Of Maize and Men: The Effect of a New World Crop on Population and Economic Growth in China

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Abstract

We examine the question of whether China was trapped within a Malthusian regime at a time when Western Europe had all but emerged from it. By applying a difference-in-differences analysis to maize adoption in China from 1600 to 1910, we find that cultivation of this New World crop failed to raise per capita income. While maize accounted for a nearly 19% increase in the Chinese population during 1776-1910, its effect on urbanization and real wages was not pronounced. Our results are robust to different sample selection procedures, to the control of variables pertinent to Malthusian "positive checks", to different measures of economic growth and to data modifications. Our study thus provides rich empirical support to the claim that under the conditions in 18th- and 19th-century China, new agricultural technologies led to the Malthusian outcome of population growth without wage increases and urbanization.

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1. Introduction

According to economic theories duly influenced by Malthus, the world before the 18th century was trapped within a Malthusian regime, as technological progress and land expansion primarily generated an increase in the size of the population but seldom income per capita.[1] China provides compelling evidence on this Malthusian process. The high-pressure demographic regime with positive Malthusian checks in China at the time implied that productivity growth was most likely transformed at much higher rates into population growth than it did in Europe (Voigtländer and Voth, 2006). Indeed, With a population that almost tripled from 130 million in 1500 to 400 million in 1900 (Cao, 2000; Ho, 1959; Perkins, 1969), China alone accounted for approximately one-third of the world's population increase (Figure 1), and yet per capita GDP remained stagnant at the subsistence level of roughly US$600 (in adjusted terms) for an even longer period (Maddison, 2001).

Figure 1 about here

This paper uses systematic evidence about China as a whole to ask how a particular technology influenced growth in population and income. To answer that question, we thus construct a unique data set from historical gazetteers on the adoption of maize—a New World crop originated from today's Mexico, to test whether the adoption of what essentially is a new agricultural technology has had the effect of boosting both population and economic growth—modern economic growth in short (e.g., Galor, 2005; 2011), or just population growth. We choose to study the impact of New World crops because of the allegedly vast improvements in caloric and nutritional intake they brought to the Old World population. For example, Nunn and Qian (2011) find that the potato contributed to an increase in Old World population of 25-26% between 1700 and 1900 and to a rise in urbanization of 27-34%. This latter finding led them to the bold claim that population growth induced by the "Columbian Exchange", which is defined as "the

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[1] While the "quality-quantity tradeoff" has often been associated with Europe's escape from the Malthusian regime (Clark, 2007; Galor and Weil, 2000; Galor, 2011; Lucas, 2002), the fact that it did not occur until the mid-19th century, whereas the divergence had already begun in 1700 when Western Europe had higher per capita incomes than China (Broadberry and Gupta, 2006; see also Jones, 1981; Landes, 2006), suggests that explanation for the divergence lies in the period before 1800.

exchange of diseases, ideas, food crops, and populations between the New World and the Old World …." (Nunn and Qian, 2010: 163), may have played a *causal* role in moving the Old World into a new epoch of modern economic growth. Of the three New World crops—maize, sweet potato, and the potato—that China adopted, we study maize because it was the most suitable for cultivation in China, and because of data availability.[2]

By employing a difference-in-differences (DID) approach, we present evidence on the contribution of maize planting to population growth in China. Specifically, we find that maize accounted for an increase in population of nearly 19% during 1776-1910—a magnitude that may be considered a lower bound estimate of the effect of all New World crops taken together or an upper bound estimate of the effect of maize alone. Our results are robust to the inclusion of a variety of controls ranging from alternative channels of agricultural innovation such as the multiple cropping of rice, to the direct "positive checks" of civil wars and epidemics.

Unlike the alleged growth effect of the potato, maize failed to deliver economic growth to this Middle Kingdom, regardless of whether we measure growth by urbanization or real wages. We thus present the very first evidence that massive population growth in the Old World, driven by the adoption of New World crops, was hardly a sufficient condition for Industrial Revolution—at least not in the case of China; China was still operating under a Malthusian regime even by the end of the 19th century.[3]

While our contribution is primarily empirical, the rich evidence our analysis provides on China's Malthusian regime is important for understanding long-run economic growth in the tradition of the unified growth theory (Galor and Weil, 2000; Galor, 2005, 2011). More specifically, our study sheds much needed light on a fundamental puzzle underlying the sharp contrast between Europe and China in their trajectories of long-run economic growth, which recently has attracted tremendous scholarly interest (e.g.,

[2] While sweet potato was the other popular New World crop China adopted, data on its diffusion are available only at the provincial level (see Jia, 2013).

[3] However, China's failure to industrialize at an important historical juncture was not the result of a small and dwindling agricultural surplus being consumed entirely by a growing population (e.g., Elvin, 1973; Perkins, 1969); rather, growing population pressure represented more of an endogenous outcome of a rise in agricultural productivity, thanks—at least in part—to the adoption of maize.

Broadberry and Gupta, 2006; Jones, 1981; Landes, 2006; Lucas, 2002; Pomeranz, 2000; Pritchett, 1997; Voigtländer and Voth, 2006, 2013a, 2013b, Rosenthal and Wong, 2011).

The remainder of this paper is organized as follows. In Section 2, we provide a brief account of how maize was diffused in China, and in Section 3 we introduce our data and their sources and the variables employed in the empirical analysis. Our empirical strategies and baseline results are described in Section 4, whereas a host of robustness checks are discussed in Section 5. In Section 6, we present evidence on the relationship between maize planting and economic growth. Section 7 provides a brief conclusion.

2. The Diffusion of Maize in China, 1600 to 1910

Of the three New World crops—maize, potato and sweet potato—adopted by the Chinese during the 16th to 20th centuries, maize and sweet potato experienced the most rapid and widespread diffusion, and thus likely contributed the most to population growth (Ho, 1959). In the case of the potato, although there were scattered accounts of its cultivation in the early 1800s (Cao, 2005a, 2005b; Lee, 1982), its wider diffusion had to wait until the latter half of the 19th century (Wang, 1994, pp. 1023).[4]

While taste may have been an important reason why the potato was the least preferred New World crop,[5] it was suitability of cultivation—defined in terms of soil, slope, and climatic characteristics—that better explains why maize and sweet potato were chosen over the potato (Food and Agriculture Organization, 2002 Global Agro-Ecological Zones (GAEZ) database).[6] Figure 2 shows that only about 10% of the land in China was suitable for cropping the potato (Panel A), compared to 20% for the sweet potato (Panel

[4] As a matter of fact, the potato was not even mentioned in the Chinese text until 1847 in the *Almanac of Plants (Zhiwu Mingshi Tukao)* by Wu Qijun. It did not appear, for example, in the *Complete Treatise on Agricultural Affairs* (*Nongzheng Quanshu*)—the first agricultural encyclopedia ever published in China in the 17th century (Xu, 1639).

[5] The Chinese consider the potato bland in taste (Ho, 1959; Perkins, 1969).

[6] The GAEZ database provides an index ranging from 0 (very suitable) to 8 (very unsuitable) on the suitability of all major staple crops cultivated in China. For each prefecture, we take the index of maize to be our measure of land suitability. See Nunn and Qian (2011) for an application, and in the Chinese context Kung and Ma (2014).

B), but over 55% for maize (Panel C). In particular, maize could be easily grown in the entire basin surrounding the *Huai* River, the middle and the lower Yangtze region, the North China plain (especially Shandong Province), and the valleys in the populous, southwestern province of Sichuan.[7] The Irish experience provides a contrasting perspective that supports our view. In Ireland, the soil characteristics were suitable for planting only potato but not the other two New World crops (Connell, 1962; Mokyr, 1981; Mokyr and O'Gráda, 1984; Gaez, 2002). Owing to data limitations on the sweet potato, however, we restrict our analysis to the effect of maize on population growth and economic development in historical China.

Figure 2 about here

Brought to the Old World by Columbus in 1492 and spread rapidly in the subsequent two centuries, maize was the traditional crop in today's Mexico. In China, maize was introduced around the middle of the 16th century via three routes. The first was the Silk Road from Central Asia and the Pamir Mountains into Gansu, a province in northwest China. Second, it was also brought to the southwestern province of Yunnan via India and Myanmar; and, third, the Portuguese also brought this crop to the coastal province of Fujian in the south (Cao, 1988; Tong, 2000, p. 18; see Figure A1 in the Appendix).

Figure 3 illustrates the geographic diffusion of maize in China between roughly 1580 and 1900, from which two observations are immediately apparent. First, although maize was introduced into China as early as the 16th century, its initial diffusion—the first 200 years—was extremely slow, suggesting that the Chinese farmers were yet to discover the advantages of maize (i.e., its resistance to droughts). Second, the early adopters were seemingly confined to the three initial points where maize was first brought into China—namely Gansu, Yunnan, and Fujian. And while maize did spread quickly in Yunnan Province soon after its adoption, its spread to the overland was limited due to the province's peripheral location and high transport costs, according to Guo (1986), a historian who studies the diffusion of maize in China. In the north—a region highly suitable for cropping maize (as maize is also resistant to cold weather), Henan Province

[7] Compared to sweet potato maize is more resistant to cold weather, which thus also favored its diffusion in North China (Zhang and Hui, 2007).

was also an early adopter of this New World crop by dint of its physical proximity to Gansu, where the crop was spread throughout the province from west to east, whereas Guangdong and Fujian were among the early adopters in the south.[8] At any rate, even by 1650 the maize-adopting prefectures in China were far and few between (36/267, a mere 13.4%), and were invariably confined to prefectures conveniently located along major transport nodes (Guo, 1986).

Historical accounts suggest that the diffusion of maize began to gather momentum only after 1750, particularly after the *Qianlong* reign (1735-1796), and reached an apex by the end of the *Daoguang* reign (1820–1850) (Guo, 1986). This narrative is consistent with our data, which show that it was not until around 1750 that maize began to diffuse more rapidly in more than a third of the region north of the Yangtze River and also gained popularity in the south in at least seven provinces (Figure 3).[9] What our data also consistently show is that, after nearly doubling during the 1651-1750 period, the number of prefectures adopting maize doubled yet again in the next 150 years (1751-1900), so that by the turn of the 20th century maize was planted virtually everywhere in the country.[10]

Figure 3 about here

The above pattern of maize diffusion in China suggests that its adoption at the outset was slow and confined largely to the three points where it was first introduced, whereas its subsequent diffusion, which was significantly more rapid, was likely premised on the suitability of soil and climatic conditions. To see if that was indeed the case, we

[8] Gansu Province is located west of Henan Province.

[9] These southern provinces are Sichuan, Hunan, Hubei, Guizhou, Guangxi, Zhejiang, and Jiangxi (Guo, 1986). These trends are thus highly consistent with Ho's (1959) observations that by the 18th century "[t]he hills and mountains along other tributaries of the Yangzi [Yangtze] were likewise turned into maize fields" (p. 185), and that by 1750 maize could be found planted in roughly half (approximately 47%) of the prefectures in which it would eventually be adopted.

[10] Ho (1959) notes that between 1904 and 1933 maize accounted for 17% (up from 11%) of the farm acreage in North China, at the expense of barley, millet and sorghum. The same trend was observed for the three northeastern Manchurian provinces, which, while especially suited for cropping maize, did not do so until the late 19th century, upon the Qing government's eventual removal of the erstwhile restrictions placed upon the ethnic Han to migrate and live there (Gottschang and Lary, 2000; Kung and Li, 2011). These provinces are not included in our analysis.

calculate the mean suitability of the adopting prefectures in the three periods and their correlations. Reported in Table A1 in the Appendix, the results show that those prefectures cropping maize in the second and third periods had significantly more suitable soil, climate and slope characteristics than those cropping maize in the initial period, whereas those doing so in the second and third periods were not significantly different from each other in terms of suitability. On the contrary, there is no significant difference among the prefectures in the distance from the three initial adoption points. Together, these results provide suggestive evidence that the earnest diffusion of maize was likely driven by suitability and the prevailing climatic conditions.

The spread of maize in China had, by the account of a Chinese historian, led to substantial increases in cropping acreage and output—4.3 times between 1380 and 1900 (Wang, 1973), resulting in a steep rise in productivity from under 140 catties per *mu* of land in 1368 to about 240 catties by the middle of the 19th century (Perkins, 1969, pp. 16-17).[11] Indeed, the growing importance of maize is also reflected in the declining share of rice over time—from accounting for roughly 70% of the total agricultural output in 1637 (Song, 1637) to only 36% in 1931–1937 (Ho, 1959, p. 192).[12] Given that up to 55% of the output increase (of roughly 55 million tons of grain) over this lengthy period of time came from the expansion in cropping acreage (Perkins, 1969, p. 26 and pp. 31-32), small wonder that maize adoption has been hailed by Ho (1959) as the second "agricultural revolution" (see also Lan, 2002).[13]

3. Data and Measurement

[11] By the end of the Qing Dynasty (around the 1900s), maize was established as the most popular staple of the Chinese after only rice and wheat—the traditional staples for thousands of years (Zhou, 2007; see also Wang, 1994). Not only was maize 5 to 15 times more productive (around 180 *jin* or 90 kg per Chinese *mu* of land; one mu is equivalent to 0.067 hectare or 0.16 acre) than other "mixed" cereals in China such as barley and sorghum (Perkins, 1969), of the three New World crops it also provided the most calories (106 kcal/100 g compared to 99 for sweet potato and 76 for the potato).

[12] Maize consumption varied from region to region. In regions where few, if any, acreage was cropped in rice or wheat (especially in the hilly areas), maize made up nearly 80% of the inhabitants' daily food consumption (Song, 2007: 67; see also Ho, 1959, p. 185).

[13] The first agricultural revolution refers to the introduction of *Champa* rice from *Champa* (the middle and southern parts of today's Vietnam) during the Song dynasty.

In order to conduct our empirical analysis we put together a unique panel data set from a number of historical sources spanning the period 1600–1910. Our dataset, which covers 267 (out of 317) prefectures ("*fu*" in Chinese) in 18 provinces in China, allows us to empirically test the effect of maize on population and economic growth in the historical Chinese context (Figure 4).[14] We choose the prefecture as our unit of empirical analysis because China was so enormous in size that comparisons at the province level would likely conceal the high heterogeneity that likely exists within a single province.[15] In fact, our data clearly reveal that the number of years between the earliest year and the latest year in which maize was adopted for a province ranged from a minimum of 119 years to a maximum of 321 years, with an average of 280 years (refer to Table A2 in the Appendix for details).

Figure 4 about here

3.1 Definition of Variables

Population Density. Our dependent variable is population density of the following years: 1600, 1776, 1820, 1851, 1880 and 1910. Population data for 1600 are derived from Fangzhong Liang (1980), who constructed population figures of the Ming dynasty at the county level based on estimates from the Qing historian Zuyu Gu. Data for the subsequent five periods are all obtained from "*A History of Population in China*", compiled by Shuji Cao (2000) at the prefecture level. Cao's work is the first attempt to systematically construct population data at the prefecture level of the Qing dynasty based on more than 3,000 local gazetteers, whose validity has been verified by the 1953 census survey and has survived the scrutiny of such eminent China scholars as Ho (1959), Perkins (1969), and Skinner (1977). To see for ourselves that Cao's population data are not widely off the mark, we perform a correlation test with five other relevant, albeit less detailed, sources (in the sense that they are either cross sectional or available only at the province level).[16]

[14] Located primarily in the remote northeastern and northwestern corners, the five provinces dropped were all populated by the ethnic minorities, which covered less than 10% of the total population around the 1820s.

[15] A prefecture is equivalent to the administrative level between a province and a county in today's China.

[16] Except for Cao (2000), who provides population data at the prefecture level, and Gu (1692), who provides county-level population data circa 1600, all other sources are at the province level. For example, in addition to constructing a series of county population estimates based on Gu, Liang (1980) also provides population estimates for 12 years after 1600 (beginning from 1661 and ending in 1912) but at the province

Reported in Panel A of Table A3 in the Appendix, the resulting correlation matrices show that all six sources are significantly correlated at the 1% level of significance (Panel B reports the specific years enumerated in the other data sources).

For the entire nation as a whole (and for all periods), average population density was 111 (persons) per square kilometer, which for a country as diverse as China surely masks significant regional variations. For instance, at the one extreme was *Taicang fu* (of today's Suzhou city) in Jiangsu Province, which had 671 people per square kilometer, whereas at the other extreme was *Anxizhou fu* in Gansu province, where the corresponding density was a mere 0.4.

Maize Planting. The ideal way to examine the effect of maize adoption on population growth is to collect data on the precise timing and acreage of maize cultivation. Unfortunately, such data are not available. As a second best measure we employ the *publication year* of the local gazetteer (*difangzhi*) that first mentioned maize in a prefecture to proxy for the year in which maize was first adopted. Indeed, a total of 8,264 gazetteers had been published from the beginning of the Song dynasty (circa 960) to the end of the Qing dynasty (1910), with an average of one gazetteer appearing every 23 years (Jin, 1996). This is a reliable method because local governments in China, regardless of their level—province, prefecture and county—had had a very long tradition of publishing gazetteers, in which detailed affairs of their economies, societies and culture were meticulously compiled; this may explain why local gazetteers are often regarded as local encyclopedia. Since our unit of analysis is the prefecture, the prefectural gazetteers—all 1,119 volumes—are our primary source of information.[17] Given that a gazetteer contains specific information regarding the types of crops cultivated in a prefecture (detailed under the section "local produce" or *wuchan*), we reviewed all 1,119 prefectural gazetteers to

level, which we adopt here for comparison. By the same token, we disaggregate Skinner's (1977) data on what he refers to as "macro-regions" into provinces—with those belonging to the same region sharing the same population density (e.g., Zhejiang, Jiangsu, and Anhui all belong to the Yangtze region). Doing so enables us to compare the population data of various sources at the province level.

[17] The provinces had published 368 volumes; the counties 6,777. Together with the 1,119 published by the prefectures the total amounts to 8,264.

ascertain whether, and if so when, a prefecture adopted maize.[18] Specifically, our rule-of-thumb is to ascertain *which* of these publications first mentioned the planting of this crop.[19] For example, suppose that a prefecture had published its gazetteers in 1700, 1725, 1750 and 1775, and maize was first mentioned in the 1725 publication, we assume that 1725 is the year in which maize was adopted.

However, one may be concerned that, as population growth accelerated (especially during the *Qianlong* reign of 1735-1795) government officials grew increasingly interested in agricultural production, resulting in gazetteers devoting greater coverage to the crops—maize and others—under cultivation. Should that really be the case, the variance across prefectures in when the gazetteers began paying more attention to agriculture may well be associated with subsequent population growth—whether or not maize played a role. To find out if that was the case, we randomly surveyed 10% of the gazetteers published after 1600. Shown in Figure A2 in the Appendix, we do not find a monotonic increase in the number of crops mentioned in the gazetteers, relieving us of this particular concern. But just in case, we control also for the prefecture-specific time trend in the regressions, in addition to clustering the standard errors at the province and province-and-period levels.

Second, concern may also be raised as to whether a prefecture would continue to plant maize and thus be mentioned again in subsequent publications. With the exception of four prefectures, this was indeed the case.[20] To see if this may affect our estimations we thus excluded these prefectures in our regressions and found that the results remain unchanged (and hence not separately reported). Third, to the extent that some prefectures published

[18] Typically, a gazetteer contains the following sections: a general introduction to the prefecture, its geography, population figures and culture, local dignitaries, local produce, major (historic) events, and so forth.

[19] To be sure there are altogether 20 prefectures that had either not published their own gazetteers or failed to keep them. To overcome this issue, we looked for gazetteers at the county level (one prefecture typically consisted of several counties). Where maize planting was reported by more than one county in a prefecture, we employ the report with the *earliest* publication date to proxy for the year of adoption for that particular prefecture. Also, to ensure that our estimations are robust, we re-estimated column 3 (our baseline regression) of Table 3 by dropping these 20 prefectures and obtained similar results (hence not separately reported).

[20] These four prefectures are *Weihui* and *Shanzhou* of Henan Province, *Jining* of Shandong Province, and *Jingdongting* of Yunnan Province.

their gazetteers more frequently than others, the timing of maize adoption would likely be more accurately recorded for those that published their gazetteers more frequently. To make sure that our estimations will not be biased by this possible discrepancy, we also tried assigning greater weights to those prefectures with more publications, but do not find any significant difference in the results from those of the estimation without weighting (hence also not separately reported).

Civil War and Epidemics. Civil wars and epidemics are the conventional "positive checks" in Malthus' theory. We must therefore control for their possible effects on population density for the period covered in our analysis. As the largest civil war with the most severe casualty in Chinese history, the Taiping Rebellion of 1851-1864 provides a good example (Cao, 2000; Ho, 1959; Perkins, 1969).[21] Data on civil war are obtained from "A Military History of China" (*Zhongguo Junshi Shi*). This compendium contains detailed records of warfare (time, place, parties involved) in China for the period A.D. 750-1911. Altogether 896 wars were fought during the period 1600-1910 (refer to Figure A3 in the Appendix).[22]

We employ the same method for computing epidemics. According to Mark Elvin (1973), China experienced "two most widespread and lethal epidemics in her recorded history" (p. 310), both of which occurred in our period of analysis (1586-89 and 1639-44). In 1588, for instance, 92 prefectures or counties in as many as 13 provinces were affected, and 99 localities in 10 provinces were badly affected in 1641. Unlike the data on war, however, those on the epidemics are available at the level of the province only. Table 1 summarizes the descriptive statistics of all the variables of interests.

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[21] Estimates of the casualty range from 50 million (Perkins, 1969) to 73 million (Cao, 2000). The demographic impact of this rebellion is well illustrated by Perkins: "Were it not for the *Taiping* Rebellion, rising population in the late nineteenth and early twentieth centuries might have outstripped the ability of Chinese agriculture to provide adequate food supplies" (p. 29).

[22] Although we have information on the annual incidence of warfare for each prefecture, we are constrained by the limited data we have on our dependent variable. Given this limitation, we can only employ the average frequency of war between the six time points for which we have information on population density, in our regressions. For example, altogether eight wars were fought between 1851 and 1880 in *Caozhou fu*, a prefecture located in the southwest Shandong Province. The average war incidence is thus 0.27 wars per year (8 wars in 30 years).

Table 1 about here

3.2 Descriptive Evidence

Before we proceed with our empirical analysis we first offer some descriptive evidence on the relationship between maize planting and population density in China for the period from 1600 to 1910. Table 2 indicates that at any time from 1776 forward, a comparison between prefectures with and without maize shows a larger population for those with maize. Moreover, not only is the observed difference significant across all six periods under examination, the *magnitude* of the difference—adoption minus non-adoption—increases steadily over time. The question of overriding importance in this context is whether the initially denser regions also developed faster due to reasons unrelated to maize, which we address using the estimation strategy below.

Table 2 about here

4. Estimation Strategy and Empirical Results

4.1 Estimation Strategy

Given that we have information on when a prefecture adopted maize, we can exploit a standard DID design to examine the effect of maize adoption on population density across prefectures based on the following specification:

$$popden_{it} = \alpha M_{it} + \beta X_{it} + fu_i + p_t + \epsilon_{it} \qquad (1)$$

where *i* indexes a prefecture (*fu*), *t* indexes a time interval, and *popden* (in natural log) stands for the population density of prefecture *i* in 1600, 1776, 1820, 1851, 1880 and 1910. The key explanatory variable of interest is M_{it}, a dummy variable that equals to 1 if maize was adopted, and 0 otherwise, in prefecture *i*. The parameter of interest in Equation (1) is thus α, which measures the impact of adopting maize on population density in China during 1600–1910. X_{it} represents a vector of control variables including war and epidemics, which will be examined in the section on robustness checks. As befits a fixed-effect model, fu_i captures the time-invariant regional characteristics for prefecture i that may be associated with the adoption of maize, whereas p_t controls for the temporal effects in our estimation. Finally, in Equation (1) ε_{it} is the disturbance term that absorbs the effects of other random sources of differences in the dependent variable.

4.2 Baseline Results

The empirical results are reported in Table 3. Column 1 reports the baseline estimate, in which the only controls are prefecture and period fixed effects. In this benchmark estimation, maize adoption has the effect of increasing population density by about 17%. To control for the possibility that the prefectures may not be exhibiting a common time trend, we control for the prefecture-specific time trend in columns 2 through 5. Doing so reduces the magnitude to approximately 7–10%, suggesting that part of the effect of maize adoption on population density does come from the prefectures having different time trends.[23] In column 3 we cluster the standard errors at the province level, whereas in column 4 they are further clustered at the province-and-period levels. Considering the relatively small number of clusters (18 provinces), we also re-estimated column 3 using Cameron *et al.*'s (2008) wild cluster bootstrap, and confirmed maize's significant contribution.[24]

To deal with issues arising from spatial correlations, we report Conley (1999) spatial correlation robust standard errors in the square brackets (just below the clustered standard errors) in columns 1 through 4,[25] and results of the Generalized Spatial Two-Stage Least Squares (GS2SLS) procedure developed by Kelejian and Prucha (1998,

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[23] Although we have controlled for period fixed effects in our regressions, concern about systematic bias between the two data sources nonetheless obligates us to employ only Cao's data to re-estimate Tables 3 and 4 for the shorter period of 1776-1900, for which we obtained broadly similar results (hence not separately reported).

[24] The p-values of the bootstrap t-statistics of 500 and 1,000 times are respectively 0.047 and 0.048.

[25] Conley (1999) standard errors adjust for potential spatial interdependence of observations. Typically, spatial independence is assumed to decrease in the distance between two observations and, considering the fact that the prefecture is not a very large spatial unit, there is complete independence for prefectures that are two degrees apart. But we also tried other cutoff values (1, 3, 4 and 5 degrees) and the results stayed the same (Table A4 in the Appendix).

1999, and 2004) in column 5.[26] As can be seen from column 5, the estimated result of GS2SLS is strikingly similar to that of the OLS, reaffirming that our results are robust to how the standard errors are clustered, and to the varying degrees to which we control for spatial correlations.

Table 3 about here

To further allay the concerns that our results may be driven by a particular prefecture or time period, we re-estimate Equation (1) again based on column 3 of Table 3 by dropping a prefecture each time. We did the same for the time period. Reported in Figures A4 and A5 in the Appendix, the results show that our estimations are robust to this exercise.

To gauge the overall contribution of maize to population growth for the 1776-1910 period,[27] we first multiply the pertinent coefficient of 0.099 (column 3, Table 3) by the change in the mean of maize planting during the 1776-1910 period (0.467) to obtain the population growth attributed to growth in maize output (of 0.0462).[28] We then divide this growth rate by the increase in population during the same period ((131.077/105.178)-1= 24.62%). The resulting contribution of maize to population growth is 18.77% (0.0462/0.2462), which is somewhat lower than the potato's contribution to population growth in the Old World.[29]

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[26] As a special form of Generalized Method of Moments (GMM) for models with spatially interdependent variables, this approach uses exogenous factors and their spatial lags as instruments for the endogenous regressor of maize adoption. The estimators of GS2SLS are considered to be consistent and asymptotically normal (Kelejian and Prucha, 2004), and are not subject to the influence of the "omitted common factors" in the spatial interdependence (Das et al. 2003; Kelejian et al., 2013).

[27] Given that maize adoption did not begin in earnest until 1700 and that population explosion in China occurred around the mid-1700s (not to mention that the population data on 1600 are based on a different source), it makes better sense to calculate maize's contribution to population growth for the shorter period of 1776–1910.

[28] In 1776, 51.8% of our prefectures adopted maize. The corresponding magnitude was 98.5% in 1910. 0.467 is thus the rate of change in maize adoption between 1776 and 1910.

[29] As maize accounted for just 5% of the total crop acreage during 1914-1918 (Perkins, 1969), it raises the concern of whether this New World crop was in fact able to support a substantial 18.77% increase in population. Based on the assumptions that the acreage sown with maize had been doubled during 1776-1910

5. Validity and Robustness Checks

In this section we first provide evidence on the validity of a parallel trend assumption, before conducting a number of robustness checks focusing on sample selection, the control of variables pertinent to Malthusian "positive checks", and the effect of maize adoption on grain price.

5.1 The Validity of Parallel Trend Assumption

To ensure that there was not a different pre-trend between the adoption and non-adoption areas we perform a validity check. We code each time period as being some number of periods away from a prefecture's adoption of maize—a specification that essentially estimates several leads and lags. The results are plotted in Figure 5, in which the horizontal axis measures the number of periods away from a prefecture's maize adoption (marked by the 0 vertical line in the middle), whereas the vertical axis measures the change in population density corresponding to each of the periods—as represented by the dots connecting the solid line, and conditional on prefecture and period fixed effects and prefecture-specific time trend. The dotted lines indicate the 95% confidence intervals where standard errors are clustered at the provincial level. Figure 5 suggests that there is not much of a systematic difference in the population trend between the maize adoption and non-adoption areas prior to a prefecture's initial adoption: population density rose initially from periods -3 to -2 but fell from -2 to -1 before it rose again from -1 to 0. However, in none of those scenarios is the change statistically significant. By contrast, the rise in population density from period 0 to 1 is positively significant at the 5% level,

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from 31.4 to 62.8 million Chinese *mu* and with the estimated yield of 130 catties per *mu*, China should be able to produce approximately 4,095 million metric tons of maize. Whether or not this would be sufficient to support an 18.77% growth in the overall population can be gauged from the following back-of-the-envelope calculation. We know that population had increased by over 100 million people between 1776 and 1910 (104.88 million to be exact, Lin, 1996), so 18.77% would be 19.68 million. Given the life expectancy of 33 or 12,045 days back then (Lin, 1996), a male adult required a daily caloric intake of 1,900 calories for work and survival, averaging 22.9 million calories for each person in his lifetime (Liu and Hwang, 1977). For a total of 19.68 million people, the amount of calories required would be 450, 557 billion. Given that 100 grams of maize could yield 106 calories, 4,096 million metric tons of maize would translate into 434,006 billion calories—a shortfall of just 3.67%.

suggesting that maize adoption does have a significantly positive effect on population growth.

Figure 5 about here

To address the concern that the noticeable jump between periods 0 and 1 may be due to chance, we randomly assign maize adoption dates using the same distribution of assignment dates that are in the actual data. We then estimate a "treatment" based on the randomly assigned adoption dates in a large number of trials (e.g., n= 5,000, 10,000 and 30,000). Figure A6, which reports the distribution of the t-values of each of these regressions, shows that the result of these random assignments is insignificant in the overwhelming majority of cases. Moreover, the fraction of the distribution is greater than the absolute value of the respective t-statistics by only 4.64%, 4.24% and 4.55% in the three panels, suggesting that our estimated effect of maize adoption on population density is unlikely spurious.

Another approach to verify that there was not a pre-adoption trend in population growth between the maize adoption and non-adoption areas before 1600 we regress maize adoption on population density in 1600. We find that it has no significant effect on initial adoption, regardless of whether we control for the time trend or period dummies in their interaction with population density in 1600 (results reported in Table A5 in the Appendix). Alternatively, we also control for initial population and interact it separately with the time trend and period dummies to see if maize adoption continues to explain population growth. Reported in Table A6 in the Appendix, we find that the main effect of maize adoption remains significant, whereas the negative coefficient of the time trend suggests that areas with initially higher growth rate tend to slow down thereafter. Together, these results provide consistent suggestive evidence supporting the claim that the initially denser areas developed faster precisely because of the adoption of maize.

5.2 Local Technological Progress and Other New World Crops

Dwight Perkins (1969) has noted that up to 45% of the increase in grain output in China between the 14th and the early 20th centuries came from adopting an early-ripening seed variety (see also Elvin, 1973; Goldstone, 2003; Huang, 1990; and Li, 1998).[30] To ensure that our estimate of the effect of maize on population density does not pick up the effect of this innovation, an ideal control is the change in cropping index over time and across space. Unfortunately, such data are available only after John L. Buck conducted his monumental survey of farms across China in the 1930s (Buck, 1937). But the fact that technological advancement in Chinese agriculture came primarily from the adoption of early-ripening rice makes it feasible for us to conduct a falsification test using a restricted sample. That is, although the early-ripening variety shortens the crop cycle by as much as one-third (from 120 to 80 days), its adoption is constrained by geography; namely it can be adopted only in areas with sufficient daylight. This implies that, when planted in North China, the early-ripening variety will take as long a time to harvest as its middle- or late-ripening counterparts. An increase in latitude to the north by one degree is roughly equivalent to an increase in distance of 112 kilometers in the same direction; this has the effect of shortening the amount of daylight and results in a lengthening of the crop cycle by two additional days. Simply stated, in areas north of 33 degrees north latitude the adoption of early-ripening rice is technically infeasible (Zhang, 1996).[31] Thus, by restricting our sample to those prefectures located in the north of 33 degrees north latitude we can safely exclude the possible effect of early-ripening rice on population density. We repeat the same regression exercise on this subsample and report the result in column 1 of Table 4. The estimate of 15.7% is substantially larger than the baseline result of 9.9% (column 3, Table 3), suggesting that heterogeneous effects likely exist between north and south China; with early-ripening rice being less available in the north the effect of maize on population expansion was likely greater there than in the south.[32]

5.3 War and Epidemics

As anticipated by Malthus, factors such as war and epidemics, which affect population outcomes by increasing mortality, have a significant and negative effect on

[30] As mentioned earlier, up to 55% of the output increase (of roughly 55 million tons of grain) over this lengthy period of time came from the expansion in cropping acreage (Perkins, 1969).

[31] The crop cycle of early-ripening rice is approximately less than 80 days. Add another 20 days for the normal cycle and another 40 days for the late-ripening variety.

[32] The baseline result, which represents the average treatment effect, should lie somewhere in between the two.

population density (Ho, 1959; Liu and Hwang, 1977; Perkins, 1969). In our estimation, an additional war incidence reduces population density by roughly 2.3% (column 2, Table 4), whereas an additional epidemic incidence reduces population density by 4.0% (column 3, Table 4). In other words, war and epidemics are likely omitted variables whose exclusion would likely generate an upward bias in the coefficient of maize. If that is the case their inclusion in the population regression should reduce the coefficient on maize, which is exactly what we find (compare, for example, column (2) of Table 4 with column (4) of Table 3).[33] However, it is also possible that war and epidemics are themselves endogenous outcomes of maize adoption, as maize cultivation can reduce population pressure in the short run and thus reduce the incidence of war and epidemics. To clarify this we adopt a strategy similar to the one employed in Figure 5.[34] Reported in Figure 6, the result shows that war incidence does not vary much before and after maize adoption, and thus provides suggestive evidence that war and epidemics are more likely confounding factors than the endogenous outcomes of maize adoption.[35]

Table 4 and Figure 6 about here

5.4 Grain Price

An important assumption underlying our empirical strategy is that the introduction of maize effectively increased the supply of grain over time. If that conjecture is correct, we should expect maize adoption to have the effect of lowering grain prices. To do so we need data on long-term grain prices. Under the Qing regime local governments were required to keep systematic records on grain prices on a monthly basis. The pertinent data are available for the period 1738-1910 for the 267 prefectures that we have henceforth employed in our analysis. To allow comparability among various grain crops grown in different regions, we convert grain output into standardized kilocalories,[36] after which we

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[33] As omitted variables, war and epidemics may conceivably reduce maize adoption via one of the following channels: (a) it would be difficult to experiment with new crops during wartime and when disease is spreading, and (b) war and epidemics may reduce population pressure and thus the need to adopt maize.

[34] We are unable to do the same with epidemics as that variable is available only at the province level.

[35] We thank an anonymous referee for alerting us to this concern.

[36] Conversion is based upon sources compiled by the Institute of Nutrition and Food Safety, Chinese Center for Disease Control and Prevention (2002).

adjust prices according to the exchange rate of U.S. dollar to silver in 1900 based on the price deflators compiled by K. Peng (2006).

The resulting long-term price trend is plotted in Figure 7, which shows a secular rise over time—a trend consistent with what historians of China have found (e.g., Peng, 1993; K. Peng, 2006; Quan, 1972). For example, whereas 10,000 kilocalories of grain only cost 0.0131 USD in 1770 (in 1900 purchase power), they cost more than doubled to 0.0264 USD in 1900.[37]

Figure 7 about here

In Figure 8 we replicate our analysis with population density (Figure 5) and war (Figure 6), this time with grain price. The point estimates show that there was no simple, monotonic movement in grain price in either direction before maize adoption, but prices began to exhibit a secular downward trend after adoption, albeit not statistically significant at the conventional levels. Nevertheless this secular downward trend suggests the need for a more rigorous analysis.

Figure 8 about here

Our econometric specification for ascertaining the relationship between maize adoption and changes in grain price is essentially the same as that of Equation (1)—a standard DID design, except now population density is replaced with grain price:

$$GP_{it} = \alpha M_{it} + \beta X_{it} + fu_i + year_t + \epsilon_{it} \quad (2)$$

[37] Quan (1972), for instance, refers to the secular rise in the price of rice during 17th century-China as the "price revolution". Curiously, this was a period when grain prices in the rest of the world went south (Latham and Neal, 1983). The reason why grain prices in China went up can be attributed to its exceedingly low level of grain imports. For instance, if we take Perkins' (1969) estimate of China's annual grain production of approximately 110 million metric tons during the mid-to-late 19th century as benchmark, its import of no more than 55,000 tons per annum amounted to at most a mere 0.1% of its total output (Hsiao, 1974; Zhou, 1937). In other words, China failed to take advantage of the falling secular trend of world grain prices to compensate for its own deficits.

Where GP_{it} is the grain price in prefecture *i* in year *t*, M_{it} is the key variable indicating the year when maize was adopted in prefecture i, fu_i is prefecture fixed effect and $year_t$ is year fixed effect. In addition to controlling for prefecture and year fixed effects, we control also for the prefecture-specific time trend. Thus, as with Equation (1), the parameter of interest in Equation (2) is still α, which measures the impact of adopting maize on the changes in grain price within the same region from one period to another during 1600-1910. The results are reported in Table 5, in which we first examine the effect of maize on grain prices one period after the adoption. The negative coefficient of the maize adoption dummy shows that the adoption of maize did have the anticipated effect of lowering grain price. Specifically, grain price was 3.7% lower after maize was adopted. However, reverse causality may be a concern, in that grain price may affect maize cultivation via its effect on migration; that is, some may be forced by high grain prices to migrate to areas where it was feasible to grow maize. Unfortunately we do not have detailed data on internal migration for the period covered by our analysis. However, what we do know is that large-scale, cross-province migration had all but stopped after 1776 (e.g., Cao, 2000). Much of the migration that occurred since took place more or less within the same province.[38] We therefore add an interaction term between the two dummy variables of province and period based on the specification in column 1 and the result remains unchanged (hence not separately reported).

A remaining concern is that the relationship between maize adoption and grain price may be spurious. The reason is that in the Malthusian world, a population increase at any given point is bound to be "corrected" subsequently in the absence of technological change; this further implies that grain prices would increase with a population increase, but decrease subsequently in accordance with a reduction in the population.[39] To check if

[38] For the period that concerns us there were two major waves of migration across provinces. The first occurred in the early Ming (the so-called "*hongwu* migration wave", ended in 1393), and the second in the early Qing (which ended in 1776). The magnitude of the former amounted to approximately 11 million or 15.7% of the entire population of 70 million, whereas the latter, while involving more people in absolute terms (15.67 million), constituted a much smaller percentage—5.7% of 275 million people (see Cao, 2000).

[39] We can check if that is indeed the case by bounding the effects of the underlying causes of growing populations net of the causal effects of maize adoption. By plotting the pre-adoption population growth trends along the vertical axis in Figure A7 prior to maize adoption (set at the 0 vertical line), it is indeed the case that, after subtracting the projected population changes from the estimated effects of maize on

that was the case, we thus estimate also the effect of maize adoption on grain price one period *before* the adoption. We find that in sharp contrast to the result in column 1, the coefficient of that point estimate is insignificant (column 2), suggesting that maize does have an independently significant effect of lowering grain prices after adoption.

Table 5 about here

6. Population Growth without Economic Development

Nunn and Qian (2011) find that in the Old World the potato contributed not only to population growth but also to economic growth (measured by urbanization rates). To see whether or not the adoption of maize in China led to the same outcome we regress the change in economic development, measured by urbanization rates in one instance and per capita real wages in another, on maize adoption.[40] The data on China's urbanization are obtained from two sources. The first is Cao (2000), who meticulously estimates urbanization rates at the province level for the years 1776 and 1893 using various scattered population sources from a variety of local gazetteers—including province-, prefecture- and county-level gazetteers. The other source is the monumental survey of Christianity in China conducted by Milton Stauffer (1922) between 1918 and 1921, which contains detailed population statistics on cities with more than 25,000 inhabitants for the year 1920.

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population growth (to the right of the 0 vertical line), prefectures having experienced higher population growth prior to maize adoption did subsequently experience a slowdown—a finding confirming the Malthusian predictions.

[40] As suggested by Paul Bairoch (1988) and Jan de Vries (1976) and popularly adopted by Acemoglu et al., (2002, 2005) and Nunn and Qian (2011), urbanization rate is employed to proxy for economic prosperity prior to the Industrial Revolution, before reliable GDP figures became available. While doubts might be cast over the appropriateness of using urbanization rate in the Chinese context, if urbanization in Europe meant increases in manufacturing, whereas non-agricultural goods were produced outside of cities in China—a form of proto-industrialization (Greif and Tabellini, 2010), evidence suggests that China’s urbanization rates were indeed closely related not only to the level of commercialization but also to exports (Skinner, 1977; Xu and Wu, 2014), and to regional specialization in the production of silk, porcelain and other exports in late imperial China (Fu, 1989; Li, 2000; Liu, 1996; Skinner, 1977; Xu and Gao, 2009). The appropriateness of comparing the urbanization rates between China and Europe is perhaps validated by a recent exercise that endeavors to directly compare the GDP and productivity across various economic sectors between an economically developed Chinese county in the Yangtze delta and the Netherlands in 1820 (Li and Van Zanden, 2012).

Together, these two data sources allow us to compute the share of urban population in the overall population as a measure of urbanization at the provincial level. Cao's estimates suggest that overall urbanization rate or the share of urban population in China's overall population had in fact *dropped* slightly from 7.4% in 1776 to 7.1% in 1893, whereas Stauffer's (1922) survey shows that overall urbanization rate by the 1920s was a mere 4.3%.[41] For the regressions, we employ all three time points, namely 1776, 1893 (Cao, 2000) and 1910 (Stauffer, 1922).[42] In Figure 9 we plot urbanization rates measured at the provincial level for the periods before and after maize adoption, and find that urbanization rates did not change significantly after adoption of this crop.

Figure 9 about here

We have previously compiled data on real wages of long-term agricultural laborers (*changgong*) from the 178 court cases involving loan disputes in the Qing dynasty, with detailed wage records spanning the period 1735–1842 (Chen, 2011).[43] Collected by the Department of Justice (*Xingke Tiben*), these wage records provide the most detailed information on wages across China (Wu, 1983; Wu, 1992). To ensure comparability over time, we adjusted the value of the wages based on K. Peng’s (2006) estimates of purchasing power of rice. The result is that per capita real wages for the period 1740 through 1840 averaged about 5000 *wen*,[44] which, when translated into purchasing power amounted to approximately 200 kilograms of rice—an amount that barely enabled a peasant family to subsist. Using the Fan nonparametric local regression method and the Epanechnikov kernel, the trend line in Figure 10 shows that there was no distinct rise in

[41] Granted, these overall percentages must be masking huge inter-regional differences. Two of the most advanced provinces in China, Jiangsu and Zhejiang in the southeast, for instance, were far more urbanized than the rest—14.3% in the case of Jiangsu and 13.7% in the case of Zhejiang (Cao, 2000; see also Li, 2000).

[42] The population variable is for the year 1910 but the urbanization variable, based on Stauffer's (1922) figure, is from 1920.

[43] Unlike casual or day laborers, long-term agricultural laborers were hired to work for landlords on a year-round basis. Receiving a fixed wage, their duties entailed a wide variety of farm tasks as demanded by seasonal needs. See Huang (1985) for a more detailed description of this type of farm labor.

[44] *Wen* is the currency unit of the Qing Dynasty.

real wages throughout the entire period under analysis.[45] In Figure 11 we also plot the changes in real wage before and after maize adoption, and find that real wage did not change significantly after maize adoption.[46]

Figures 10 and 11 about here

We report the pertinent regression results in Panel A of Table 6, where we can see that maize has no significant effect on either urban population (represented as percentage share) or per capita real wage. The result is robust to the inclusion of a number of interaction terms between maize adoption and various geographic factors such as provincial capital, the Grand Canal (the major transportation route linking North and South China), and the Yangtze River (the most navigable river in China running from east to west).[47] To further confirm that the effect of maize on income was minor, we examine the coefficients of maize adoption on the two dependent variables at the 95% confidence intervals. These coefficients are 0.14 and 0.16 for urbanization and 0.11 and 0.13 for real wage. Evaluating these numbers at the mean urbanization rate of 7.1% (Cao, 2000), the maximum increase in urbanization (0.16) due to maize is a mere 1.1%. To further ensure that we have not overlooked the possible long-run effects of maize we also lag maize adoption by one period and report the results in Panel B of Table 6. The point estimates of lagged maize adoption on urbanization and real wage are quantitatively small, suggesting that, even though maize adoption may have boosted income (and thus population) in the short run, in the long run the extra income would be consumed by population growth,

[45] Against the lack of an upward trend in real wages, the secular rise in grain prices suggest that there was likely a shift in income distribution towards farm households with net surplus of food to sell—notably the landlords. The widening income gap between landlords and landless laborers during 18^{th}- and 19^{th}-century China was indeed a concern for many historians of China (e.g., Fang, 1994, 2004; Li, 1991; and Yao et al., 2007, among others). For Huang (1985), the growing disparity in land wealth was a critical precondition precipitating the Communist revolution.

[46] Table A7 in the Appendix presents the data from Figures 6, 8, 9, and 11, as well as the pre/post adoption coefficients.

[47] The significance of the interaction term between adoption and Grand Canal suggests that the impact of adoption on real wage is significantly larger in prefectures located near the canal than those outside of it. However, the main effect of adoption remains insignificant in that specification. To find out if adoption may be significant in the more advanced economies of Jiangsu, Zhejiang and Anhui we restrict our sample to these three provinces but the result remains unchanged (hence results not separately reported).

reverting the economy to the Malthusian steady states.[48] In short, evidence suggests that population very likely responded to maize adoption much more quickly than did either urbanization or real wages.

Table 6 about here

One last concern in this context pertains to measurement error. It is not impossible that maize adoption's apparent lack of contribution to economic growth is due primarily to the coarseness of the measures of economic growth vis-a-vis those of population density. To ensure that this is not the case, we perform a placebo test by re-examining the effects of maize adoption on population density based on a data set constructed using only those years for which the data on both urbanization and real wages, on the one hand, *and* population density on the other, are available.[49] Reported in Table A8 in the Appendix, the effect of maize adoption on population density having *adjusted* for both urbanization and real wages remains significant (respectively at the 1% and 5% level), suggesting that maize adoption's lack of significance for economic growth is not due to data inadequacy.

7. Conclusion

Against the sharply divided views over whether China was Malthusian in late imperial times, we set out to test this question empirically by analyzing a unique historical data set that we constructed ourselves on the adoption of maize—a New World crop. We find analytical evidence that an increase in agricultural productivity was not sufficient to drive up per capita income—at least not in China. While maize had contributed to an increase of nearly 19% in the Chinese population during the period of the crop's diffusion (circa

[48] As Voigtländer and Voth (2006) show, under a Malthusian regime productivity growth will be transformed much more quickly into population growth, thereby keeping per capita income low. Additional and broader supportive evidence are provided by Ashraf and Galor (2011). They find that in a large sample of countries, the effect of technology on population in the year 1-1500 is an order of magnitude higher (approximately 10 times larger) than its effect on income per capita.

[49] For population data we have chosen the data points of 1776, 1850 and 1893, which are either exactly identical or very close to those on urbanization (1776 and 1880) and real wage (which ends in 1842).

1776-1900), it failed to free the Chinese economy from the stranglehold of Malthusian forces.

Our estimations of maize's contribution to population but not economic growth are robust to the inclusion of a number of variables pertaining to alternative channels of productivity increase and to wars and epidemics, as well as to different measures of economic growth and to data modifications. Precisely because it provides a counter-example to the story of sustained (modern) economic growth, our study thus provides rich empirical evidence for understanding the importance of long-run economic growth in the tradition of the unified growth theory, and, by doing so underscores the sharp contrast between Europe and China in their diverging growth trajectories.

References

A Farewell to Alms: A Brief Economic History of the World (Clark, Gregory). *Princeton University Press*, Princeton, 2007.

A Generalized Moments Estimator for the Autoregressive Parameter in a Spatial Model (Kelejian H H and Prucha I R). *International Economic Review* Volume 40, Issue 2, 509–533, 1999.

A Generalized Spatial Two-Stage Least Squares Procedure for Estimating A Spatial Autoregressive Model with Autoregressive Disturbances (Kelejian H H and Prucha I R) . *Journal of Real Estate Finance and Economics* Volume 17, Issue 1, 99–121, 1998.

Agricultural Development in China 1368–1968 (Perkins, H. Dwight). *Edinburgh University Press*, Edinburgh, 1969.

Albion's Seed: Four British Folkways in America (Fischer D. Hackett). *OUP USA*, New York, 1989.

Almanac of Plants (Zhiwu Mingshi Tukao) (Wu Qijun). *The Commercial Press*, Beijing, 1847.

American foods and Europe's population growth 1750–1850 (Langer, W). *Journal of Social History* Volume 8, Issue 2, 51–66, 1975.

American Treasure and the Price Revolution in 18th Century China (Meizhou Baiyin yu Shibashiji Zhongguo Wujiageming de Guanxi) (Quan Han-sheng). In Discussion of Chinese Economic History, Volume 2 (Zhongguo Jingjishi Luncong), *Xinya Yanjiusuo*, Hong Kong, 1972.

A Monetary History of China (Zhongguo Huobi Shi) (Peng Xinwei). Translated by Edward H. Kaplan. *Western Washington University*, Bellingham, 1993.

A New Inquiry into the Geography of the Diffusion of Maize and Sweet Potato in China (*Yumi he Fanshu Chuanru Zhongguo Luxian Xintan*) (Cao, Shuji). *Research on Chinese Social and Economic History* (*Zhongguo Shehui Jingjishi Yanjiu*) Issue 4, 62–74, 1988.

A New Inquiry into the Role of the Overseas Chinese in Introducing Sweet Potato into China (*Huaqiao Yinjin Fanshu Xinkao*) (Li, Tianxi). *Journal of Chinese Agricultural History (Zhongguo Nongshi).* Issue 1, 107–11, 1998.

Assessing the Development of the Landlord Economy in Ming and Qing Dynasties from the Perspective of Changing Land Rights (*Cong Diquanxingshi de Bianhua kan Mingqingshidai Dizhujingji de Fazhan*) (Li Wen-zhi). *Journal of Chinese Social and Economic History* (*Zhongguo Shehuijingjishi Yanjiu*) Issue 1, 12–22, 1991.

Autarky and the Rise and Fall of Piracy in Ming China (Kung, James Kai-sing and Chicheng Ma). *Journal of Economic History* Volume 74, Issue 2, 509–34, 2014.

Before and Beyond Divergence: The Politics of Economic Change in China and Europe (Rosenthal, Jean-Laurent and Wong, Roy Bin). *Harvard University Press*, Cambridge, 2011

Before the Great Divergence? Comparing the Yangzi Delta and the Netherlands at the Beginning of the Nineteenth Century (Li, Bozhong and Jan Luiten Van Zanden). *Journal of Economic History* Volume 72, Issue 4, 956–989, 2002.

Bootstrap-Based Improvements for Inference with Clustered Errors (Cameron A.C., J. Gelbach, and D.I. Miller). *Review of Economics and Statistics* Volume 90, Issue 3, 414–27, 2008.

Can Cultural Norms Reduce Conflicts? Confucianism and Peasant Rebellions in Qing China (Kung, James Kai-sing and Chicheng Ma). *Journal of Development Economics* Issue 111, 132–49, 2014.

Change in Chinese Historical Climate (Zhongguo Lishi Qihou) (Zhang, Pixian). *Shandong Science and Technology Press*, Jinan, 1996.

China's Foreign Trade Statistics, 1864–1949 (Hsiao Liang-lin). *Harvard University Press*, Cambridge, 1974.
Chinese Local Histories: A Comprehensive Annotated Catalog (Zhongguo Difangzhi Zongmu Tiyao) (Jin, Enhui). *Hanmei Tushu Ltd*, Taipei, 1996.
Cities and Economic Development: From the Dawn of History to the Present. (Bairoch, Paul). *University of Chicago Press,* Chicago, IL, 1988.
Commercialization as Exogenous Shocks: The Effect of the Soybean Trade and Migration in Manchurian Villages, 1895–1934 (Kung, James Kai-sing and Nan Li). *Explorations in Economic History* Volume 48, Issue 4, 568–89, 2011.
Comparative Historical Analysis and Knowledge Accumulation in the Study of Revolutions (Goldstone, A. Jack). Dietrich Reuschemeyer and James Mahoney, eds. Comparative Historical Analysis, *Cambridge University Press*, Cambridge, 2003.
Complete Treatise on Agricultural Administration (Nongzheng Quanshu) (Xu, Guangqi). *Shanghai Guji Chubanshe*, Shanghai, 1639.
Cultural and Institutional Bifurcation: China and Europe Compared (Greif A and Tabellini G). *American Economic Review* Volume 100, Issue 2, 135–140, 2010.
Discussions on the Wages of Rural Long-term Laborers in the Qing Dynasty (Qingdai Nongcun Changgong Gongjia Zonghengtan) (Wu, Miantang). *Research on Chinese Economic History (Zhongguo Jingjishi Yanjiu)* Issue 3, 71–78, 1992.
Divergence, Big Times (Pritchett, Lant). *Journal of Economic Perspectives* Volume 11, Issue 3, 3–17, 1997.
Dynamics and Stagnation in the Malthusian Epoch (Ashraf, Quamrul, and Oded Galor). *American Economic Review* Volume 101, Issue 5, 2003-41, 2011.
Early Industrialization in the Yangzi Delta, 1550–1850 (Jiangnan de Zaoqi Gongyehua, 1550-1850) (Li, Bozhong). *Social Sciences Academic Press*, Beijing, 2000.
Economic and Social Transition in Ming and Qing (Mingqing Shehui Jingji Bianqian) (Fu, Yilin). *Zhonghua Shuju,* Beijing, 1989.
Emergent Horticultural Economies of the Eastern Woodlands (Keegan W). *Southern Illinois University at Carbondale, Center for Archaeological Investigations*, Occasional Paper No. 7, 1987.
Essentials of Historical Geography (Dushi Fangyu Jiyao) (Gu, Zuyu). *Shanghai Shudian Chubanshe*, Shanghai, 1962.
Estimation of Simultaneous Systems of Spatially Interrelated Cross Sectional Equations (Kelejian H H and Prucha I R.). *Journal of Econometrics* Volume 118, Issue 1, 27–50, 2004.
Exploitation of the Works of Nature (Tiangong Kaifu) (Song Yingxing). *Yuelu Shushe*, Changsha, 1637.
Finite Sample Properties of Estimators of Spatial Autoregressive Models with Autoregressive Disturbances (Das, D., Kelejian, H., Prucha, I). *Papers in Regional Science* Volume 82, Issue 1, 1–26, 2003.
Food Supply and Population Growth in Southwest China, 1250–1850 (Lee, James). *Journal of Asian Studies* Volume 41, Issue 4, 711–746, 1982.
From Stagnation to Growth: Unified Growth theory (Galor, Oded). In Aghion, P. and Durlauf, S. N. (eds.), *Handbook of Economics Growth*. *Elsevier Science*, North-Holland, Amsterdam, Volume 1A, 2005.
Gaez (FAO's Global AgroEcological Zones). http://fao.org/Ag/AGL/agll/gaez/index.htm, 2002.
GMM Estimation with Cross Sectional Dependence (Conley T G). *Journal of Econometrics* Volume 92, Issue 1, 1–45, 1999.

Grain Price since Qing Dynasty: An Interpretation and Re-interpretation from Historical Perspective (Qingdai Yilai de Liangjia: Lishixue de Jieshiyu Zaijieshi) (Peng, Kaixiang). *Shanghai Renmin Chunbanshe*, Shanghai, 2006.
Historical Geography of China (Zhongguo Lishi Dilixue) (Lan, Yong). *Higher Education Press*, Beijing, 2002.
Historical Statistics on Hukou, Land and Land Tax of China (Lidai Hukou, Tudi, Tianfu Tongji) (Liang, Fangzhong). *Zhonghua Shuju*, Beijing, 1980.
History of Maize Science and Technology of China (Zhongguo Yumi Kejishi) (Tong, Bingya). *China Agricultural Technology Press*, Beijing, 2000.
History of Population in China. Volume 5 (Cao, Shuji). *Fudan University Press*, Shanghai, 2000.
How the West 'Invent' Fertility Restriction (Voigtländer Nico and Voth Hans-Joachim). *American Economic Review* Volume 103, Issue 6, 2227-2264, 2013b.
Institute of Economics, Chinese Academy of Social Sciences. Grain Prices Data during Daoguang to Xuantong of the Qing Dynasty. *Guangxi Normal University Press*, Guilin, 2010.
Institute of Nutrition and Food Safety (INFS), Chinese Center for Disease Control and Prevention. China Food Composition, *Peking University Medical Press*, Beijing, 2002.
Irish History with the Potato (Mokyr, Joel). *Irish Economic and Social History* Issue 8, 8–29, 1981.
Land Taxation in Imperial China, 1750–1911 (Wang Yeh-chien). *Harvard University Press*, Cambridge, 1973.
Land Utilization in China (Buck L. John). *University of Chicago Press,* Chicago, 1937.
Maize in Tropical Africa (Miracle, M). *University of Wisconsin Press*, Madison, Wisconsin, 1966.
Chronology of Warfare in Dynastic China (Zhongguo Lidai Zhanzheng Nianbiao) Military History of China (Writing Group). *China PRC Press*, Beijing, 2003.
New Developments in Irish Population History, 1700-1850 (Mokyr, Joel and Ó Gráda, Cormac). *Economic History Review* Volume 37, Issue 4, 473–88, 1984.
Nutritional Implications of Staple Food Crop Successions in Usambara, Tanzania (Fleuret, P. and Fleuret A). *Human Ecology* Issue 8, 311–27, 1980.
Peasant Rebellions as 'Positive Check': Empirical Evidence from Qing China (Chen, Shuo). *HKUST Working Paper,* 2011.
Population Change and Economic Development in Mainland China since 1400 (Liu, P. K. and Hwang, Kuo-shu). Modern Chinese Economic History: Proceedings of the Conference on Modern Chinese Economic History, in Hou, Chi-ming and Yu, Tzong-shian (eds.), *Academia Sinica*, Taipei Taiwan, 1977.
Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and Beyond (Galor, Oded, and Weil, N. David). *American Economic Review* Volume 90, Issue 4, 806–28, 2000.
Qinghua: the Important Commercial Town of North Henan Province in the Ming and Qing Dynasties: a Study Focused on the Inscriptions (Mingqing Shiqi Yubei de Shangyezhongzhen Qinghua: yi Beikeziliao Weizhongxin de Kaocha) (Xu, Tan and Wu, Zhiyuan). *Journal of Historical Science* (*Shixue Yuekan*) Issue. 6, 105–19, 2014.
Real Wages of Rural Hired Laborers in Early Qing Dynasty (Qing Qianqi Nongye Gugong de Gongjia) (Wu, Liangkai). *Research on Chinese Social Economic History* (*Zhonggong Shehui Jingjishi Yanjiu*) Issue 2, 17–30, 1983.
Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution (Acemoglu, Daron, Johnson, Simon and Robinson A. James). *Quarterly Journal of Economics* Volume 117, Issue 4, 1231–94, 2002.

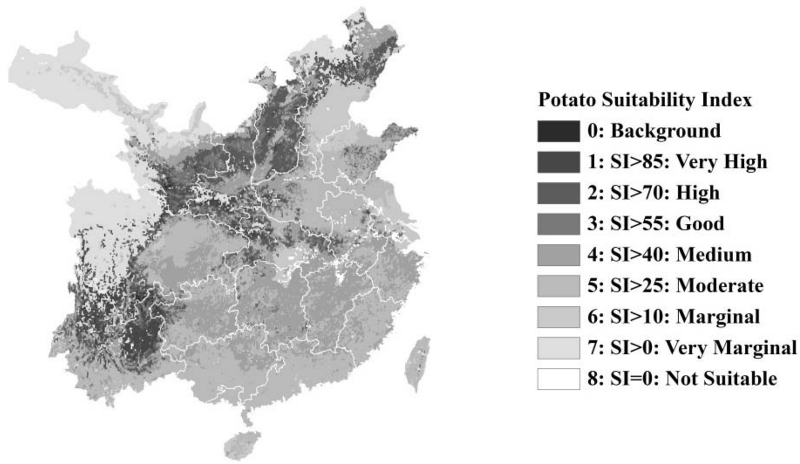
Rice (*Mi*) (Zhou Xi-zhou). *Institute of Economic Research,* Bank of China, 1937.
Seeds of Change: Five Plants Which Changed the World (Hobhouse, W). *Harper & Row*, New York, 1986.
Several Questions Regarding the Diffusion of Maize and Sweet Potato in China (Yumi, Fanshu zai Zhongguo Chuanbozhong de Yixie Wenti) (Guo, Songyi). Discussion Forum on Qing History (Qingshi Luncong), *Zhonghua Shuju*, Beijing, 1986.
Spatial spillovers in the development of institutions (Kelejian Harry H., Peter Murrell, Oleksandr Shepotylo). *Journal of Development Economics* Issue 101, 297–315, 2013.
Studies on the Population of China, 1368–1953 (Ho, Ping-ti). *Harvard University Press*, Cambridge, 1959.
Studies on the Spreading and Growing Influence of Crops Originated in America during the Ming- Qing Dynasties: Focusing on Maize, Sweet Potato and Tobacco (Song, Junling). *Henan University*, PhD Thesis, 2007.
Study on the Statistical Materials on the Historical Population of China (Zhongguo Lishi Renkou Tongji Ziliao Yanjiu) (Yang, Zihui). *China Reform Publishing House*, Beijing, 2002.
Swallows and Settlers: The Great Migration from North China to Manchuria (Gottschang, Thomas and Lary, Diana). *The University of Michigan*, Michigan, 2000.
The Average and Expected Life Expectancies of the Chinese throughout the Dynasties (Zhongguo Lidai ren de Pingjunshouming he Yuqishouming) (Lin Wan-xiao). *Life and Disaster (Shengming yu Zaihai)* Issue 5, 27–27, 1996.
The Cambridge World History of Food (Kiple Kenneth and Ornelas C. Kriemhild). *Cambridge University Press*, Cambridge, 1999.
The Christian Occupation of China: A General Survey of the Numerical Strength and Geographical Distribution of the Christian Forces in China (Stauffer, Milton T). *China Continuation Committee*, Shanghai, 1922.
The City in Late Imperial China (Skinner, G. William). *Stanford University Press*, Stanford, 1977.
The Collection of Natural Disasters and Unusual Years in Historical China (Zhongguo Gudai Zhongda Ziranzaihai he Yichang Nianbiao Zongji) (Song, Zhenghai). *Jiaoyu Chubanshe*, Guangzhou Guangdong, 1992
The Columbian Exchange: A History of Disease, Food, and Ideas (Nunn, Nathan and Qian, Nancy). *Journal of Economic Perspectives* Volume 24, Issue 2, 163–88, 2010.
The Corn Economy of Indonesia (Timmer, C. P., ed). (1987). *Cornell University Press*, New York Ithaca, 1987.
The Daily Life of Small Landlords in Recent 'Jiangnan' (Jindai Jiangnan Xiaodizhu de Richangshenghuo) (Yao Bang-yi, Cheng Zai and Yao Pu). *Historical Review* (*Shilin*) Issue. 1, 99–111, 2007.
The Early Modern Great Divergence: Wages, Prices and Economic Development in Europe and Asia, 1500–18001 (Broadberry S and Gupta B). *Economic History Review* Volume 9, Issue 1, 2–31, 2006.
The Economy of Europe in an Age of Crisis 1600-1750 (de Vries, Jan). *Cambridge University Press*, Cambridge, 1976.
The Effects of the American Cereal Crops on Agricultural Production and Social Economy of China (*MeizhouZuowu de Chuanru dui WoguoNongyeShengchan he ShehuiJingji de Yingxiang*) (Cao, Ling). *Ancient and Modern Agriculture (Gujin Nongye)* Issue 3, 78–88, 2005b.
The European Miracle: Environments, Economies, and Geopolitics in the History of Europe and Asia (Jones, Eric. L). *Cambridge University Press*, Cambridge,1981.

The Great Divergence: China, Europe, and the Making of the Modern World Economy (Pomeranz, K). *Princeton University Press*, Princeton, 2000.
The History of Chinese Population (Zhongguo Renkoushi) (Zhao, Wenlin and Xie, Shujun). *People's Press*, Beijing, 1988.
The Impact of Potatoes on Old World Population and Urbanization (Nunn, Nathan and Qian, Nancy). *Quarterly Journal of Economics* Volume 126, Issue 2, 593–650, 2011.
The Industrial Revolution: Past and Future (Lucas, R.E). *Harvard University Press*, Cambridge, 2002.
The Influence of American Cereal Crops on the Diet and Lifestyle of the Chinese People (*Meizhouzuowu de Chuanru dui Woguo Renmin Yinshi Shenghuo de Yingxiang*) (Cao, Ling). *Agricultural Archaeology* (*NongyeKaogu*) Issue 3, 176–81, 2005a.
The International Market in Rice and Wheat, 1868-1914 (Latham A. J and Neal Larry). *Economic History Review* Volume 36, Issue 2, 260–80, 1973.
The Labor Market in 'Jiangnan' in Early Qing (Qingdai Qianqi Jiangnan de Laodongli Shichang) (Fang Xing). *Research in Chinese Economic History* (*Zhongguo Jingjishi Yanjiu*), Issue 2, 3–12, 2004.
The Motivations for Planting Maize in the Mountainous Regions during Mid-late Qing Dynasty (Qingdai Zhongwanqi Shandi Guangzhong Yumi zhi Dongji) (Zhang, Xiangwen and Hui, Fuping). *Journal of Historical Science (Shixue Yuekan)* Issue 10, 34–39, 2007.
The Origin and Development of Agriculture in China: Primary Exploration of Agricultural History. Volume 2 (Zhongguo Nongye Qiyuan yu Fazhan: Zhongguo Nongyeshi Chutan) (Wang, Qizhu). *National Translate and Edit Bureau Press*, Taipei, 1994.
The Pattern of the Chinese Past (Elvin, Mark). *Stanford University Press*, Chicago, 1973.
The Peasant Economy and Social Change in North China (Huang, P). *Stanford University Press*, Stanford, 1985.
The Peasant Family and Rural Development in the Yangzi Delta, 1350-1988 (Huang, P). *Stanford University Press*, Stanford, 1990.
The Potato in Ireland (Connell, K.H). *Past and Present* Issue 23, 57–71, 1962.
The Question of Usurious Lending in Early Qing (Qingdai Qianqi Nongcun Gaolidai Ziben Wenti) (Fang Xing). *The Qing History Journal* (*Qingshi Yanjiu*) Issue. 3: 11–26, 1994.
The Rise of Europe: Atlantic Trade, Institutional Change and Growth (Acemoglu, Daron, Simon Johnson, and James Robinson) *American Economic Revie*w Volume 95, Issue 3, 546–79, 2005.
The Spread of Maize and Related Issues in Sichuan Province during the Qing Dynasty (Yumi zai Qingdai Sichuan de Chuanbo Jiqi Xiangguan Wenti) (Zhou, Bangjun). *Ancient and Modern Agriculture* (*Gujin Nongye*) Issue. 4, 65–75, 2007.
The Three Horsemen of Riches: Plague, War, and Urbanization in Early Modern Europe (Voigtländer Nico and Voth Hans-Joachim). *The Review of Economic Studies* Volume 80, Issue 2, 774-811, 2013a.
The Trade in Longjiang, Xixinguan and Nanjing in Early Period of Qing (Qingdai Qianqi de Longjiang, Xixinguan yu Nanjing de Shangye) (Xu, Tan and Gao, Fumei). *Historical Research (Lishi Yanjiu)* Issue 2, 68–81, 2009.
The World Economy: A Millennial Perspective (Maddison, Angus). OECD, 2001.
Unified Growth Theory (Galor, Oded). *Princeton University Press*, Princeton, 2011.
Urban Usury in Qing (Qingdai Chengshi Gaolidai) (Liu, Qiugen). *Researches in Chinese Economic History (Zhongguo Jingjishi Yanjiu)* Issue 4, 80–91, 1996.
Weather Shocks, Sweet Potatoes and Peasant Revolts in Historical China (Jia, Ruixue). *The Economic Journal* Volume 124, Issue 575, 92–118, 2014.

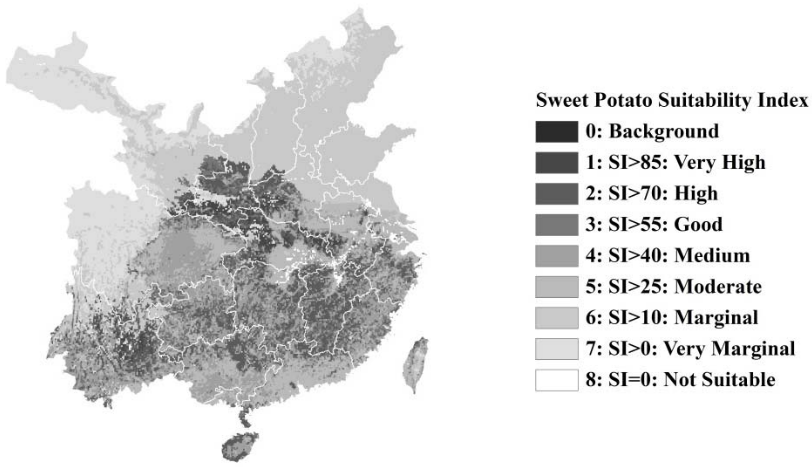
Why Europe and the West? Why Not China? (Landes, S. David). *Journal of Economic Perspectives* Volume 20, Issue 2, 3–22, 2006.
Why England? Demographic Factors, Structural Change and Physical Capital Accumulation during the Industrial Revolution (Voigtländer Nico and Voth Hans-Joachim). *Journal of Economic Growth* Volume 11, Issue 4, 319–61, 2006.

Figure 1. Population in China and the World

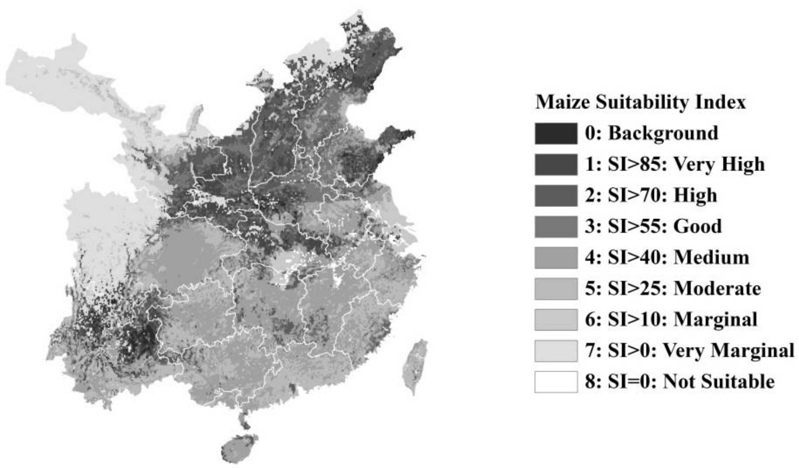
Figure 2. Share of Soil Suitability for Various New World Crops



A. Share of Soil Suitability for Potato



B. Share of Soil Suitability for Sweet Potato



C. Share of Soil Suitability for Maize

Source: GAEZ (2002)

Figure 3. The Diffusion of Maize in China

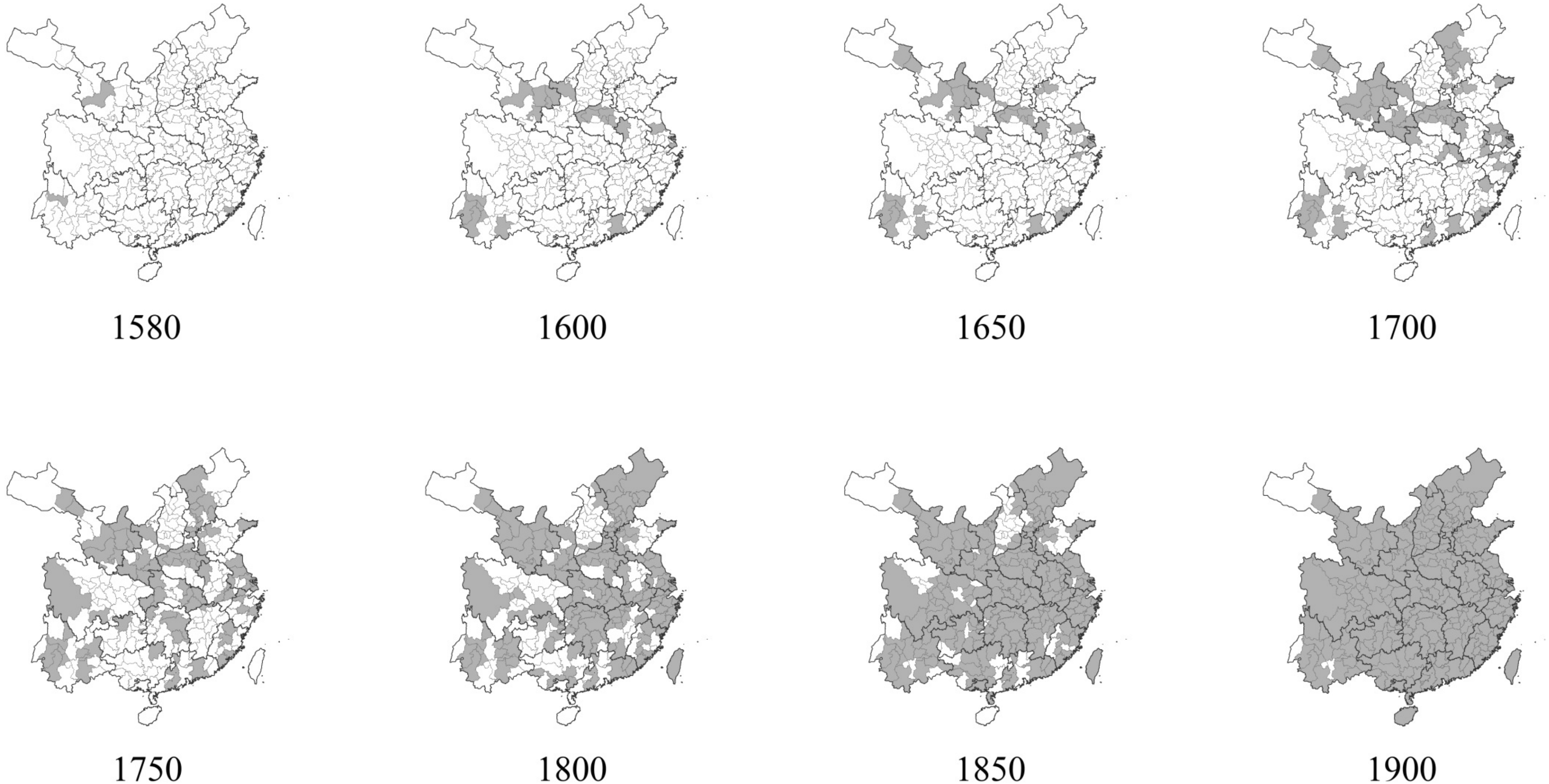
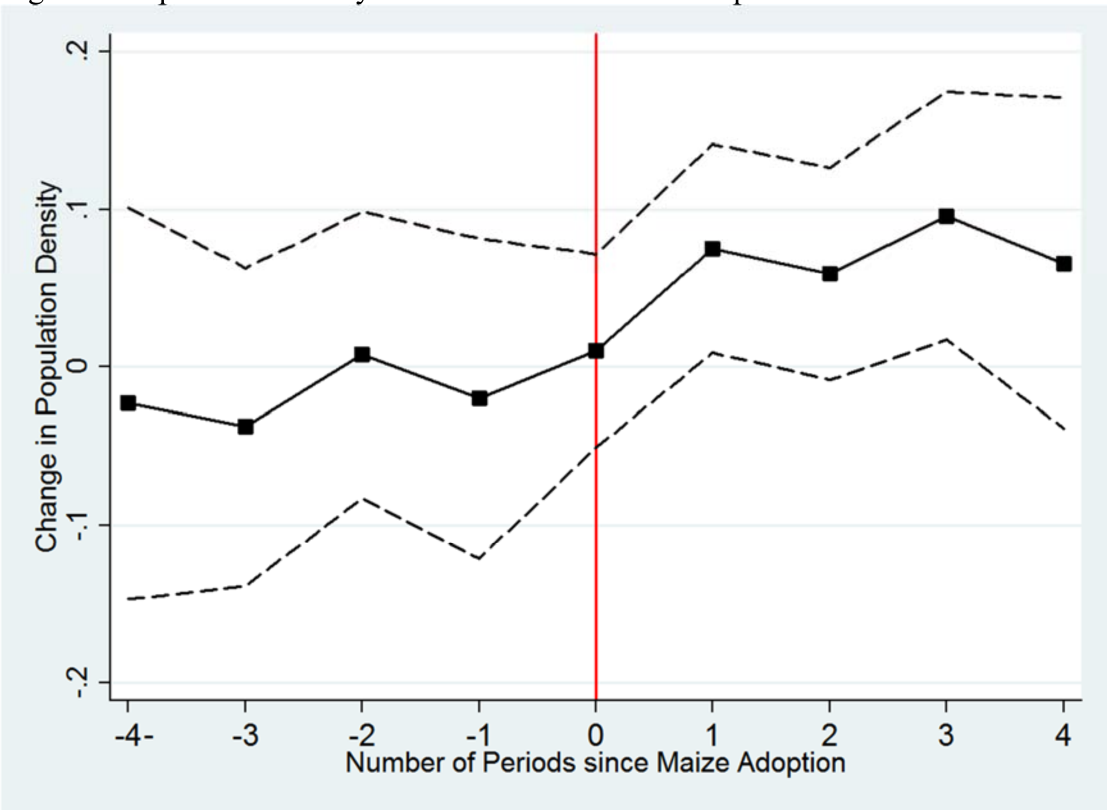


Figure 4. Sample Prefectures of China

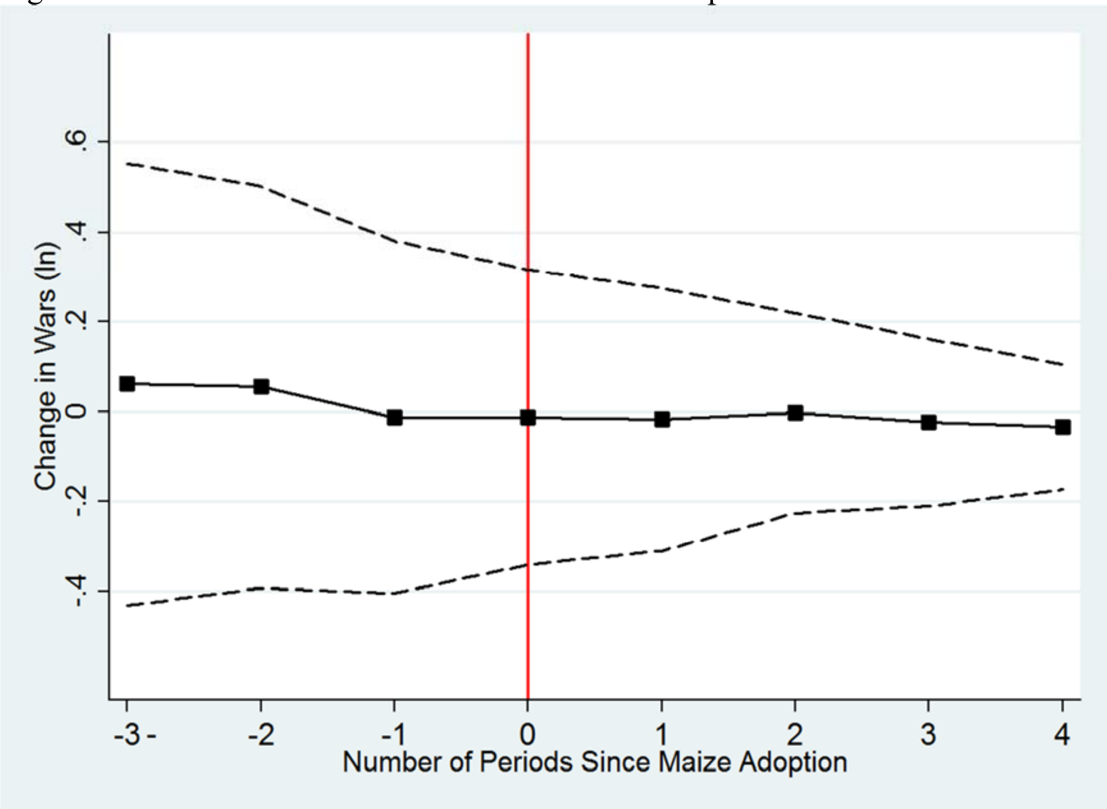
Note: Map of (Qing) China in 1820
Source: “CHGIS, Version 4” Cambridge: Harvard-Yenching Institute, January 2007.

Figure 5. Population Density before and after Maize Adoption



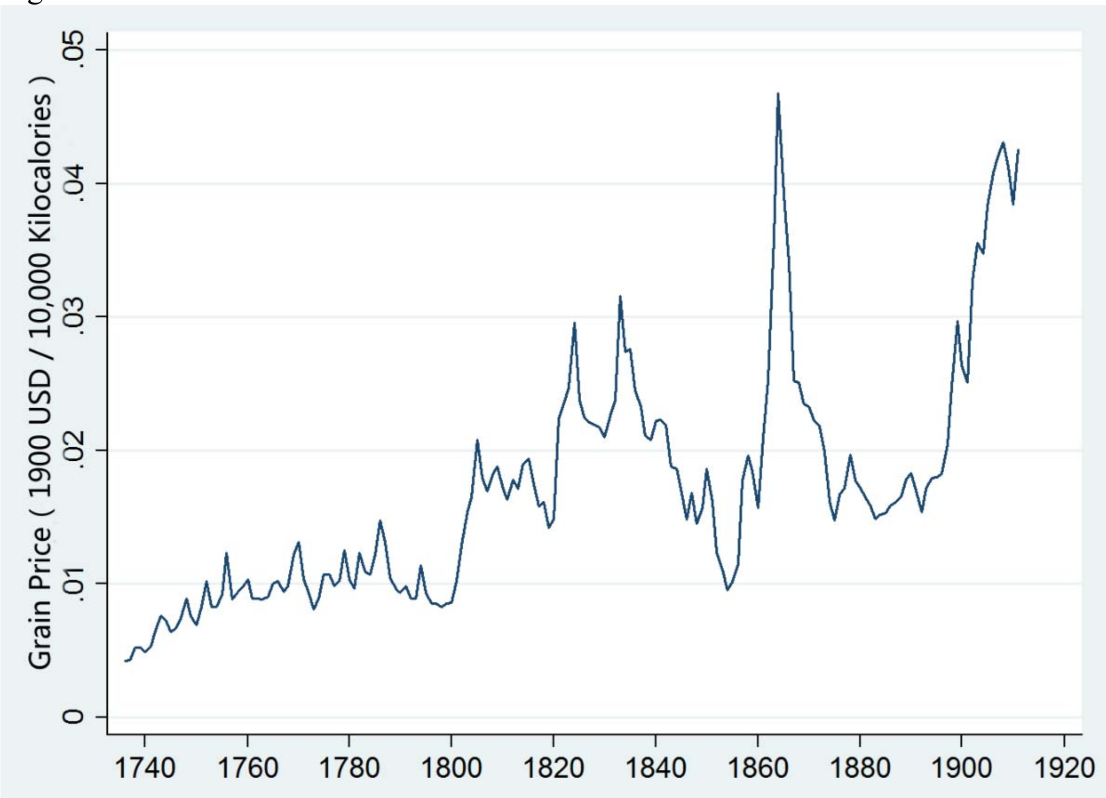
Note: The horizontal axis measures the number of periods before and after maize adoption. The solid line indicates changes in population density conditional on prefecture fixed effects, period fixed effects and prefecture-specific time trends. The dotted lines indicate the 95% confidence intervals where standard errors are clustered at the province level.

Figure 6. Incidence of War before and after Maize Adoption



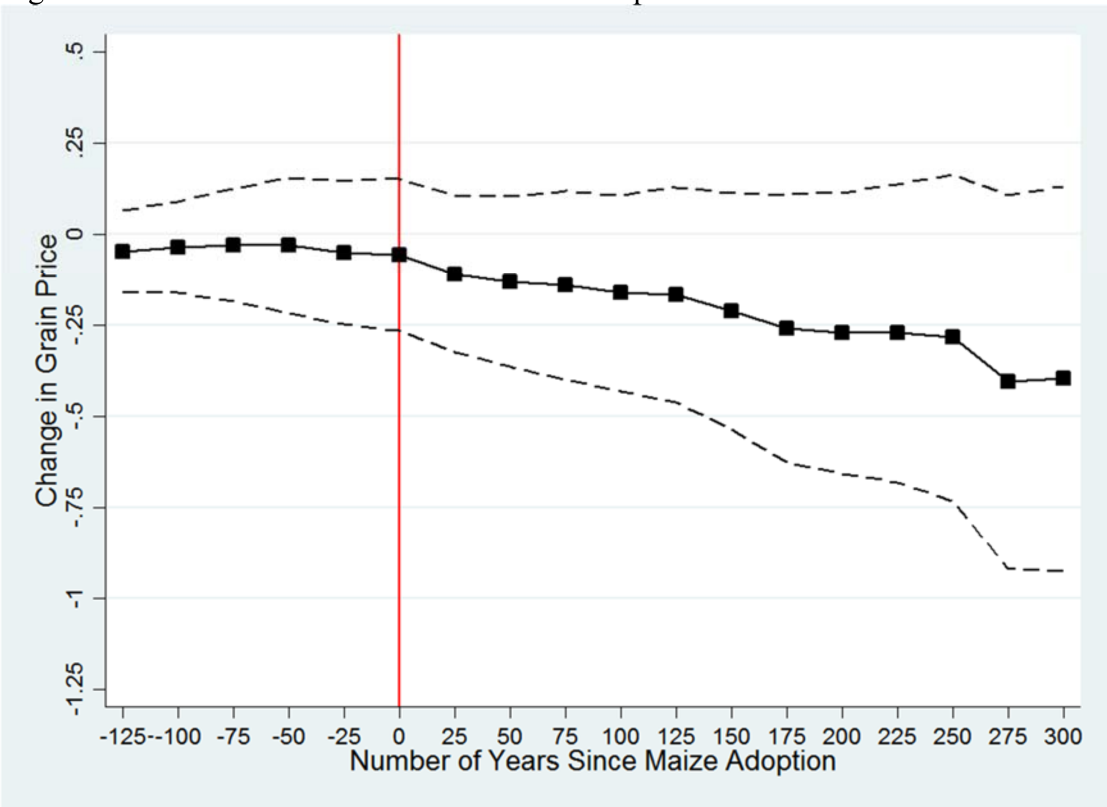
Note: The horizontal axis measures the number of periods before and after maize adoption. The solid line indicates changes in wars conditional on prefecture fixed effects, period fixed effects and province-specific time trends. The dotted lines indicate the 95% confidence intervals where standard errors are clustered at the province level.

Figure 7. Grain Price from 1738 to 1910



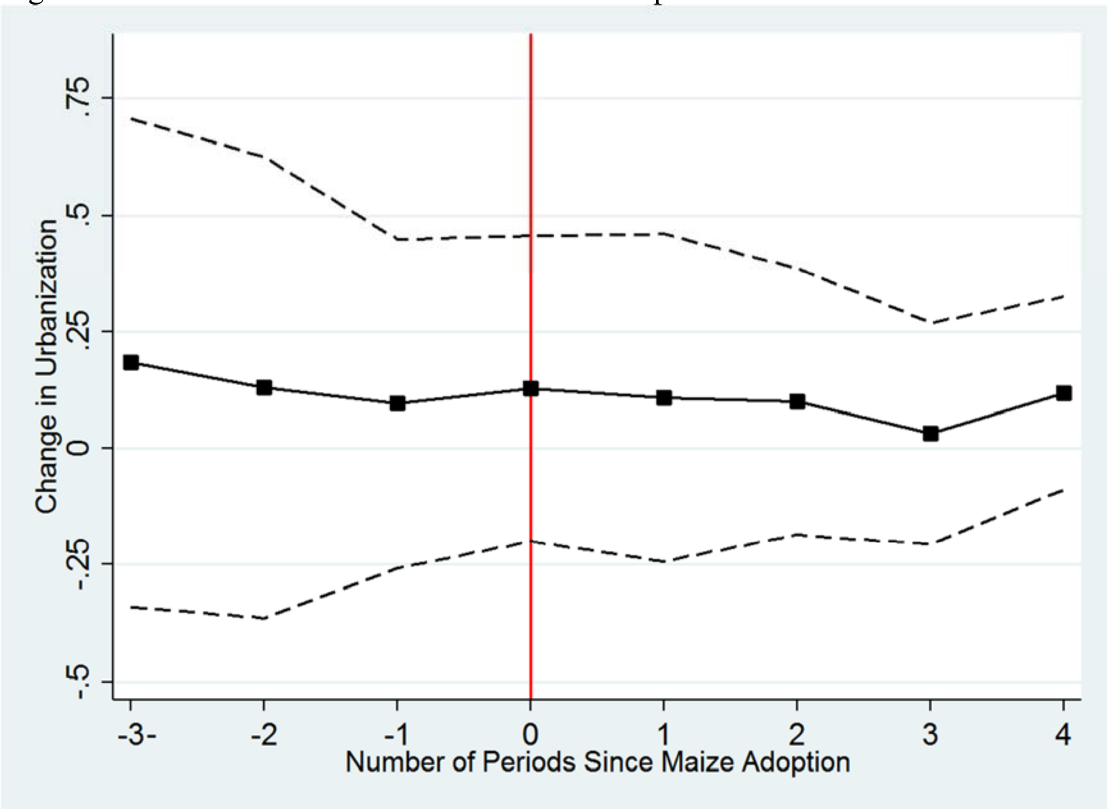
Note: Data on grain price are obtained from "Qing Dynasty's Price of Food Database," Institute of Modern History, the Academia Sinica, Taiwan (http://140.109.152.38/DBIntro.asp), and "Grain Prices Data during *Daoguang* to *Xuantong* of the Qing Dynasty", Institute of Economics, Chinese Academy of Social Sciences (2010). The data were originally kept by the Qing government. Local officials reported grain prices to the central government each month. Given that cropping patterns were different across regions, to ensure comparability we convert one *dan* of grain (of various kinds) into the standardized kilocalories. Conversion is based upon sources compiled by the Institute of Nutrition and Food Safety, Chinese Center for Disease Control and Prevention (2002). The *dan* is the unit of weight employed at the time. Each *dan* equals 83.5 kg. The standard calories of various crops are obtained from Yang. (2002). We then calculate the yearly average price. Finally, we adjust the price according to purchasing power parity, which is 1,900 USD. The deflator is obtained from Peng (2006).

Figure 8. Grain Price before and after Maize Adoption



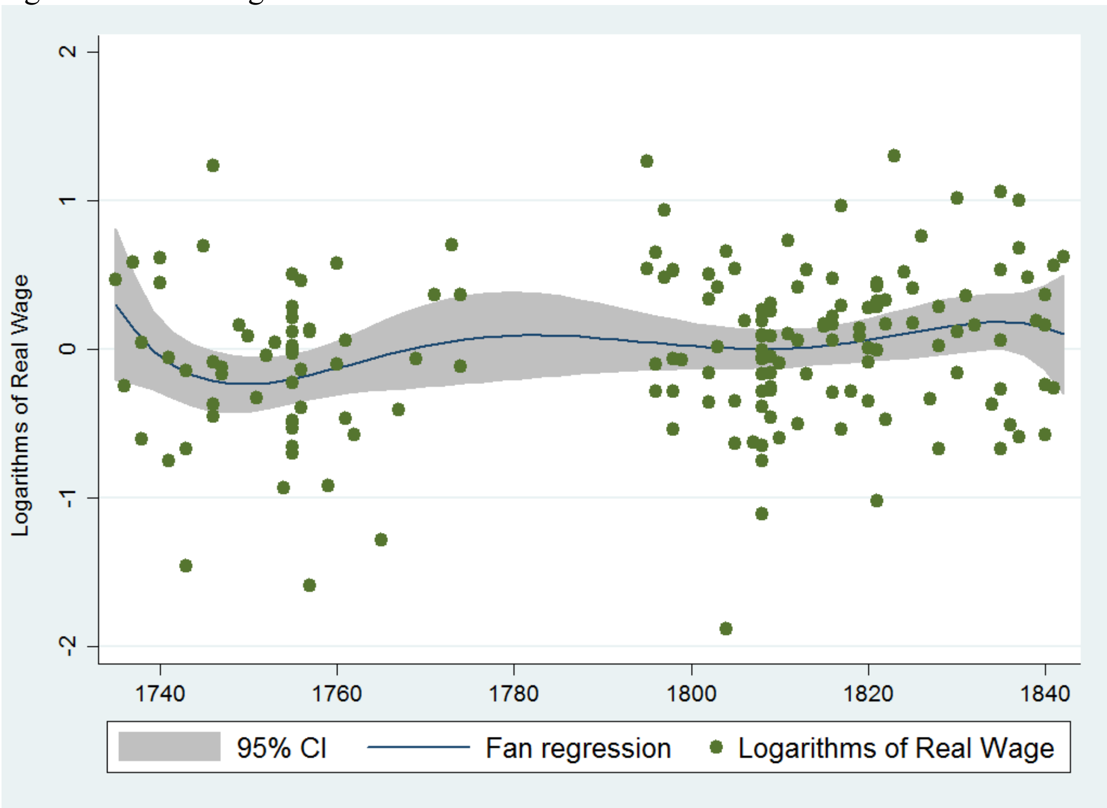
Note: The horizontal axis measures the number of years before and after maize adoption. The solid line indicates changes in grain price conditional on prefecture fixed effects, period fixed effects and prefecture-specific time trends. The dotted lines indicate the 95% confidence intervals where standard errors are clustered at the province level.

Figure 9. Urbanization before and after Maize Adoption



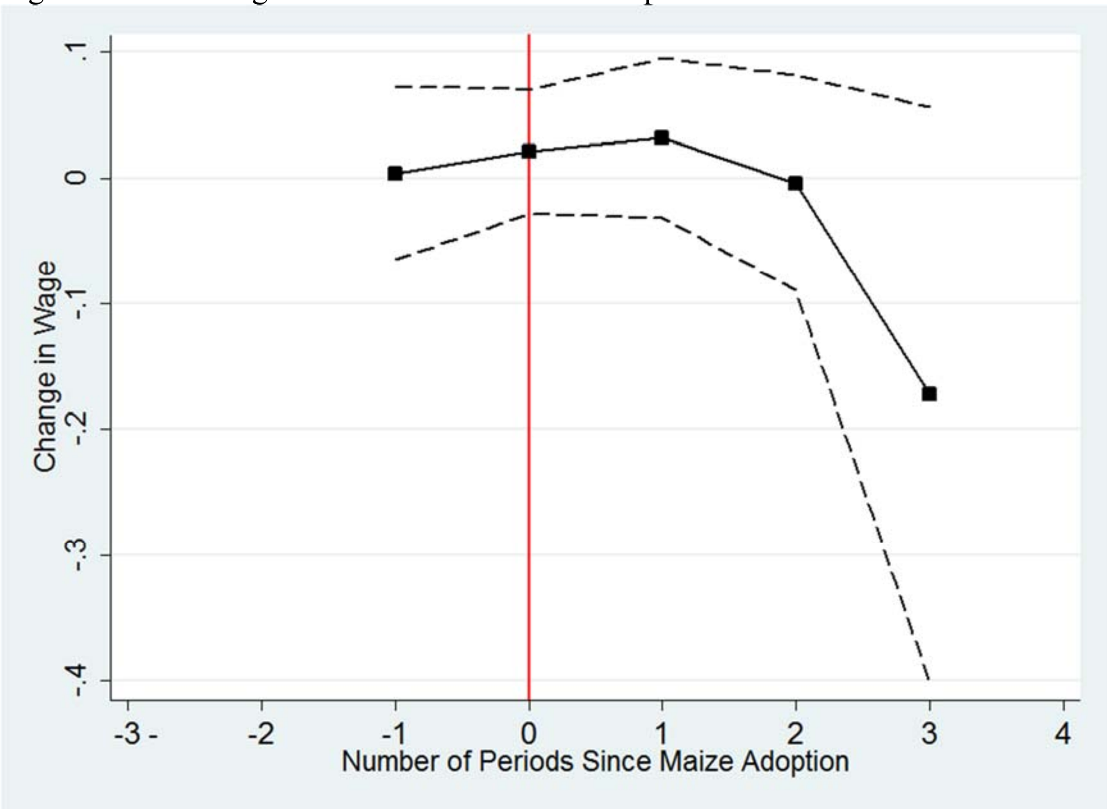
Note: The horizontal axis measures the number of periods before and after maize adoption. The solid line indicates changes in urbanization conditional on prefecture fixed effects, period fixed effects and province-specific time trends. The dotted lines indicate the 95% confidence intervals where standard errors are clustered at the province level.

Figure 10. Real Wage from 1740 to 1840



Note: The y-axis measures logarithms of real wage conditional upon provincial fixed effects. The value has been adjusted to 1760/80 *wen* based on Peng's (2006) estimates of the purchasing power of rice. *Wen* is the currency unit of the Qing Dynasty.

Figure 11. Real Wage before and after Maize Adoption



Note: The horizontal axis measures the number of periods before and after maize adoption. The solid line indicates changes in wage conditional on prefecture fixed effects, period fixed effects and provincial-specific time trend. The dotted lines indicate the 95% confidence intervals where standard errors are clustered at the province level.

Table 1. Summary of Descriptive Statistics

	Data Sources	Observations	Number of Geographic Units	Number of Time Periods	Mean	Standard Deviation
Population density (person/km^2)	A, B	1,556	267	6	110.680	124.699
Maize Adoption	C	1,587	267	6	0.686	0.464
Frequency of war	D	1,335	267	6	0.277	0.921
Frequency of Epidemics	E	90	18	5	0.913	1.210

Source:
A: Cao (2000).
B: Liang (1980).
C: Various local gazetteers
D: "Military History of China" Writing Group (2003).
E: Song (1992).

Table 2. Simple Comparison between Non-adoption Areas and Adoption Areas

	Non-adoption areas			Adoption areas			(adoption)−(non-adoption)
Population density (*ln*) in	mean	S.D.	Obs.	mean	S.D.	Obs.	mean
1600	2.293	1.285	185	2.033	1.488	24	-0.260
							(0.284)
1776	3.916	1.060	121	4.395	1.085	144	0.479***
							(0.132)
1820	3.922	1.101	75	4.588	0.986	190	0.666***
							(0.139)
1851	3.932	1.288	43	4.638	0.962	222	0.706***
							(0.170)
1880	3.579	1.352	25	4.367	0.990	240	0.788***
							(0.216)
1910	N	N	0	4.483	1.019	265	
Total	3.231	1.434	449	4.441	1.082	1085	1.211***
							(0.067)

Note: *, **, and *** denote significance at the 90%, 95%, and 99% levels respectively.

Table 3. Maize Planting and Population Density

	Dependent Variable: Population Density (*ln*)				
	(1)	(2)	(3)	(4)	(5)
Maize Adoption	0.172***	0.099***	0.099*	0.099**	0.073***
	(0.045)	(0.032)	(0.051)	(0.048)	(0.027)
	[0.045]	[0.049]	[0.049]	[0.049]	
Constant	4.114***	-18.772***	-18.772***	-19.768***	-9.727**
	(0.037)	(0.355)	(0.701)	(1.170)	(4.719)
Prefecture fixed effects	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes
Prefecture-specific time trend	No	Yes	Yes	Yes	Yes
Spatial autocorrelation coefficient (σ)					0.468**
Observations	1,534	1,534	1,534	1,534	1,614
R-squared	0.786	0.939	0.939	0.97	0.963

Notes: *, **, and *** denote significance at the 90%, 95%, and 99% levels respectively. Coefficient in model (3) is reported with standard errors clustered at the province level, while coefficient in model (4) is reported with standard errors clustered at province-and-period simultaneously. Standard errors in square brackets are Conley standard errors robust for spatial correlation. Model 5 applies the Generalized Spatial Two-Stage Least Squares (GS2SLS) procedure developed by Kelejian and Prucha (1998, 1999, and 2004), which uses exogenous factors and their spatial lags as instruments for endogenous maize adoption.

Table 4. Maize and Population Growth (Robustness Check)

Dependent Variable: Population Density (*ln*)			
	Sample restricted to the north of 33° latitude (north)	War Frequency	Epidemics Frequency
	(1)	(2)	(3)
Maize Adoption	0.157**	0.076*	
	(0.056)	(0.041)	
Maize Planting Duration (decade)			0.032***
			(0.002)
War Frequency		-0.023***	
		(0.007)	
Epidemics Frequency			-0.040**
			(0.018)
Constant	-19.522***	0.668	4.826***
	(0.791)	(0.389)	(0.686)
Prefecture fixed effects	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes
Prefecture-specific time trend	Yes	Yes	No
Province-specific time trend	No	No	Yes
Observations	1,009	1,310	90
R-squared	0.948	0.745	0.851

Note: *, **, and *** denote significance at the 90%, 95%, and 99% levels respectively. Coefficients are reported with standard errors clustered at the province level.

Table 5. Grain Price before and after Maize Adoption

Dependent Variable:	Grain Price (ln)	Grain Price in period *prior* to the adoption of maize (ln)
	(1)	(2)
Maize Adoption	-0.037**	-0.028
	(0.017)	(0.017)
Constant	-1.986**	-3.332***
	(0.782)	(0.636)
Prefecture fixed effects	Yes	Yes
Period fixed effects	Yes	Yes
Prefecture-specific time trend	Yes	Yes
Observations	40107	39443
R-squared	0.444	0.455

Notes: *, **, and *** denote significance at the 90%, 95%, and 99% levels respectively. Coefficients are reported with standard errors clustered at the province level.

Table 6. Effects of Maize Planting and lagged Maize Planting on Economic Development

Panel A

Dependent Variable:	Urban Population Share (%)				Real Wage (*ln*)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Maize Adoption	0.16	0.15	0.14	0.16	0.13	0.13	0.11	0.13
	(0.10)	(0.10)	(0.09)	(0.10)	(0.14)	(0.14)	(0.14)	(0.15)
Adoption* Provincial Capital		0.12				0.24		
		(0.10)				(0.41)		
Adoption* Grand Canal			1.41				1.26***	
			(1.32)				(0.40)	
Adoption*Yangtze River				0.10				-0.08
				(0.51)				(0.14)
Constant	9.21***	9.21***	9.42***	9.22***	8.32***	8.32***	8.64***	8.32***
	(0.69)	(0.69)	(0.74)	(0.67)	(1.03)	(1.04)	(0.90)	(1.04)
Prefecture fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture-specific Time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	795	795	795	795	647	647	647	647
R-squared	0.96	0.96	0.96	0.96	0.80	0.80	0.80	0.80

Panel B

Dependent Variable:	Urban Population Share (%)				Real Wage (*ln*)			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Lag Maize Adoption	0.03	0.03	0.02	0.02	0.07	0.07	0.07	0.04
	(0.17)	(0.17)	(0.15)	(0.19)	(0.14)	(0.15)	(0.15)	(0.14)
Adoption* Provincial Capital		0.01				0.04		
		(0.11)				(0.28)		
Adoption* Grand Canal			0.12				0.19	
			(0.41)				(0.29)	
Adoption*Yangtze River				0.16				0.26
				(0.45)				(0.41)
Constant	8.42***	8.42***	8.34***	8.46***	9.10***	9.13***	9.32***	8.91***
	(2.14)	(2.14)	(1.99)	(2.07)	(2.10)	(2.08)	(1.74)	(2.10)
Prefecture fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture-specific Time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	807	807	807	795	657	657	657	657
R-squared	0.95	0.95	0.96	0.96	0.80	0.80	0.80	0.80

Note: *, **, and *** denote significance at the 90%, 95%, and 99% levels respectively. Coefficients are reported with standard errors clustered at the province level.