

[73] Voigtländer, Nico, and Hans-Joachim Voth. 2012. "Persecution perpetuated: the medieval origins of anti-Semitic violence in Nazi Germany." *Quarterly Journal of Economics* 127(3): 1339-1392.

[74] Wen B, Li H, Lu D, et al. 2004. "Genetic Evidence Supports Demic diffusion of Han Culture." *Nature* 431(7006): 302-305.

[75] Wu, Songdi. 1997. *History of Migration in China* [in Chinese: Zhongguo Yimin Shi]. Fujian: Fujian People's Press.

[76] Wurm, Stephen A., Rong Li, and Theo Baumann. 1987. *Language atlas of China*. Hong Kong: Longman Group.

[77] Zhu, Baojiong, and Peilin Xie (Ed.). 1980. *Ming Qing jinshi timing beilu suoyin (Index of Names of Jinshi Graduates in the Ming and Qing Periods)*. Shanghai: Shanghai guji chubanshe.

[78] Zurndorfer, Harriet Thelma. 1989. *Change and Continuity in Chinese Local History: The Development of Hui-chou Prefecture 800 to 1800*. Brill Press.

Table I: Variable Definitions and Data Sources

	Sources	Obs.	Mean	S.D.
Migrants: Number of migrants	1	287	4.77	15.79
Ln (1+Migrants)	1	287	0.66	1.13
Change in changes in the share of surnames	2	287	0.34	1.16
Ln (GDP per capita: thousand CNY), 2000	3	287	1.62	0.65
Ln (Lights / Area), 2000	4	287	0.70	1.17
South: =1 if located in the Southern Song	5	287	0.62	0.49
Coastal	5	287	0.13	0.33
Distance to major pots	5	287	817.49	419.13
Longitude	5	287	112.36	4.74
Latitude	5	287	31.48	4.89
Main waterways: =1 if having main river around 1080	6	287	0.54	0.50
Jinshi ratio, the Northern Song	7, 8	287	83.65	183.66
Ln (Household density: people/km2), 1080	5, 8	287	1.58	1.23
Ln (Area)	5	287	8.83	0.85
Ln(Wheat suitability)	9	287	1.33	0.35
Ln(Rice suitability)	9	287	1.05	0.38
Ln(Maize suitability)	9	287	1.52	0.19
Ln(Sweet potato suitability)	9	287	1.19	0.38
Great circle distance to Hangzhou (1,000 kilometers)	5	287	0.95	0.41
Change in waterways, 1080-1480	6	287	0.06	0.23
Boundary change, 1080-1200	5	287	0.47	0.50
Excess number of NBOs, 1127-30	10	287	0.10	0.38
Ln (Population density: million/km^2), Southern Song	5, 8	284	-10.86	1.06
Ln (Population density: million/km^2), early Ming	5, 11	287	-10.79	0.91
Ln (Population density: million/km^2), mid Ming	5, 11	287	-10.12	0.78
Ln (Population density: million/km^2), late Ming	5, 11	287	-9.78	0.77
Ln (Population density: million/km^2), early Qing	5, 11	287	-9.54	0.78
Ln (Population density: million/km^2), mid Qing	5, 11	287	-9.34	0.78
Ln (Population density: million/km^2), late Qing	5, 11	287	-9.06	0.85
# of presented scholars/population, Southern Song	7, 8	284	166.00	405.53
# of presented scholars/population, early Ming	11, 12	287	57.49	64.72
# of presented scholars/population, mid Ming	11, 12	287	71.63	95.69
# of presented scholars/population, late Ming	11, 12	287	39.82	48.09
# of presented scholars/population, early Qing	11, 12	287	30.16	40.76
# of presented scholars/population, mid Qing	11, 12	287	22.04	24.65
# of presented scholars/population, late Qing	11, 12	287	22.77	27.93
% High school or above	13	285	12.87	4.95
Ln (# of Quotas), 1776 (mid-Qing)	14	287	3.99	0.87
Ln (Presented scholars/Quota), 1776 (mid-Qing)	12, 14	287	4.51	0.46

Sources: 1. Wu (1997); 2. CBDB; 3. RADI (2014); 4. NOAA (2014); 5. CHGIS (2007); 6. Liu (2015); 7. Chaffee (1995); 8. Liang (1980); 9. GAEZ (2012); 10. Ji (1782); 11. Ge (2000); 12. Zhu and Xie (1980); 13. 2000 Population Census; 14. Kun (1899).

I want to see if we can
replicate these two numbers

Table II: Historical Migrants and Economic Prosperity in 2000 - Baseline Results

Dependent variable:	Ln (GDP Per Capita)			Ln (Lights / Area)			Ln (Population / Area)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln (Migrants)	0.258***	0.160***	0.144***	0.348***	0.232***	0.177***	0.186***	0.094**	0.057
	(0.035)	(0.043)	(0.040)	(0.062)	(0.067)	(0.063)	(0.041)	(0.042)	(0.043)
South	-0.212**	-0.098	-0.054	-1.210***	-0.730***	-0.938***	-0.267**	-0.395***	-0.733***
	(0.083)	(0.113)	(0.130)	(0.145)	(0.170)	(0.194)	(0.113)	(0.136)	(0.150)
Ln (HH density in 1080)		Y	Y		Y	Y		Y	Y
Ln (Area)		Y	Y		Y	Y		Y	Y
Song waterway			Y			Y			Y
Distance to major ports			Y			Y			Y
Coastal			Y			Y			Y
Longitude			Y			Y			Y
Latitude			Y			Y			Y
Initial human capital			Y			Y			Y
Province dummies		Y	Y		Y	Y		Y	Y
Observations	287	287	287	287	287	287	287	287	287
R-squared	0.159	0.566	0.592	0.210	0.662	0.706	0.054	0.675	0.746

Notes: Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%.

Table III: Historical Migrants and Economic Prosperity in 2000 - Robustness Checks

Dependent variable:	Ln (GDP Per Capita)				Ln (Lights/Population)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln (Migrants)	0.144***	0.121***	0.136***	0.130***	0.120***	0.104**	0.135***	0.129***
	(0.040)	(0.041)	(0.042)	(0.042)	(0.045)	(0.048)	(0.049)	(0.049)
South	-0.054	-0.083	-0.008	-0.158	-0.208	-0.190	-0.042	-0.123
	(0.130)	(0.130)	(0.139)	(0.157)	(0.169)	(0.168)	(0.171)	(0.207)
Basic controls	Y	Y	Y	Y	Y	Y	Y	Y
Crops suitability		Y	Y	Y		Y	Y	Y
Dist. to Hangzhou			Y	Y			Y	Y
Main river damage				Y				Y
Boundary change				Y				Y
North * Boundary change				Y				Y
Province dummies	Y	Y	Y	Y	Y	Y	Y	Y
Observations	287	287	287	287	287	287	287	287
R-squared	0.592	0.604	0.611	0.625	0.626	0.633	0.651	0.659

Notes: Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies.

Table IV: Instrumented Results

Dependent variable:	Ln (GDP Per Capita)			Ln (Lights/Population)		
	(1)	(2)	(3)	(4)	(5)	(6)
	Second Stage					
Ln (Migrants+1)	0.264***	0.263***	0.275***	0.238***	0.238***	0.237***
	(0.067)	(0.066)	(0.072)	(0.070)	(0.070)	(0.074)
Number of NBOs, 1100-26		-0.076	-0.083		0.046	0.046
		(0.092)	(0.094)		(0.114)	(0.114)
Number of NBOs, 1131-62			-0.025			0.003
			(0.037)			(0.040)
Additional controls	Y	Y	Y	Y	Y	Y
Basic controls	Y	Y	Y	Y	Y	Y
Observations	287	287	287	287	287	287
R-squared	0.610	0.611	0.608	0.653	0.653	0.653
	First Stage: Ln (Migrants+1)					
Excess number of NBOs, 1127-30	1.146***	1.149***	1.082***	1.146***	1.149***	1.082***
	(0.159)	(0.158)	(0.159)	(0.159)	(0.158)	(0.159)
Number of NBOs, 1100-26		0.204	0.223		0.204	0.223
		(0.161)	(0.159)		(0.161)	(0.159)
Number of NBOs, 1131-62			0.116			0.116
			(0.113)			(0.113)
Additional controls	Y	Y	Y	Y	Y	Y
Basic controls	Y	Y	Y	Y	Y	Y
Observations	287	287	287	287	287	287
R-squared	0.792	0.794	0.798	0.792	0.794	0.798
F-stat	99.3	100.5	84.7	99.3	100.5	84.7

Notes: Robust standard errors in parentheses;***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy.

Table V: Overidentification test

Dependent variable:	Ln (GDP Per Capita)			Ln (Lights/Population)		
	(1)	(2)	(3)	(4)	(5)	(6)
	Second Stage					
Ln (Migrants+1)	0.250***	0.348**	0.221***	0.222***	0.352**	0.183**
	(0.062)	(0.160)	(0.070)	(0.065)	(0.178)	(0.074)
Excess number of NBOs, 1127-28		-0.172			-0.228	
		(0.248)			(0.274)	
Excess number of NBOs, 1129-30			0.112			0.148
			(0.146)			(0.159)
Number of NBOs, 1100-26	Y	Y	Y	Y	Y	Y
Additional controls	Y	Y	Y	Y	Y	Y
Basic controls	Y	Y	Y	Y	Y	Y
Observations	287	287	287	287	287	287
R-squared	0.614	0.589	0.620	0.655	0.636	0.659
	First Stage: Ln (Migrants+1)					
Excess number of NBOs, 1127-28	0.878***	0.878***	0.878***	0.878***	0.878***	0.878***
	(0.217)	(0.217)	(0.217)	(0.217)	(0.217)	(0.217)
Excess number of NBOs, 1129-30	1.354***	1.354***	1.354***	1.354***	1.354***	1.354***
	(0.219)	(0.219)	(0.219)	(0.219)	(0.219)	(0.219)
Number of NBOs, 1100-26	Y	Y	Y	Y	Y	Y
Additional controls	Y	Y	Y	Y	Y	Y
Basic controls	Y	Y	Y	Y	Y	Y
bservations	287	287	287	287	287	287
R-squared	0.798	0.798	0.798	0.798	0.798	0.798
F-stat	53.4	27.4	84.7	53.4	27.4	84.7

Notes: Robust standard errors in parentheses;***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy.

Table VI: Migration, human capital, diversity and economic development

Dependent variable:	% ≥ High school		ELF Index		Ln (GDP Per Capita)			Ln (Lights/Population)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	OLS	IV	OLS	IV	OLS	OLS	OLS	OLS	OLS	OLS
Ln (Migrants)	1.638***	3.207***	0.039**	0.071**	0.008	0.103**	0.002	0.017	0.103**	0.010
	(0.478)	(0.800)	(0.016)	(0.030)	(0.028)	(0.040)	(0.027)	(0.040)	(0.050)	(0.040)
% ≥ High school					0.074***		0.072***	0.067***		0.066***
					(0.005)		(0.005)	(0.007)		(0.007)
ELF Index						0.655***	0.242		0.624***	0.247
						(0.178)	(0.148)		(0.194)	(0.176)
Number of NBOs, 1100-26		Y		Y						
Additional controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Basic controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	285	285	285	285	285	285	285	285	285	285
R-squared	0.394	0.357	0.335	0.325	0.814	0.643	0.817	0.755	0.666	0.757

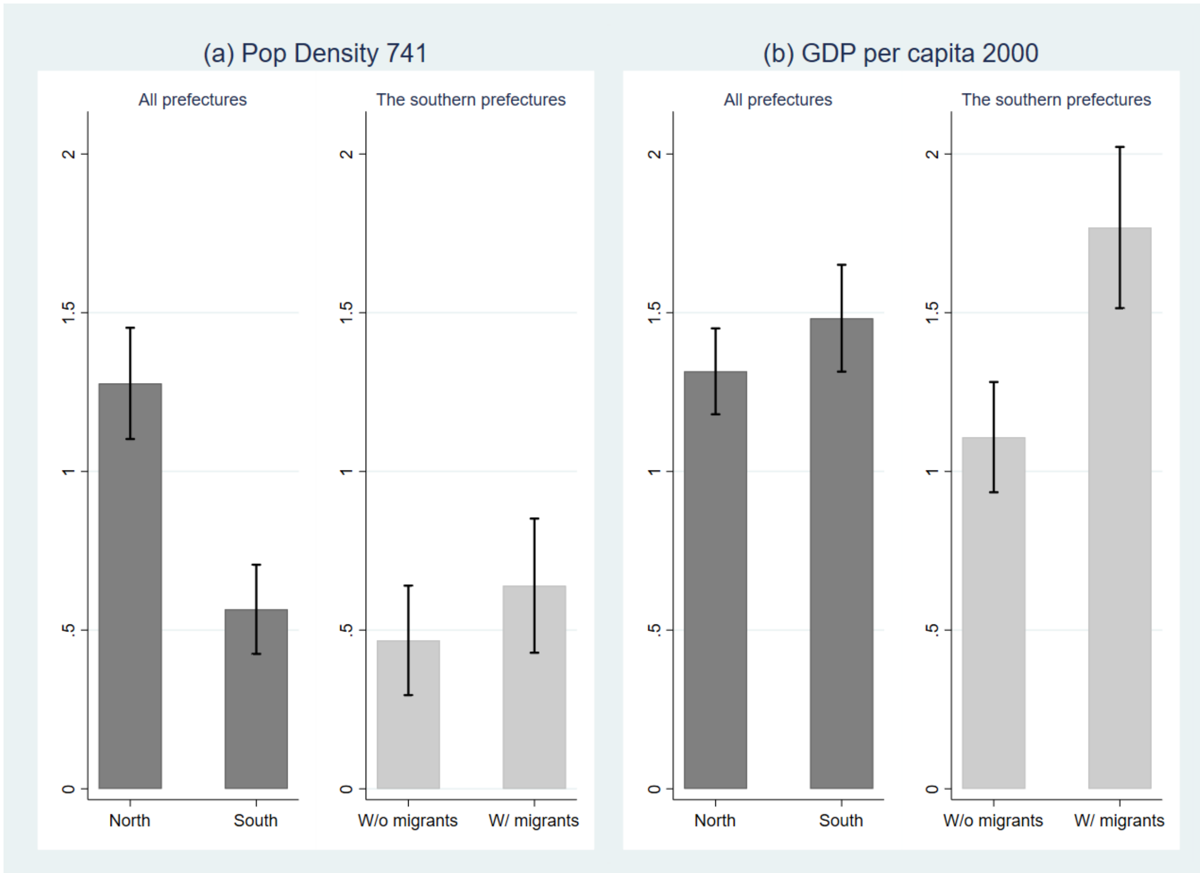
Notes: Robust standard errors in parentheses;***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy.Two Song prefectures are dropped since there is no county whose centroid is located in them, and then the sample size decreases from 287 to 285.

Table VII: Instrumented effect of migration on the human capital of migrants and locals

	Ming Dynasties (1368-1644)			Qing Dynasties (1644-1905)			2005		
Dependent variable:	Migrants	Locals	Locals - Migrants	Migrants	Locals	Locals - Migrants	Migrants	Locals	Locals - Migrants
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln (Migrants+1)	-0.011	0.067	0.077	0.147*	0.110**	-0.037	4.002**	3.916***	-0.137
	(0.065)	(0.052)	(0.071)	(0.076)	(0.053)	(0.085)	(1.555)	(1.364)	(1.348)
Number of NBOs, 1100-26	Y	Y	Y	Y	Y	Y	Y	Y	Y
Additional controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Basic controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	287	287	287	287	287	287	270	260	260
R-squared	0.494	0.443	0.298	0.404	0.408	0.371	0.200	0.227	0.171

Notes: Robust standard errors in parentheses;***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy. There are 17 (27) counties without any northern (southern) surnamed, and then the sample size decreases to 270 in column (5) (260 in columns (8) and (9)).

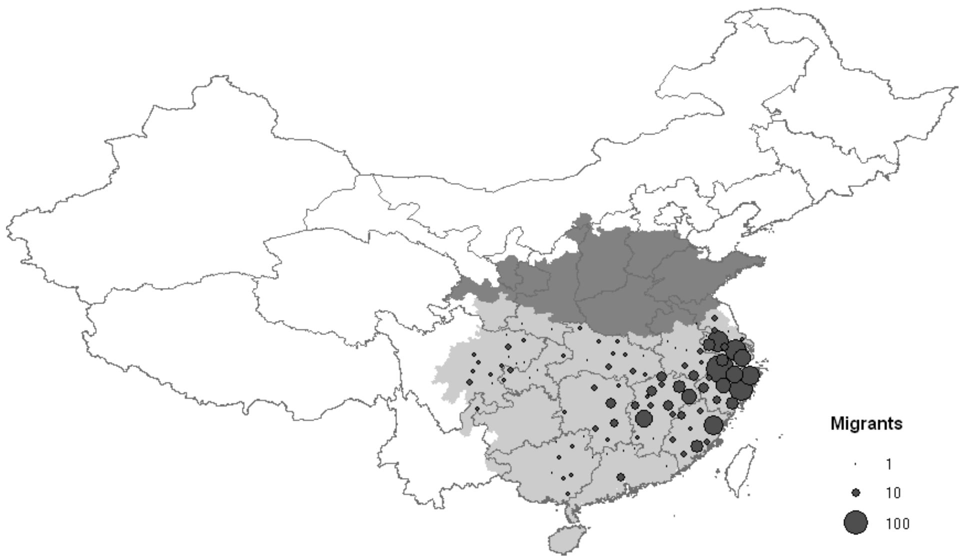
Figure I: Historic vs. contemporary economic prosperity



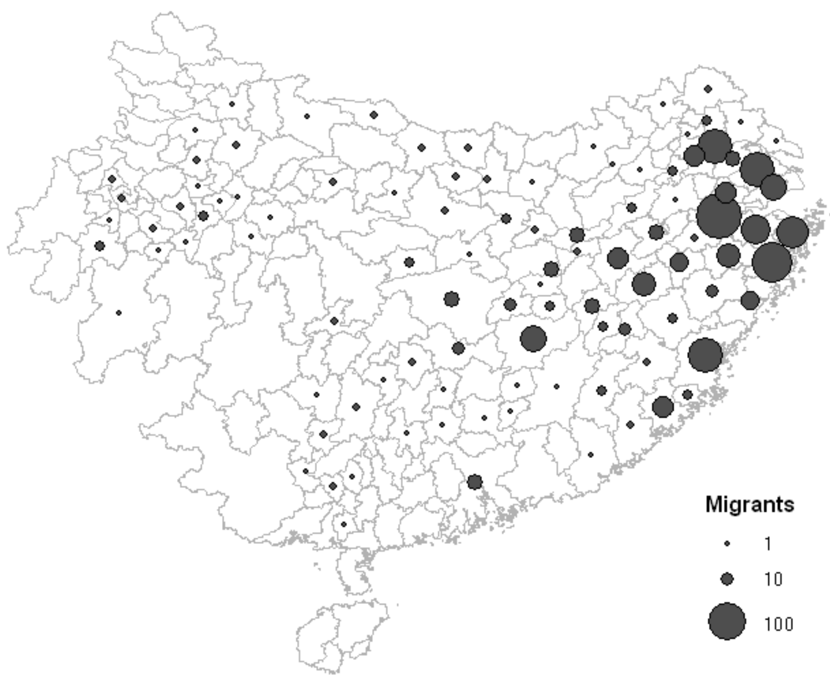
Notes: A database of 1,369 recorded migrants is used to define the southern prefectures as being either with or without migrants. Specifically, prefectures with records of any of these migrants are classified as "with migrants" and those with no records of any of these migrants are classified as "without migrants." The vertical axis in (a) represents the population density in 741 and the vertical axis in (b) represents the GDP per capita in 2000, both normalized by the standard deviation. The error bars show the 95% confidence intervals.

Figure II: Migration after the 1127 demise of the North Song Dynasty

(a) Distribution of migrants



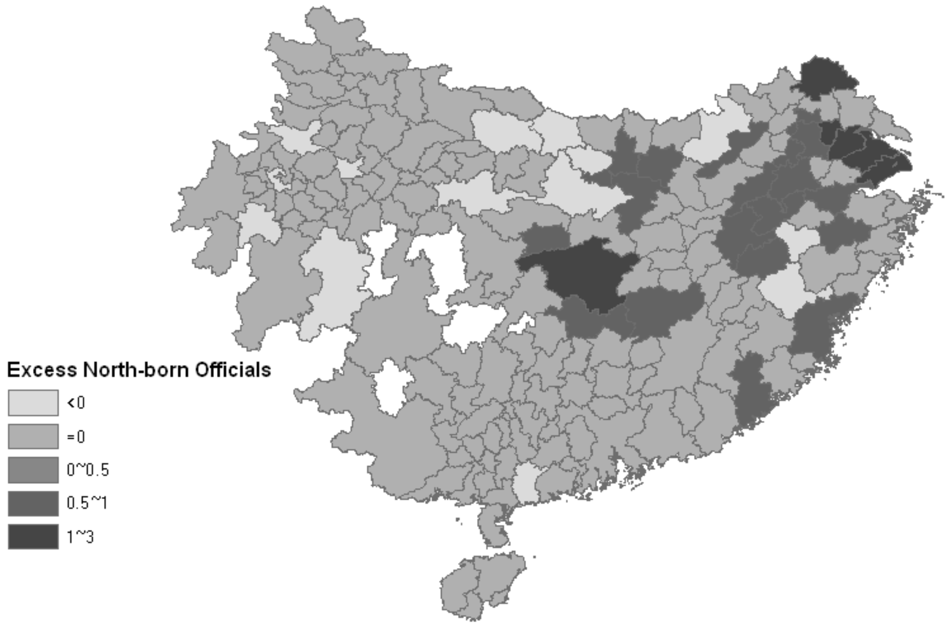
(b) Distribution of migrants in South Song



Notes: in Figure IIa the migrants fled from the dense dark region, namely the north, to lighter region, namely the south during 1127-30.

Figure III: Geographic distribution of NBOs

(a) Excess NBOs in the southern prefectures



(b) Excess NBOs versus migrants

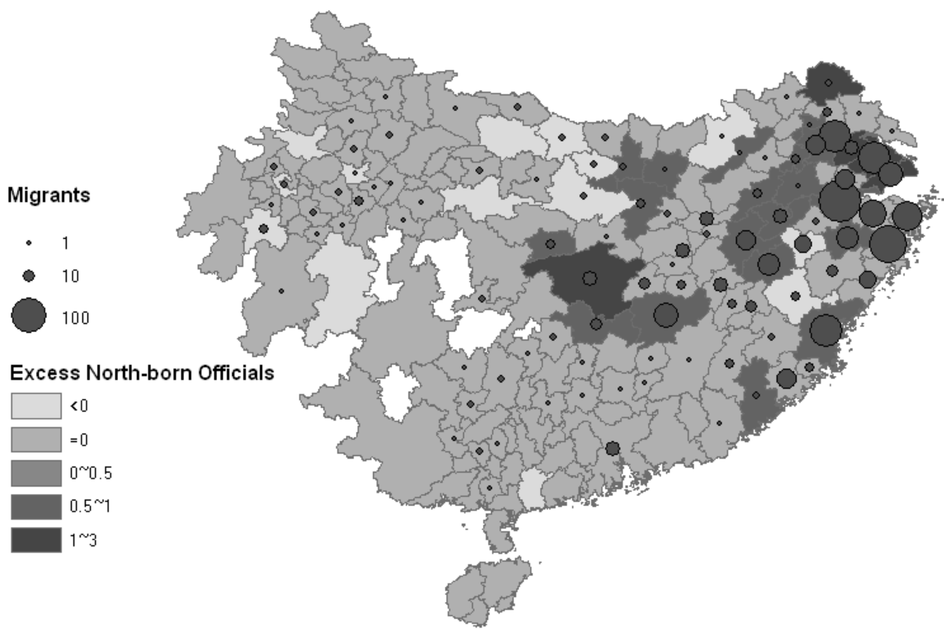
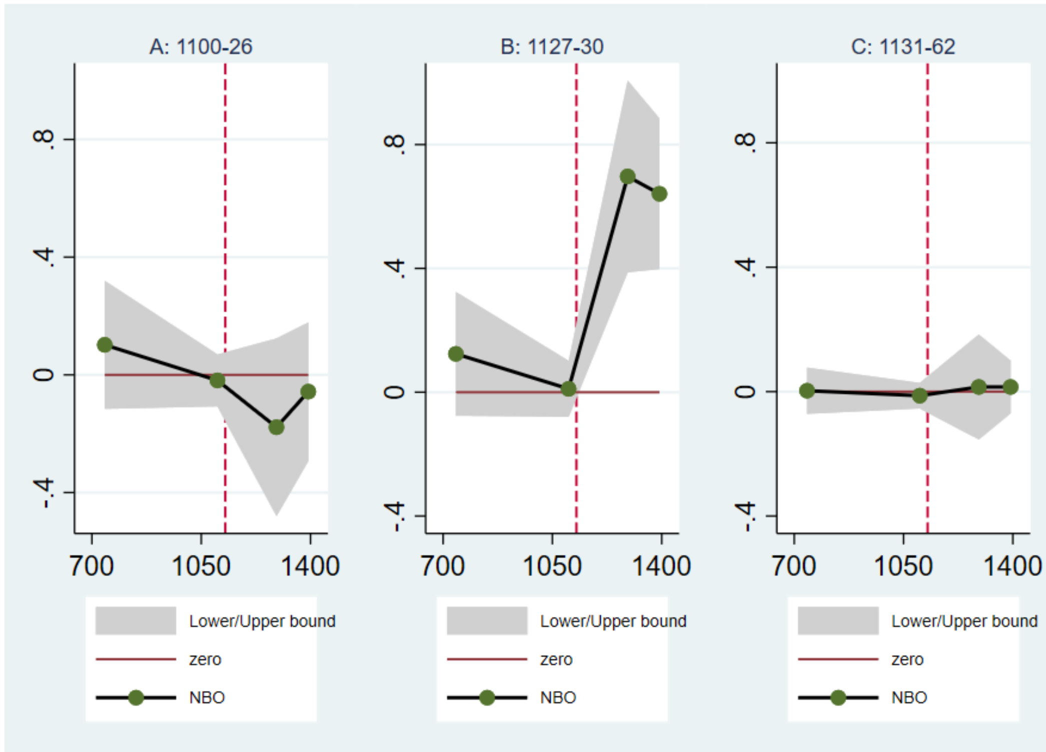


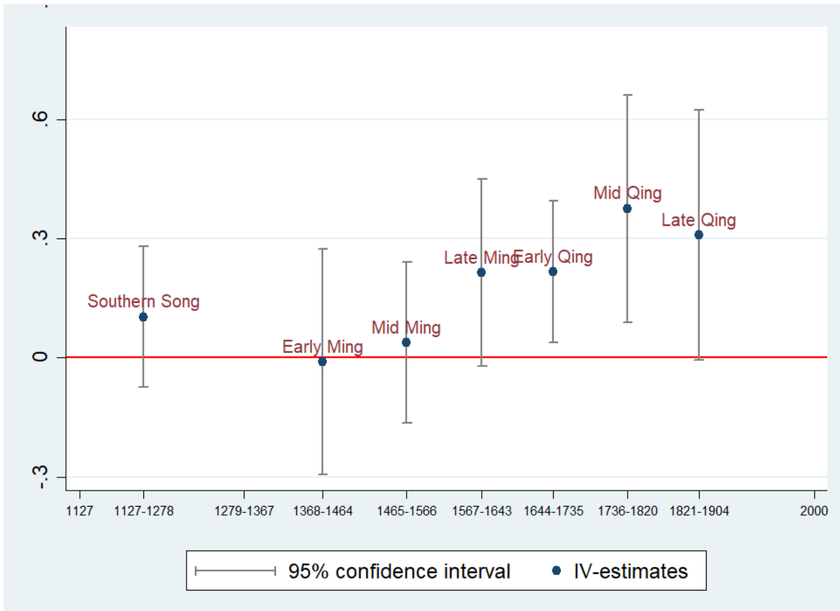
Figure IV: Effect of NBO number on historic population density



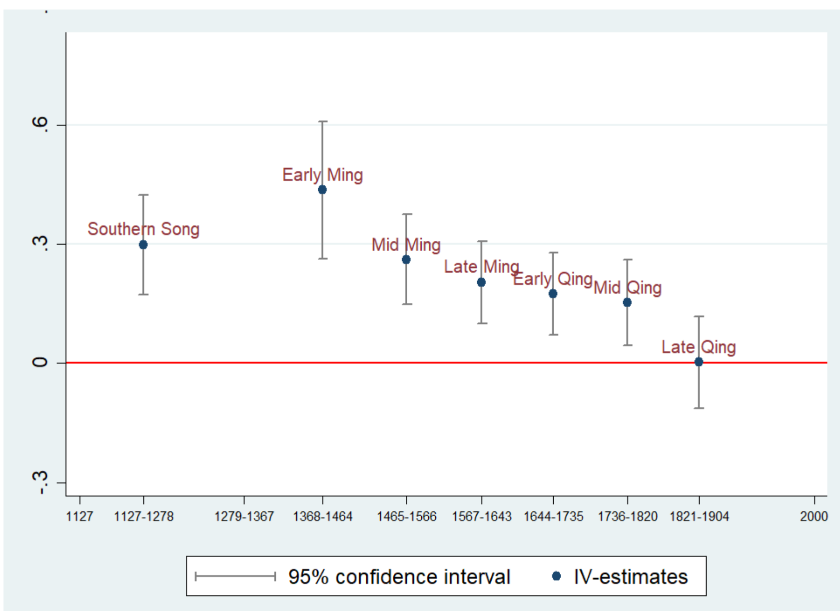
Notes: I regress the population density during the pre- and post-migration periods on the NBO number during 1100-26, 1127-30, and 1131-62 respectively, and plots the coefficients with 95% confidence interval in the figure above. The regressions include all basic and additional controls. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy.

Figure V: Impact of migrants on human capital and population density

(a) Impact on human capital during post-migration periods



(b) Impact on population density during post-migration periods

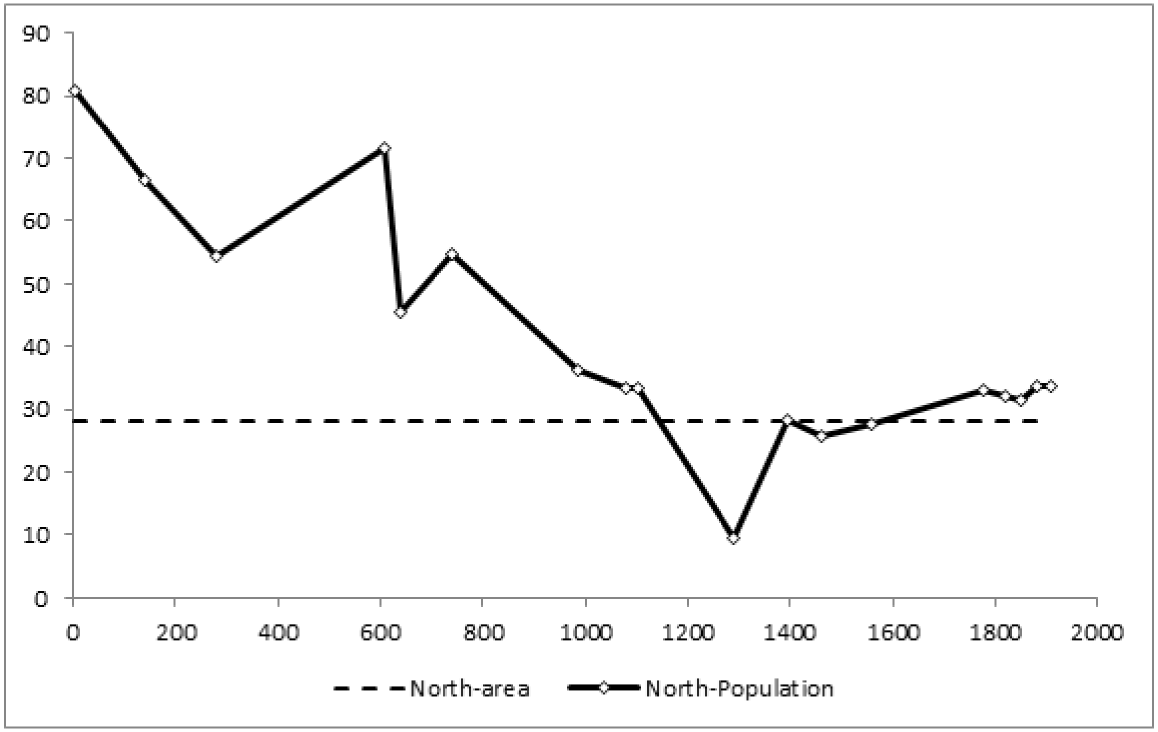


Notes: The migration is instrumented by the 1127-30 NBO number. The figures plot the coefficients with 95% confidence interval. The regressions include all basic and additional controls. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy.

Appendix (For Online Publication)

Appendix A North vs. south

Figure A1: Percentage of the population in Northern China

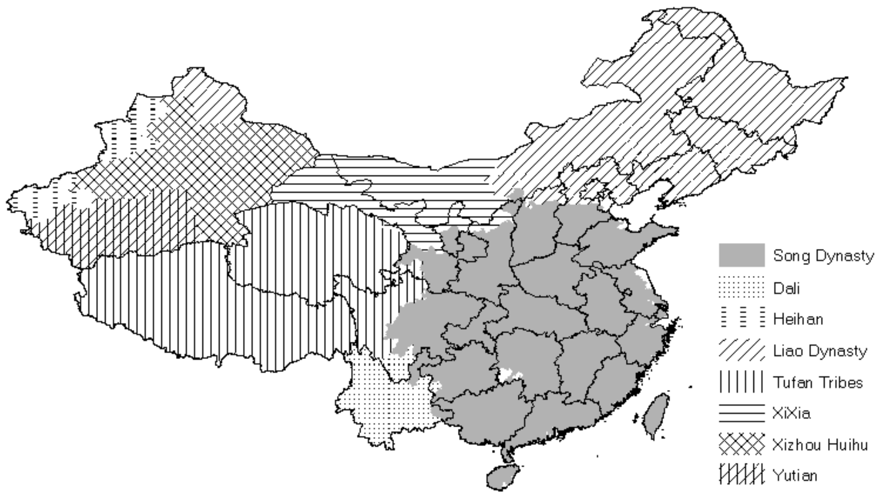


Notes: The data is gathered from Wu (1997: p 354). The dash line presents the percentage of areas of the northern China.

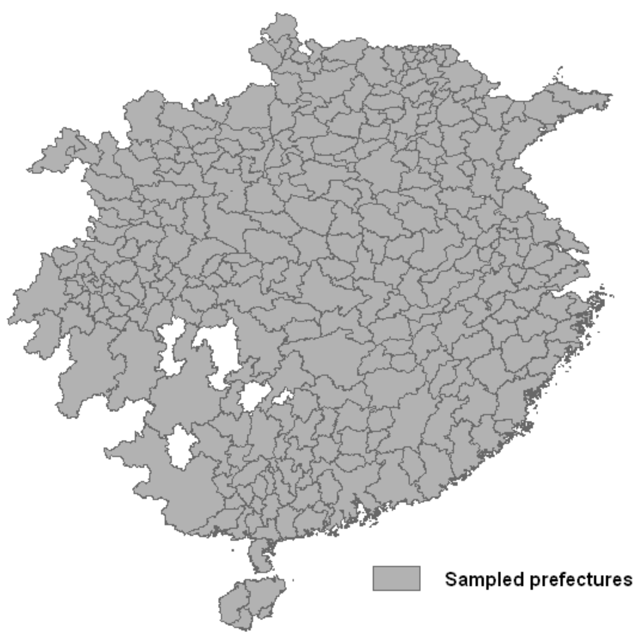
Appendix B Variables definition and data sources

Figure B1: Sampled prefectures

(a) Geographic location of sampled region



(b) Geographic location of sampled prefectures



Notes: The source of graph is CHGIS (2007). The first graph shows the geographical location of sampled region. In addition to the Northern Song Dynasty (the sampled region), nomadic groups established four regimes around the Northern Song Empire: the Liao Dynasty (founded by the ethnic Khitans), the Western Xia Dynasty (established by the Tanguts), the Tibetan empire, and the Kingdom of Dali. There were 64 battles between the Song and the northern nomadic regimes during the 10th and 11th centuries (Bai and Kung 2011). The main enemy of the Song Dynasty was the Liao Empire. The Song's military weakness led to an alternation between warfare and diplomacy with the Liao Dynasty, which resulted in a 150-year stalemate. In an effort to defeat the Liao, the Northern Song Dynasty allied themselves with the Jurchens – an ethnic group in the northeast of China – in 1121.The second graph shows the geographical location of sampled prefectures.

Cross-Validation checks on recorded migrants. Wu (1997) provides a list on all recorded migrants, and I count the number of all recorded migrants in a prefecture. To make sure the sample of recorded migrants by Wu (1997) is representative, I do a cross-validation check based on surname structure. The basic idea is that some surnames were largely distributed in the northern region, and the migration brought these surnames into the south and increased their share in the southern region. Data on Chinese surnames are obtained from the Harvard Yenching Institute's CBDB, which contains the biographical information of 29,234 individuals spanning the period 916–1279. Based on the surnames of those inhabitants and using the geographic coordinates (latitude and longitude) of their residences, I am able to place them in the CBDB on a map of our sample prefectures.

Based on the individuals in the CBDB during the period 916–1127 (the Northern Song Dynasty), We define the 10 northern surnames. If 85 percent of inhabitants with the surname lived in the north, this surname will be defined as northern surnames (the surname list is provided in Table B.1). The solid line in Figure B2 shows that the change in the share of northern surnames is positively correlated with the number of recorded migrants. There are 11 surnames that were all (100 percent) distributed in the southern region. As shown by the dashed line in Figure B2, the change in the share of those southern surnames is negatively related to the number of recorded migrants.

We define an alternative measure of the number of migrants by taking a difference in the changes of the northern and southern surnames. The geographical distribution is presented in Figure B2, which is very similar to the spatial distribution of the recorded migrants. I further check the correlation more rigorously by regressing the increase in the share of northern surnames, the increase in the share of southern surnames, and the difference between the two changes on the logged number of migrants. The results are reported in Table B.2. The significantly positive correlation between and the logged number of migrants suggests that the data on migrants is very reliable. When the total number of households before the migration period (circa 1080) is included, and the correlation between the two measures of migration remains significantly positive.

Table B.1: Surname structures based on the CBDB sample

Panel A: Northern surnames

Surname	Percentage of inhabitants in northern China, during Northern Song	Sampled individuals in southern China, during Northern Song	Sampled individuals in southern China during Southern Song
Jia	85.7	11	16
Tian	86.4	9	25
Pei	87.1	4	4
Sima	88.2	4	15
Xiang	90.2	5	36
Zhao	90.5	69	1,039
Meng	93.1	2	40
Chao	93.5	5	27
Bi	96.9	1	0
Zhe	100.0	0	3

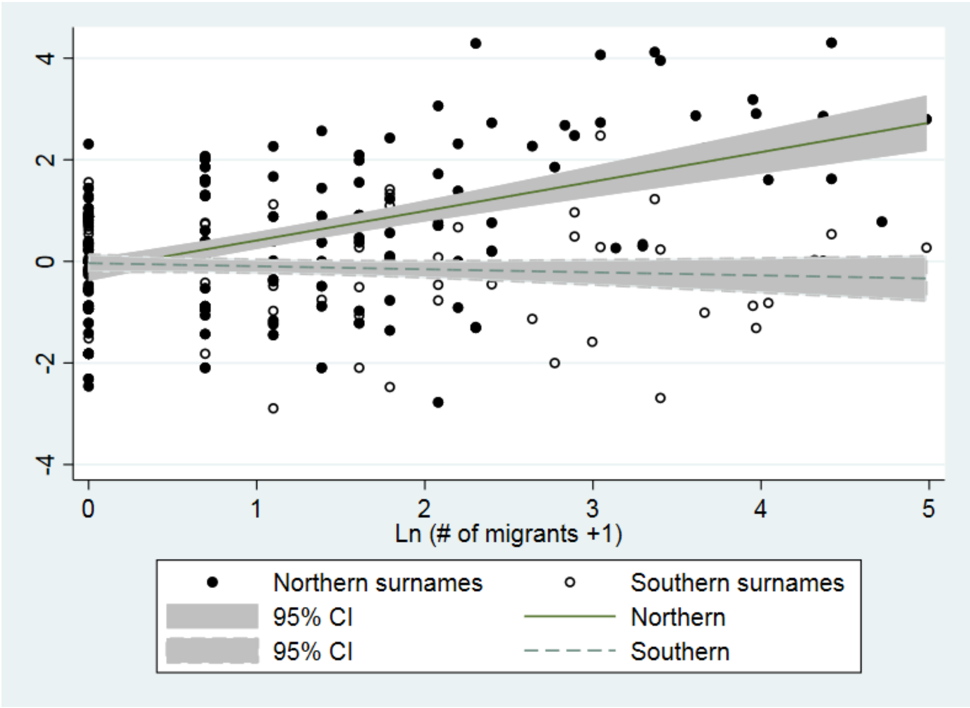
Panel B: Southern surnames

Surname	Percentage of inhabitants in northern China, during Northern Song	Sampled individuals in southern China, during Northern Song	Sampled individuals in southern China during Southern Song
Fang	0	128	288
Hong	0	25	94
Jiang	0	41	76
Liao	0	26	21
Lin	0	198	545
Mao	0	35	28
Xiao	0	57	55
Ye	0	82	122
Yu(1)	0	46	74
Yu(2)	0	27	42
Zhang	0	100	108

Notes:There were 6,741 individuals in Southern China during the Northern Song dynasty; there were 12,071 individuals in the Southern prefectures during the Southern Song dynasty.

Figure B2: Data reliability

(a) Change in the surname share versus migrants



(b) Geographic representation of the two measures

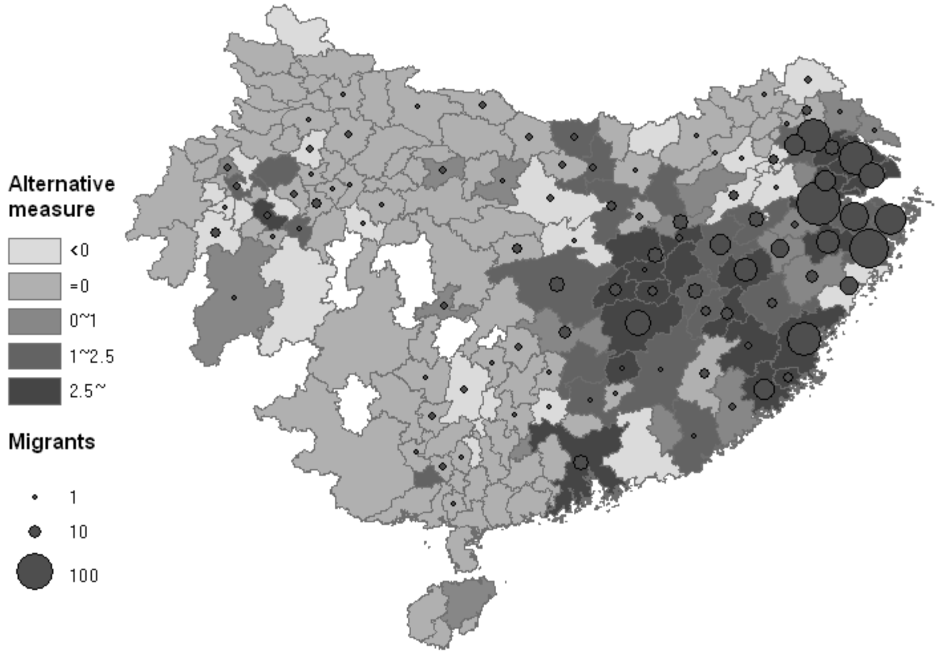


Table B.2: Correlation between recorded migrants and changes in surname share

Panel A: Correlation of Logged Migrants with the Change in the Share of Surnames

	(1) Change in the share of northern surnames		(2) Change in the share of southern surnames		(3) Change in changes (1) - (2)	
Ln (Migrants+1)	0.580***	0.522***	-0.060	-0.107*	0.640***	0.629***
	(0.069)	(0.082)	(0.051)	(0.061)	(0.072)	(0.086)
Ln (HH in 1080)		0.096		0.078		0.018
		(0.065)		(0.056)		(0.065)
Observations	178	178	178	178	178	178
R-squared	0.297	0.302	0.007	0.014	0.322	0.322

Panel B: The Correlation of the Ratio of Migrants to the Natives with the Change Surname Share

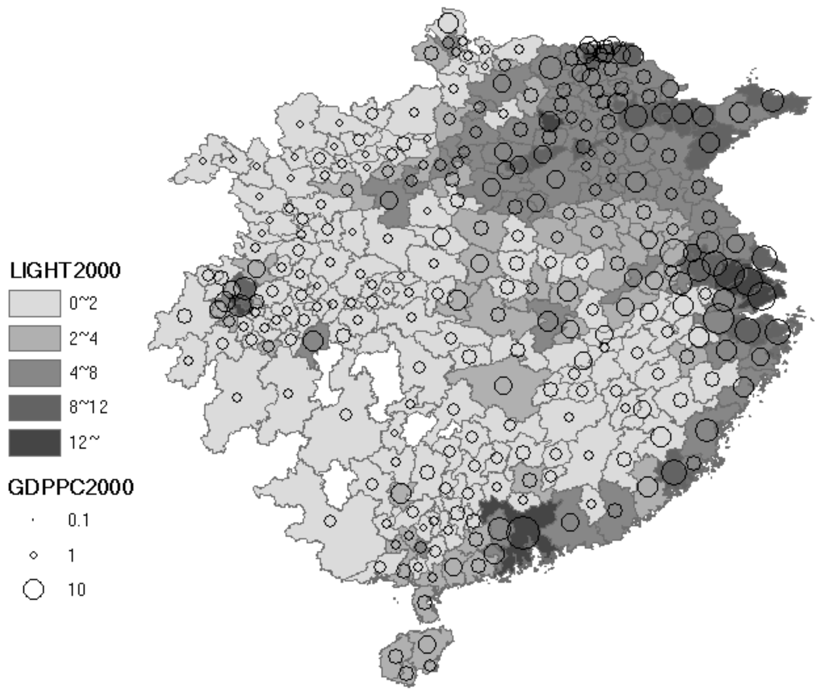
	(1) Change in the share of northern surnames		(2) Change in the share of southern surnames		(3) Change in changes (1) - (2)	
Migrants / HH in 1080	6.137***	4.800***	-0.516	-0.608	6.653***	5.408***
	(1.358)	(1.149)	(0.744)	(0.808)	(1.646)	(1.435)
Ln (HH in 1080)		0.336***		0.023		0.313***
		(0.072)		(0.051)		(0.076)
Observations	178	178	178	178	178	178
R-squared	0.127	0.221	0.002	0.003	0.133	0.205

Notes: Robust standard errors in parentheses;***: significant at 1%, **: significant at 5%, *: significant at 10%.

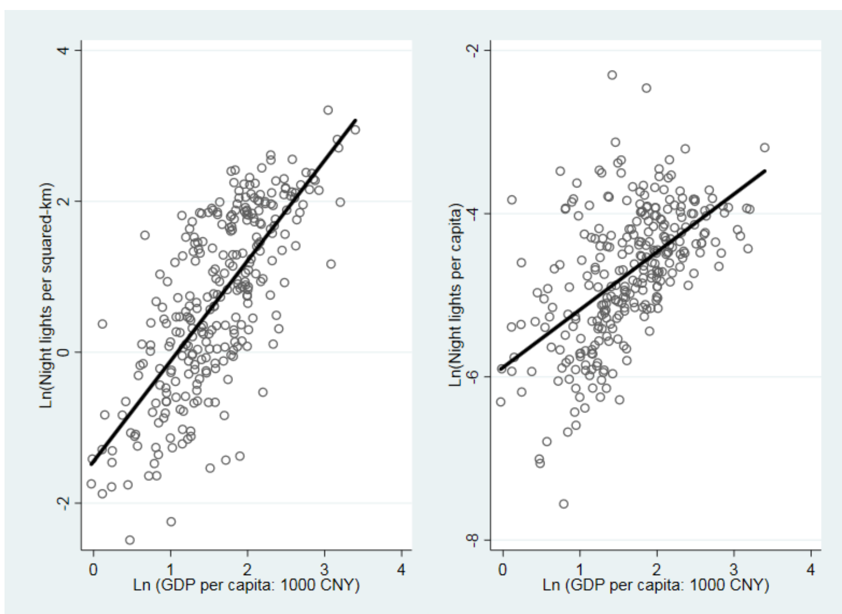
Appendix C Descriptive pattern

Figure C1: Geography of economic prosperity in 2000

(a) Average night time luminosity versus GDP per capita

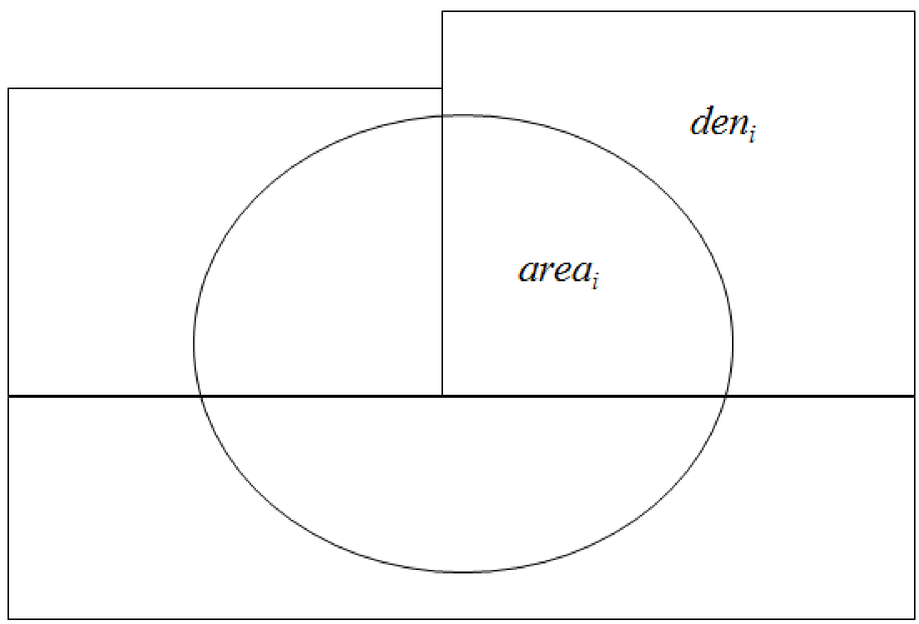


(b) Correlation between night time lights and GDP per capita in 2000



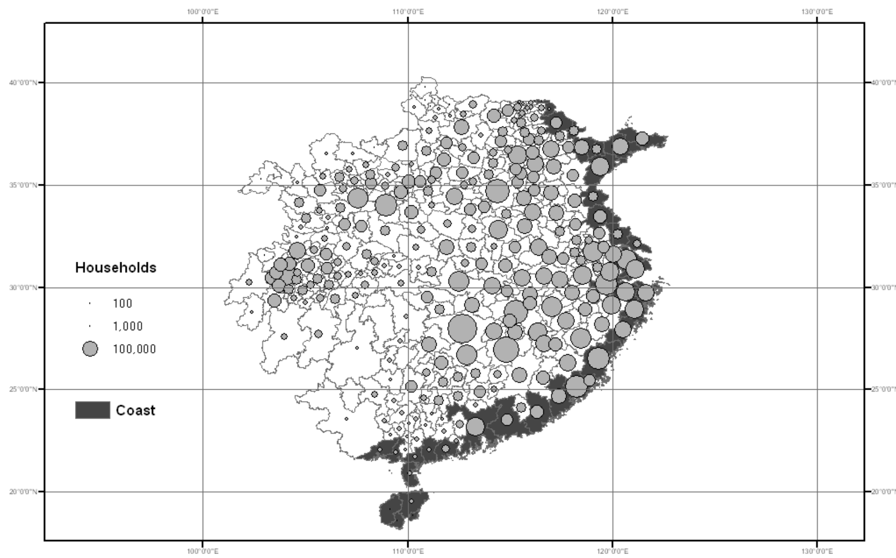
Notes: The geographical distribution of GDP per capita and Average night time lights are presented in Panel (A) of Figure C1. The two variables are strongly positively correlated (Panel B of C1).

Figure C2: Constructing historical population density of human capital



Notes: (1) The rectangular represents the boundary of Qing-prefecture, and the circle represents the boundary of Song-prefecture. Based on Ge (2000), which provides the total population of each prefecture during Qing dynasty in 1391, 1776, 1820, 1851, 1880, and 1910, I first calculate the population density of each rectangular (denoted by den_i). Based on CHGIS (2007), I second calculate the area of each fraction in the circle divided by rectangular i (denoted by $area_i$). The total population in each Song-prefecture can be calculated by summing all interactions between den_i and $area_i$, denoted by $\sum_i den_i \times area_i$. The population density can thus be calculated as $\frac{\sum_i den_i \times area_i}{\sum_i area_i}$. (2) Zhu and Xie (1980) listed all presented scholars (in Chinese: Jinshi) with their birth counties. I match them in the prefecture map during the North Song. (3) The census provides the geographic information of household registrations (Hukou) at the county level. Education at the (Song) prefectural level is calculated based on all counties whose centroids were located in the (Song) prefecture. Then, the census data can be converted into Song prefecture-level data.

Figure C3: Geography and initial economic conditions



Notes: This graph represents latitude, longitude, coast, and household size (circa 1078) in our sampled prefectures.

Figure C4: Waterway in 1078

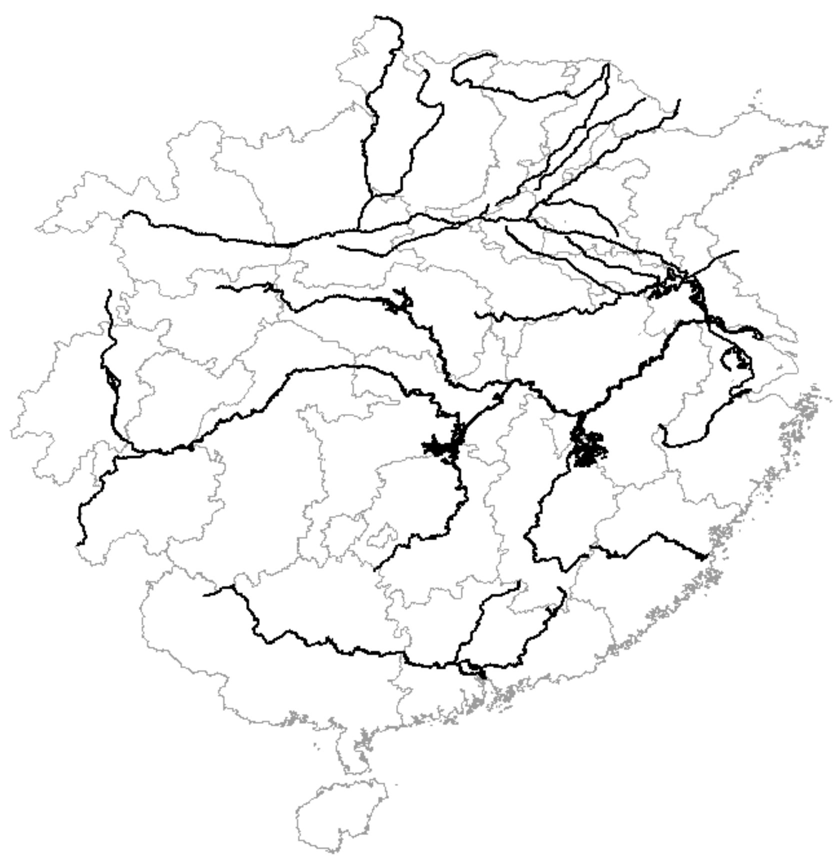


Figure C5: Crop suitability

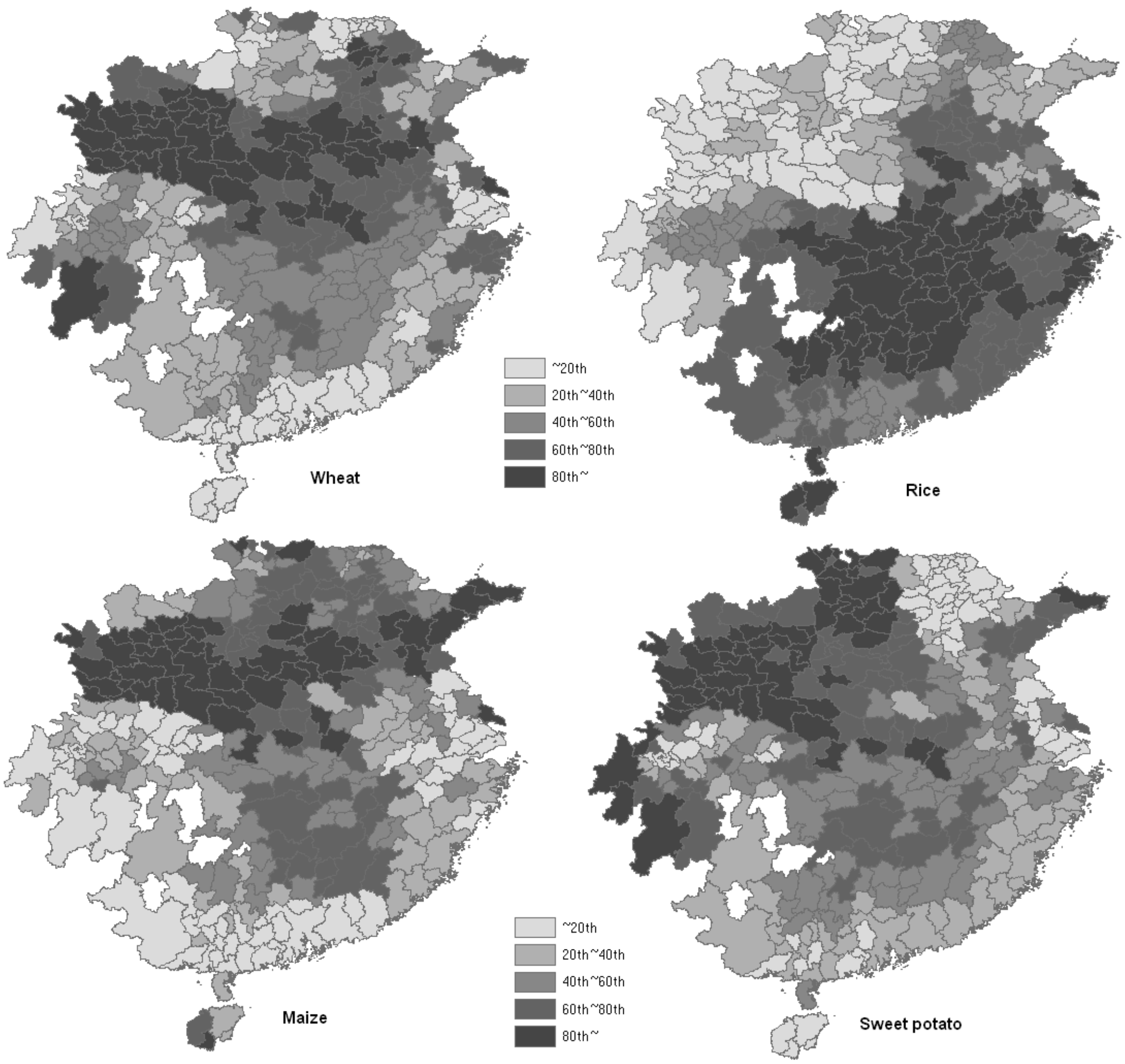
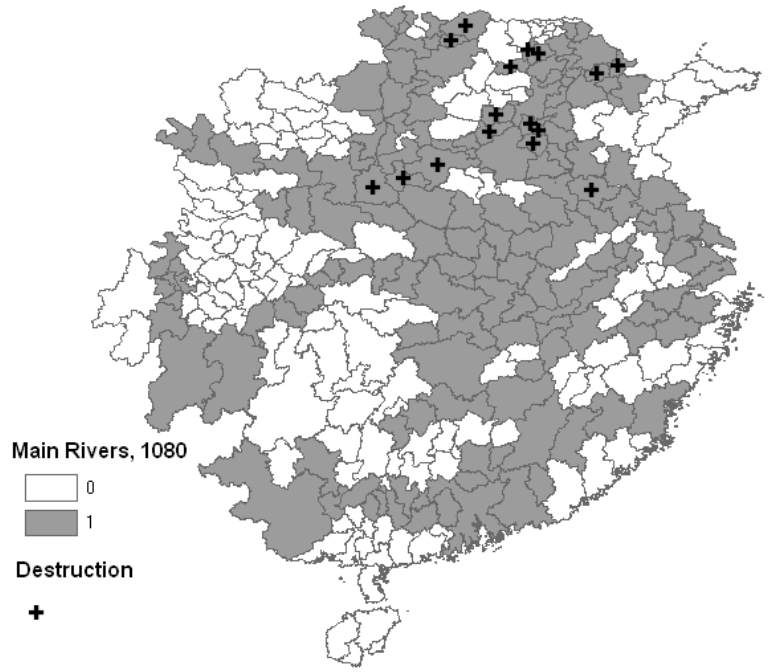
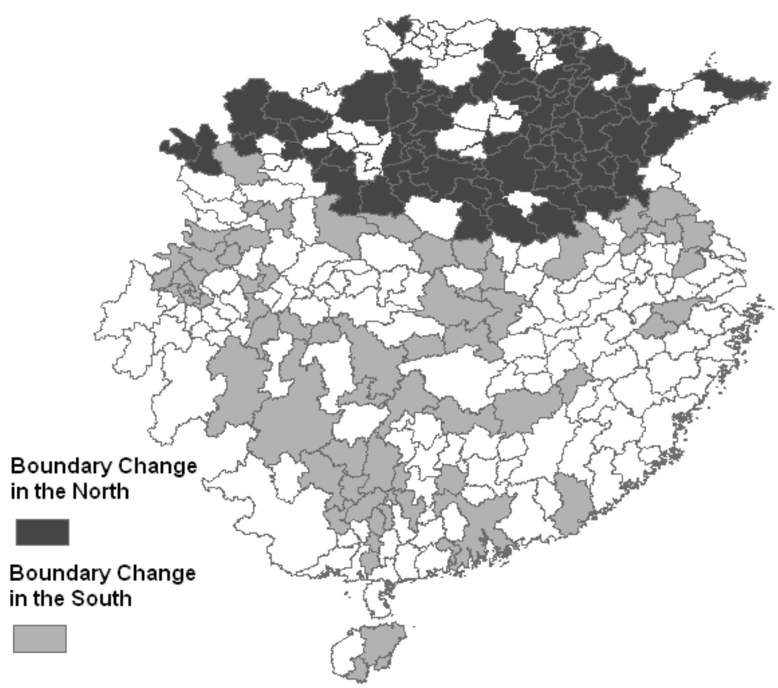


Figure C6: Impact of Sino-nomadic warfare

(a) Initial waterways and destruction



(b) Prefecture with boundary change



Appendix D Additional results

Table D.1: Determinants of the number of migrants

	Ln (Migrants)	
	(1)	(2)
South	0.578***	0.227
	(0.175)	(0.186)
Song waterway	0.165*	0.173*
	(0.090)	(0.100)
Coastal	0.333	0.517**
	(0.220)	(0.224)
Distance to major ports	-0.000	-0.001
	(0.001)	(0.001)
Longitude	0.048	-0.097
	(0.058)	(0.071)
Latitude	0.011	0.013
	(0.054)	(0.060)
Ln (HH density in 1080)	0.171***	0.169***
	(0.039)	(0.044)
Ln (Area)	0.106*	0.136**
	(0.055)	(0.064)
Jinshi ratio in Northern Song dynasty	0.000	0.000
	(0.000)	(0.000)
Ln(Rice suitability)		-0.337*
		(0.171)
Ln(Wheat suitability)		-0.535***
		(0.140)
Ln(Maize suitability)		-0.053
		(0.398)
Ln(Sweet Potato suitability)		-0.277
		(0.187)
Dist. to Hangzhou		-1.861***
		(0.672)
Main river damage		0.019
		(0.078)
Boundary change		0.103
		(0.135)
North * Boundary change		-0.193
		(0.156)
Provincial dummies	Y	Y
Observations	287	287
R-squared	0.687	0.711

Notes: Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%.

Table D.2: Results using only the southern prefectures

Dependent variable:	Ln (GDP Per Capita)			Ln (Lights / Area)			Ln (Population / Area)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln (Migrants)	0.258***	0.123**	0.110**	0.348***	0.214***	0.129*	0.186***	0.124**	0.049
	(0.035)	(0.047)	(0.043)	(0.062)	(0.074)	(0.068)	(0.041)	(0.048)	(0.044)
Province dummies		Y	Y		Y	Y		Y	Y
Ln (HH density in 1080)		Y	Y		Y	Y		Y	Y
Ln (Area)		Y	Y		Y	Y		Y	Y
Song waterway			Y			Y			Y
Distance to major ports			Y			Y			Y
Coastal			Y			Y			Y
Longitude			Y			Y			Y
Latitude			Y			Y			Y
Initial human capital			Y			Y			Y
Observations	178	178	178	178	178	178	178	178	178
R-squared	0.246	0.586	0.645	0.159	0.581	0.691	0.100	0.585	0.718

Notes: Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%.

Table D.3: Controls interacted with the north China dummy

	(1) Ln (GDPPC)	(2) Ln (Lights/Area)	(3) Ln (Population/Area)
Ln (Migrants)	0.122***	0.138**	0.045
	(0.042)	(0.066)	(0.043)
South	Y	Y	Y
Ln (HH in 1080)	Y	Y	Y
Ln (Area)	Y	Y	Y
Song waterway	Y	Y	Y
Distance to major ports	Y	Y	Y
Coastal	Y	Y	Y
Longitude	Y	Y	Y
Latitude	Y	Y	Y
Initial human capital	Y	Y	Y
North X Ln (HH in 1080)	Y	Y	Y
North X Ln (Area)	Y	Y	Y
North X Song waterway	Y	Y	Y
North X Distance to major ports	Y	Y	Y
North X Coastal	Y	Y	Y
North X Longitude	Y	Y	Y
North X Latitude	Y	Y	Y
North X Initial human capital	Y	Y	Y
Province dummies	Y	Y	Y
Observations	287	287	287
R-squared	0.636	0.736	0.763

Notes: Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%.

Table D.4: Oster test

	(1) Ln (GDPPC)	(2) Ln (Lights/Area)	(3) Ln (Population/Area)
Lower bounds for the bias-adjusted effect of migrants	0.097	0.104	0.015
Based on columns	(1) and (3)	(4) and (6)	(7) and (9)

Notes: Oster (2017) proposes the following equation to calculate an approximation of the bias-adjusted treatment effect:

$$\rho^* \approx \tilde{\rho} - \delta \frac{R_{\max} - \tilde{R}}{\tilde{R} - \dot{R}} (\tilde{\rho} - \dot{\rho})$$

In the context of this study, ρ^* represents the bias-adjusted effect of migrants on today's economic prosperity, while $\dot{\rho}$ and $\dot{R}$ ($\tilde{\rho}$ and $\tilde{R}$) denote the coefficients of the logged number of migrants and R-squared with the fewest (most) controls. δ measures the relative importance of unobservables to observables, and $R_{\max}$ is the R-squared if the regression controls for both these latter. Using the above equation with only the upper bounds of δ and $R_{\max}$ enables derivation of a set of lower bounds for the bias-adjusted effect of migrants (ρ^*). That is, first, following Oster (2017), I take 1 as the upper bound ofδ and assume that $R_{\max} = 1.3\tilde{R}$. Then, based on the two assumptions, I approximate the bias-adjusted migrant effect based on the results reported in Table II. Based on columns (1) and (3), the lower bound of bias-adjusted effect of migrants on logged GDP per capita is 0.097. Similarly, the bias-adjusted migrant effect on logged lights per squared kilometer, which is calculable based on columns (4) and (6), is equal to 0.113. These results imply a lower likelihood that the estimated migrant effect is fully driven by unobservables.

Table D.5: Spatial clustering standard errors

Dependent variable:	Ln (GDP Per Capita)				Ln (Lights / Population)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln (Migrants)	0.144***	0.121***	0.136***	0.130***	0.120***	0.104***	0.135***	0.129***
	(0.041)	(0.038)	(0.039)	(0.042)	(0.038)	(0.039)	(0.042)	(0.041)
South	-0.054	-0.083	-0.008	-0.158	-0.208	-0.190	-0.042	-0.123
	(0.141)	(0.114)	(0.124)	(0.147)	(0.215)	(0.191)	(0.180)	(0.211)
Basic controls	Y	Y	Y	Y	Y	Y	Y	Y
Crops suitability		Y	Y	Y		Y	Y	Y
Dist. to Hangzhou			Y	Y			Y	Y
Main river damage				Y				Y
Boundary change				Y				Y
North * Boundary change				Y				Y
Observations	287	287	287	287	287	287	287	287
R-squared	0.592	0.603	0.611	0.625	0.626	0.631	0.647	0.654

Notes: I account for spatial correlation using the algorithm developed by Colella et al. (2019), which allows for arbitrary spatial clustering. The distance cutoff is 200 kilometers, beyond which the correlation between error term of two observations is assumed to be zero. ***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies..

Table D.6: Measurements

Dependent variable:	Ln (GDP Per Capita)				Ln (Lights / Population)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$m_i = ln(M_i + (M_i^2 + 1)^{0.5})$	0.118***	0.105***			0.100**	0.111***		
	(0.034)	(0.035)			(0.039)	(0.042)		
Alternative measure			0.070**	0.075**			0.080**	0.084**
			(0.032)	(0.033)			(0.035)	(0.035)
Basic controls	Y	Y	Y	Y	Y	Y	Y	Y
Additional controls		Y		Y		Y		Y
Observations	287	287	287	287	287	287	287	287
R-squared	0.592	0.624	0.581	0.619	0.626	0.651	0.640	0.648

Notes: Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy.

Table D.7: Impact on migrants

Dependent variable:	Ln (Migrants +1)					Number of NBOs, 1127-30	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Number of NBOs, 1127-30	1.153***			1.149***	1.091***		
	(0.156)			(0.158)	(0.157)		
Number of NBOs, 1100-26		0.185		0.033		0.132	
		(0.165)		(0.163)		(0.095)	
Number of NBOs, 1131-62			0.233*		0.113		0.110**
			(0.122)		(0.111)		(0.044)
Ln (Migrants +1)							
Additional controls	Y	Y	Y	Y	Y	Y	Y
Basic controls	Y	Y	Y	Y	Y	Y	Y
Observations	287	287	287	287	287	287	287
R-squared	0.794	0.713	0.728	0.794	0.798	0.456	0.481

Notes: Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy.

TABLE D.8: IMPACT ON THE ALTERNATIVE MEASURE OF MIGRATION

Dependent variable:	Alternative measure based on surname change					
	(1)	(2)	(3)	(4)	(5)	(6)
Number of NBOs, 1127-30	0.713***			0.426		
	(0.215)			(0.285)		
Number of NBOs, 1100-26		0.221			0.156	
		(0.273)			(0.254)	
Number of NBOs, 1131-62			0.147			0.069
			(0.100)			(0.080)
Ln (Migrants +1)				0.249*	0.350***	0.338***
				(0.149)	(0.116)	(0.121)
Additional controls	Y	Y	Y	Y	Y	Y
Basic controls	Y	Y	Y	Y	Y	Y
Observations	287	287	287	287	287	287
R-squared	0.543	0.515	0.519	0.555	0.548	0.548

Notes: Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy.

Table D.9: Impact on economic prosperity

Dependent variable:	Ln (GDP Per Capita)					Ln (Lights/Population)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Number of NBOs, 1127-30	0.294***			0.302***	0.289***	0.280***			0.274***	0.265***
	(0.080)			(0.081)	(0.082)	(0.078)			(0.080)	(0.079)
Number of NBOs, 1100-26		-0.028		-0.067			0.090		0.054	
		(0.098)		(0.103)			(0.119)		(0.125)	
Number of NBOs, 1131-62			0.041		0.010			0.057*		0.027
			(0.029)		(0.028)			(0.029)		(0.029)
Additional controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Basic controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	287	287	287	287	287	287	287	287	287	287
R-squared	0.627	0.611	0.612	0.628	0.627	0.659	0.651	0.652	0.659	0.660

Notes: Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy.

Table D.10: The role of surname diversity

	Ln (GDP Per Capita)			Ln (Lights/Population)		
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	IV	OLS	OLS	IV
Ln (Migrants+1)	0.126***	0.130***	0.264***	0.127**	0.131***	0.244***
	(0.042)	(0.041)	(0.067)	(0.050)	(0.050)	(0.073)
Surname diversity		8.086***	8.358***		7.958**	8.143**
		(2.542)	(2.525)		(3.745)	(3.600)
Number of NBOs, 1100-26			Y			Y
Additional controls	Y	Y	Y	Y	Y	Y
Basic controls	Y	Y	Y	Y	Y	Y
Observations	270	270	270	270	270	270
R-squared	0.594	0.606	0.591	0.674	0.681	0.674

Notes: Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy.

Table D.11: Bounding analysis

	Panel A: Effect on GDP per capita						
$\bar{\gamma_2}$=	0.7*γ_2	0.8*γ_2	0.9*γ_2	1.0*γ_2	1.1*γ_2	1.2*γ_2	1.3*γ_2
$\bar{\gamma_1}$=							
0.7*γ_1	0.058	0.053	0.048	0.043	0.037	0.032	0.027
	(0.057)	(0.058)	(0.058)	(0.059)	(0.059)	(0.060)	(0.061)
0.8*γ_1	0.034	0.029	0.024	0.019	0.014	0.008	0.003
	(0.059)	(0.059)	(0.060)	(0.060)	(0.061)	(0.062)	(0.063)
0.9*γ_1	0.011	0.005	0.000	-0.005	-0.010	-0.015	-0.021
	(0.061)	(0.061)	(0.062)	(0.062)	(0.063)	(0.064)	(0.065)
1.0*γ_1	-0.013	-0.018	-0.024	-0.029	-0.034	-0.039	-0.044
	(0.063)	(0.064)	(0.064)	(0.065)	(0.066)	(0.066)	(0.067)
1.1*γ_1	-0.037	-0.042	-0.047	-0.053	-0.058	-0.063	-0.068
	(0.066)	(0.067)	(0.067)	(0.068)	(0.069)	(0.069)	(0.070)
1.2*γ_1	-0.061	-0.066	-0.071	-0.076	-0.082	-0.087	-0.092
	(0.069)	(0.070)	(0.071)	(0.071)	(0.072)	(0.073)	(0.074)
1.3*γ_1	-0.084	-0.090	-0.095	-0.100	-0.105	-0.111	-0.116
	(0.073)	(0.073)	(0.074)	(0.075)	(0.076)	(0.077)	(0.077)
	Effect on lights per capita						
$\bar{\gamma_2}$=	0.7*γ_2	0.8*γ_2	0.9*γ_2	1.0*γ_2	1.1*γ_2	1.2*γ_2	1.3*γ_2
$\bar{\gamma_1}$=							
0.7*γ_1	0.049	0.044	0.039	0.034	0.028	0.023	0.018
	(0.062)	(0.063)	(0.063)	(0.064)	(0.064)	(0.065)	(0.066)
0.8*γ_1	0.027	0.022	0.017	0.012	0.007	0.002	-0.003
	(0.063)	(0.063)	(0.064)	(0.065)	(0.065)	(0.066)	(0.067)
0.9*γ_1	0.005	0.000	-0.005	-0.010	-0.015	-0.020	-0.025
	(0.064)	(0.065)	(0.065)	(0.066)	(0.067)	(0.068)	(0.069)
1.0*γ_1	-0.017	-0.022	-0.027	-0.032	-0.037	-0.042	-0.047
	(0.066)	(0.066)	(0.067)	(0.068)	(0.069)	(0.070)	(0.070)
1.1*γ_1	-0.038	-0.044	-0.049	-0.054	-0.059	-0.064	-0.069
	(0.068)	(0.069)	(0.069)	(0.070)	(0.071)	(0.072)	(0.073)
1.2*γ_1	-0.060	-0.065	-0.070	-0.075	-0.081	-0.086	-0.091
	(0.070)	(0.071)	(0.072)	(0.073)	(0.073)	(0.074)	(0.075)
1.3*γ_1	-0.082	-0.087	-0.092	-0.097	-0.102	-0.107	-0.113
	(0.073)	(0.074)	(0.075)	(0.075)	(0.076)	(0.077)	(0.078)

Notes: Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%. All regressions have included the 1127-30 NBO number, basic controls and additional controls. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy.

Table D.12: Migration and Hakka-Cantonese Conflict

	(1)	(2)
Ln (Migrants+1)	1.099**	1.016*
	(0.500)	(0.567)
Longitude		Y
Latitude		Y
Logged population density in 1080		Y
Logged area		Y
Observations	20	20
R-squared	0.223	0.377

Notes:
(1) I collect data from Liu (2003) and calculate the number of counties in each prefecture that reported conflict between local Cantonese and Hakka groups in Guangdong province as the dependent variable. As Table D.12 shows, migration had a significant impact on the incidence of such conflicts. However, the analysis is only based on the 20 prefectures in Guangdong province; the small number of observations means that we have to be cautious about interpreting this result.
(2) Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%.

Table D.13: Correlation of surname distribution between the Southern Song dynasty and 2005

	(1)	(2)	(3)	(4)
			Northern surnames only	
Surname share in the Southern Song dynasty	0.198***	0.198***	0.154***	0.160***
	(0.020)	(0.020)	(0.056)	(0.054)
Additional controls		Y		Y
Basic controls		Y		Y
Provincial dummies	Y	Y	Y	Y
Observations	254,540	254,540	1,780	1,780
Number of prefectures	178	178	178	178
Number of surnames	1430	1430	10	10
R-squared	0.040	0.040	0.061	0.084

Notes: Surname share in a prefecture, drawn from the Population Census 2005, is the dependent variable, and Surname share in a prefecture in the Southern Song dynasty, drawn from the CBDB database, is the explanatory variable. Basic controls include latitude, longitude, the coastal dummy, Song waterways, logged area, and logged population density in 1080. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy. Beta coefficients are reported. Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%. Column (1) and (2) base on 1430 surnames, and column (3) and (4) base on the 10 identified northern surnames.

TABLE D.14: IMPACT ON INTERMARRIAGE BETWEEN NORTHERN SURNAMED AND OTHERS

	Benchmark ratio	Marriage ratios: northern surnamed and others				
	(1)	(2)	(3)	(4)	(5)	(6)
		Age $\geq$ 40				40 > Age $\geq$ 20
			High corr. pref.	Assortative	Disassortative	
Ln (Migrants+1)	-0.670	-1.095**	-0.667*	-1.326***	-0.819*	-0.178
	(0.461)	(0.433)	(0.367)	(0.475)	(0.465)	(0.436)
Number of NBOs, 1100-26	Y	Y	Y	Y	Y	Y
Additional controls	Y	Y	Y	Y	Y	Y
Basic controls	Y	Y	Y	Y	Y	Y
Observations	270	270	193	270	270	270
R-squared	0.636	0.654	0.713	0.602	0.605	0.529

Notes: (1) Based on 2005 population census, I first calculate the ratio of couples with northern and non-northern surnames to the total number of couples in a prefecture as the dependent variable (denoted by C_i^N). Then, based on the assumption that such a lower level of intermarriage is likely in a region that experienced 1127–30 southward migration, I use 2005 population census data to calculate the ratio of northern surnames in a prefecture, denoted by p_i, and the benchmark percentage of marriage between individuals with northern surnames and others, written as $2p_i(1-p_i)$. The table reports the instrumented effect of migration on the benchmark ratio, which shows that there is no significant relationship.
(2) Based on 2005 population census, I calculate the ratio of marriage between those with northern surnames and others. Because I only identify 10 northern surnames and 10 southern surnames (Appendix B), the share of people with the identified surnames in the total population is relatively small and the ratio of intermarriage between different groups is noisy. Specifically, the northern surnamed and southern surnamed make up 3.81 percent and 3.08 percent of the sample, respectively. The ratio of marriage between people with northern surnames and others is 7.28 percent. Moreover, 0.1 percent of the total number of marriages are between northern surnamed and southern surnamed persons, 0.34 percent are between northern surnamed persons, and 0.39 percent are between southern surnamed persons. Because the ratio of the marriages between northern surnamed and southern surnamed persons is extremely small, I regress the ratio of the marriages between those with northern surnames and others on the logged number of recorded migrants. I restrict the sample to those over 40, since the marriage decision of the old cohort is made by the family, rather than themselves. The instrumented results (column (2)) show that in the region with more migrants, the marriage ratio is significantly lower.
(3) Table D.13 shows that the correlation between surname distribution in the Southern Song dynasty and surname distribution in 2005 is statistically significant. However, the magnitudes of the coefficients, ranging from 0.154 to 0.198, are not very large. I further check the correlations for each prefecture and find that the coefficients range from -0.004 to 0.926. Accordingly, I drop the southern prefectures where the correlations between surname distributions in the Song dynasty and in 2005 are 0.198 or less (the

average correlation in the full sample in column (1) of Table D.13). In the subsample of high correlation prefectures, the mean of correlations between historical and modern surname distribution is 0.456. Using this subsample, I re-examine the migrant effect on intermarriage patterns and find that the main result remains robust, although the significance decreases to the 10% level, possibly due to the decrease in sample size (column (3) of Table D.14).

(4) I address the concern about assortative matching. It is possible that those with northern surnames and others may differ in terms of their level of income, education, and other characteristics. If the marriage is assortative, the likelihood of marriage between the two groups should be lower due to the differences between the two groups in other characteristics. Although a later analysis shows that in the region with migrants, the northern surnamed and southern surnamed are not different in terms of their level of education (see Table VII), I further rule out this concern by categorizing marriage into two types based on the difference in education between the wife and the husband. If their educational levels are the same, it is coded as assortative matching. If they are different, it is coded as disassortative matching. If assortative matching is a concern, the migration should have a more significant effect on that type of marriage. However, the results (columns (4) and (5)) show that migration has a significant effect on both assortative and disassortative matching, implying that assortative matching is not a big concern.

(5) As a comparison, I focus on couples aged 20 to 40. The result shows no significant association between historic migrants and today's between-group marriage likelihood (column (6)). The possible reason might be the marriages of the younger cohort have been decided by themselves rather than their families.

(6) Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, Song waterways, logged area, logged population density in 1080, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy.

Table D.15: Effect on human capital – robustness checks

	Ln (Jinshi / Population)				Ln (Academies / Population)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ming	Qing	Ming	Qing	Ming	Qing	Ming	Qing
Ln (Migrants+1)	0.197	0.343***	0.180	0.314**	0.092	0.201**	0.083	0.197**
	(0.126)	(0.127)	(0.129)	(0.125)	(0.108)	(0.092)	(0.111)	(0.093)
Ln pop. density	-0.034	-0.117	0.004	0.026	-0.603***	-0.661***	-0.587***	-0.646***
	(0.155)	(0.154)	(0.158)	(0.152)	(0.109)	(0.090)	(0.112)	(0.101)
Conflicts/Population			0.003	0.011***			0.001	0.001
			(0.002)	(0.003)			(0.002)	(0.002)
Number of NBOs, 1100-26	Y	Y	Y	Y	Y	Y	Y	Y
Additional controls	Y	Y	Y	Y	Y	Y	Y	Y
Basic controls	Y	Y	Y	Y	Y	Y	Y	Y
Observations	287	287	287	287	287	287	287	287
R-squared	0.538	0.467	0.540	0.485	0.517	0.571	0.519	0.571

Notes: Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy. In columns (5)-(8), the initial human capital condition is measured by the logged number of academies during the Northern Song dynasty instead of Jinshi ratio.

Table D.16: Effect on quota system

	Ln (Population in 1776)		Ln (Quota in 1776)		Ln (Quota/Population in 1776)	
	(1): OLS	(2): IV	(3): OLS	(4): IV	(5): OLS	(6): IV
Ln (Migrants+1)	0.060*	0.123**	0.052*	0.155**	-0.007	0.032
	(0.032)	(0.060)	(0.028)	(0.069)	(0.029)	(0.070)
Number of NBOs, 1100-26		Y		Y		Y
Additional controls	Y	Y	Y	Y	Y	Y
Basic controls	Y	Y	Y	Y	Y	Y
Observations	287	287	287	287	287	287
R-squared	0.894	0.893	0.887	0.882	0.657	0.655

Notes: Robust standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%. Basic controls include the south China dummy, latitude, longitude, the coastal dummy, distance to major ports, Song waterways, logged area, logged population density in 1080, (standardized ln) the ratio of Jinshi to population during the Northern Song dynasty, and provincial dummies. Additional controls include rice suitability, wheat suitability, maize suitability, sweet potato suitability, distance to Hangzhou, main river damage boundary change, and the interaction between boundary change and the north China dummy.

Appendix E Simple model of child quantity-quality trade-off

Introducing between-group competition into a simple model of the child quantity-quality tradeoff allows me to highlight its role on human capital accumulation and economic development. Hence, borrowing several elements from Galor and Moav (2002) and Lazear and Rosen (1981), I formalize the competition channel in a simple conceptual framework and then derive certain auxiliary predictions that could throw light on the underlying mechanism. This model first assumes an economy (e.g., a village) containing two households, j and k. Like Galor and Moav (2002), I assume that each household (e.g., household j), maximizes the following log-linear utility function:

$$u_j = (1-\pi)\ln c_j + \pi(\ln n_j + \varpi s_j)$$

where c_j represents all non-child consumption goods, and n_j is the number of surviving children. Unlike s_j in the standard quantity-quality tradeoff model, which denotes the logged quality (i.e., human capital) of each child, in my model, s_j represents the expected logged political status of children. Parameters π and ϖ then denote preferences for children and child status, respectively.

A two-player tournament. I apply this model to a two-player tournament that has two political status-related prizes: $S_H > S_L$ (cf. Lazear and Rosen 1981). The game rules specify that S_H should go to the winner and S_L to the loser. Denoting household j's probability of winning as P_j, the expected social status prize can be written as

$$s_j = P_j \ln S_H + (1-P_j)\ln S_L = P_j(\ln S_H - \ln S_L) + \ln S_L = \Delta P_j + \ln S_L \tag{7}$$

where $\Delta \equiv \ln S_H - \ln S_L$ represents the spread between winning and losing. The probability of winning (P_j) is based on both number of children, denoted by n_j, and average quality (level of human capital or education) denoted by e_j . The number of unskilled children regardless of quality is also denoted by n_j , while skilled (or educated) children are denoted by $n_j e_j$. These elements comingle in Cobb–Douglas fashion to produce the household's strength and ability to compete with the opponent, yielding the following probability that household j will win:

$$P_j = P[(1-\rho)\ln n_j + \rho \ln n_j e_j + \varepsilon_j > (1-\rho)\ln n_k + \rho \ln n_k e_k + \varepsilon_k]$$

Here, $\varepsilon_j \sim N(0, \sigma^2/2)$ and $\varepsilon_k \sim N(0, \sigma^2/2)$ represent the random or luck components, which are independent, identically distributed, and realized only after the quantity and quality of children are decided upon. Denoting the importance of human capital in the contest as ρ, I can then write the probability as

$$P_j = P[\nu \equiv \varepsilon_k - \varepsilon_j < (\ln n_j - \ln n_k) + \rho(\ln e_j - \ln e_k)]$$

where $\nu \equiv \varepsilon_k - \varepsilon_j$ also follow a normal distribution, and represents the cumulative distribution function. Because ε_k and ε_j are independent and identically distributed, the standard deviation of ν is σ .

$$P_j = \Phi[\delta \equiv \frac{(\ln n_j - \ln n_k) + \rho(\ln e_j - \ln e_k)}{\sigma}] \tag{8}$$

To better understand this tournament, I consider two extreme cases. In the first, $\rho = 0$, implying that the contest is based only on number of children, and selection of a government official is orthogonal with human capital. Then if, as jungle law prescribes, the superiority of brute force determines power, a family's size defines its physical power, meaning that families with more children are more likely to win more resources. In the alternative case, $\rho = 1$, implying that the contest relies solely on the skilled (educated) children.

Optimization. Each household is endowed with one unit of time, which is divided between child rearing and market activities, paid at a wage rate, w.[31] Designating v^n as the fraction of the individual time unit dedicated to raising a child, regardless of quality, and v^e as the fraction associated with each unit of human capital (e_j),[32] the household optimization problem is

$$\{c_j, n_j, e_j\} = \arg\max\{(1-\pi)\ln c_j + \pi[\ln n_j + \varpi(\Delta P_j + \ln S_L)]\} \tag{9}$$

subject to

$$wv^n n_j + wv^e n_j e_j + c_j \leq w$$

Based on Equations (**??**)-(9) and first order conditions, I can then solve

$$e_j^* = \frac{v^n}{v^e}\frac{\rho\varpi\Delta\phi(\delta)}{\sigma+(1-\rho)\varpi\Delta\phi(\delta)};\ n_j^* = \frac{\pi}{v^n}\frac{\sigma+(1-\rho)\varpi\Delta\phi(\delta)}{\sigma+\pi\varpi\Delta\phi(\delta)}$$

Similarly, the optimum household investment is

$$e_k^* = \frac{v^n}{v^e}\frac{\rho\varpi\Delta\phi(-\delta)}{\sigma+(1-\rho)\varpi\Delta\phi(-\delta)};\ n_k^* = \frac{\pi}{v^n}\frac{\sigma+(1-\rho)\varpi\Delta\phi(-\delta)}{\sigma+\pi\varpi\Delta\phi(-\delta)}$$

I then adopt the Nash-Cournot assumption that each player optimizes against the opponent's optimum investment (Lazear and Rosen, 1981), so that $\phi(\delta) = \phi(-\delta)$. Then

$$e^* = e_i^* = e_j^* == \frac{v^n}{v^e}\frac{\rho\varpi\Delta\phi(0)}{\sigma+(1-\rho)\varpi\Delta\phi(0)};\ n^* = n_j^* = n_k^* = \frac{\pi}{v^n}\frac{\sigma+(1-\rho)\varpi\Delta\phi(0)}{\sigma+\pi\varpi\Delta\phi(0)} \tag{10}$$

Proposition. To compare a village that has one local and one migrant household with one that has two local households, I first assume that Δ is much larger in a village inhabited by both locals and migrants. In the village with two local households, even if one household wins the contest over the other, the strong social ties between them (e.g., possible intermarriage) may lead the prize differences to be relatively smaller. In contrast, in the village with both a local and a migrant household, the difference in social and genetic backgrounds may increase mistrust and decrease social cooperation so that the winner takes almost all. Based on this assumption, I derive

$$\frac{\partial e^*}{\partial \Delta} = \frac{v^n}{v^e}\frac{\rho\varpi\phi(0)\sigma}{[\sigma+(1-\rho)\varpi\Delta\phi(0)]^2} \geq 0 \tag{11}$$

which indicates that the migrant effect (a larger Δ) will increase the human capital level when such capital can help the household win the tournament ($\rho > 0$). Such a strong association between human capital and economic development can explain why historic migrants affect today's economic prosperity, yielding another auxiliary model prediction tested below.

Migrant effect on population quantity and quality Over Time. Within the conceptual framework, I can express the migrant effect on number of children as

$$\frac{\partial n^*}{\partial \Delta} = \frac{\pi}{v^n}\frac{1-\rho-\pi}{[\sigma+\pi\varpi\Delta\phi(0)]^2}\varpi\phi(0)\sigma$$

where $\rho < 1-\pi$ generates a positive effect and $\rho > 1-\pi$ a negative one. In the political status tournament, however, the migrant effect on population density changes with the importance of human capital just as the effect on human capital changes with ρ:

[31] I make no assumptions about the budget constraints, especially on the wage rate (w). Even if there is some heterogeneity in the wage rate (cross-sectional or over time), the tradeoff still exists for both rich (higher w) and poor (lower w) families. However, in reality, not all families could afford the civil service exam. Fortunately, as Wang (1989) estimates, an average family (of five individuals) needs land holdings of around 1.5 acre to afford the entry-level exam for one individual, and 30-40% households in the late Qing period owned land above this threshold. The share of families that could afford the exam is not small.

[32] Here, I borrow the denotation used by Fernihough (2017).

$$\frac{\partial^2 n^*}{\partial \Delta \partial \rho} < 0; \ \frac{\partial^2 e^*}{\partial \Delta \partial \rho} > 0 \tag{12}$$

In the context of historic China, ρ might have increased during the Ming and Qing dynasties as the civil service exams gradually became the primary channel for selecting government officials,[33] in which case, I can formulate the following hypothesis: Immigration increased population density initially (since ρ is small), but this effect gradually decreased after the civil service exam became the primary selection channel. Conversely, immigration had no (or only a small) significant effect on human capital level during the initial period, but this effect gradually increased over time.

[33]Such quantity-and-quality tradeoff is also consistent with extant studies on the effects of socioeconomic status on family size and child quality. For instance, Shiue (2013) finds that higher status households had relatively fewer children and relatively more educated sons.