Robin Hood on the Grand Canal

Economic Shock and Rebellions in Qing China, 1650-1911 *

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Abstract

Social scientists have long pondered the effects of economic shocks on social conflicts. Despite the recent literature that has employed exogenous variation in climate changes or global prices to identify the causality, the findings are still inconclusive. This paper uses the abandonment of China's Grand Canal – perhaps the largest infrastructure project in the pre-modern world – in 1826 as a natural experiment to study the link between economic shocks and social conflicts. Using a dataset covering 575 counties from 1650 to 1911, we have found that negative economic shocks significantly generated social instability: in the period of post-abandonment, the annual incidence of rebellions was 0.009 higher in counties bordering the canal than those that are not. The magnitude of the effect accounted for about 122% of the sample mean and was robust across various specifications. We then compare the relative explanatory power of alternative explanations, and conclude that the reform was most likely to arouse rebellions by terminating the canal's role in facilitating trade.

Keywords:Economic Shocks; Conflict; Rebellions; the Grand Canal;

JEL Classification Numbers: O13, O17, D74, H56, N45, N95, Q34.

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1 Introduction

Social scientists have long pondered the effects of economic shocks on social conflicts. They have provided substantial evidence that these two factors are negatively correlated (Collier and Hoeffler, 1998, 2004; Fearon and Laitin, 2003; Humphreys, 2005; Buhaug and Rϕd, 2006; Ross, 2006; Angrist and Kugler, 2008; Bellows and Miguel, 2009). Recently, an emerging literature seeks to isolate exogenous variations to identify their causality. Most of the evidence comes from climate shocks on agricultural productivity (Miguel et al., 2004; Miguel, 2005; Mehlum et al., 2006; Miguel, 2007; Burke et al., 2009; Miguel and Satyanath, 2011; Ciccone, 2008; Iyigun et al., 2015a) and price shocks to global commodities (Besley and Persson, 2008; Brckner and Ciccone, 2010; Dube and Vargas, 2013). However, the findings are still inconclusive (Bazzi and Blattman, 2014; Burke et al., 2015; Sarsons, 2015). This paper attempts to contribute to the literature by using a unique natural experiment – the abandonment of China's Grand Canal in 1826 – to test the link between economic shocks and social conflicts.

The Grand Canal is perhaps the largest and oldest infrastructure in the pre-modern world. It spans 1,776 kilometers (1,104 miles) in length, passing through six provinces of eastern China. More than 126 million people lived in this area in 1820, which accounted for about 15% of the world population. The first parts of the canal dated back to the fifth century BC, while the various sections were finally integrated into a nationwide system during the Sui Dynasty (581-618 AD). The primary purpose of the canal was to transport tribute grain from southern China to the capital city of Beijing. In the early nineteenth century, approximately three and a half million piculs of rice (roughly 560 million lb) were delivered annually. Meanwhile, The canal benefited the adjacent regions by reducing the transport cost for long-distance trade. Grain junks were allowed to carry certain amount of duty-free commodities during their service. Private junks also used the canal extensively for trade, travel and pleasure. The Grand Canal thus developed into one of the most popular trade route within China.

In 1826, the Daoguang emperor abruptly announced the abandonment of the Grand Canal as the exclusive route for tribute grain shipping and took the sea route instead. Anecdotal evidence suggests that the decision was primarily driven by the turnover of emperors, and hence exogenous to the social economic conditions in canal areas. The reform reduced the access to trade along the canal both directly and indirectly. On one hand, the abandonment of the canal reduced the trade of commodities that were carried by official grain junks. On the other hand, the access to private trade also became more difficult and costly due to the negligence of conservancy after its abandonment. By early twentieth century, the canal had become so clogged with silt that much of its length was no longer navigable. This marked the overall decline of the canal corridor economic belt. Historians have long argued that the abandonment of the canal was responsible for the subsequent wave of social unrest in late Qing Dynasty (Esherick, 1988), yet the hypothesis has never been systematically tested.

The abandonment of the Grand Canal provides us with an ideal opportunity to identify the causality between economic shocks and social conflicts. First, it provides exogenous economic shocks not directly related to local conditions. Since China had already acquired the technology for marine shipping as early as in the fifteenth century, it is very unlikely that the reform was in respond to technological changes. Rather, it was primarily driven by the turnover of emperors. Second, the abundant data in historical China provides us with rich information to investigate the possible mechanisms. We have constructed a unique dataset consisting of 575 counties over 262 years (from 1650 to 1911). The dataset is based on the historical records officially compiled by the Qing court. It contains detailed information on the time, location and the military operations for each rebeling case throughout the Qing Dynasty. We took advantage of such detailed information to distinguish between competing theories that can explain the results. Lastly, by focusing on variations within a single country, we have obtained more homogeneity in ethnicity, regime and culture, which could have affected the economy and conflicts simultaneously (Hegre and Sambanis, 2006; Laitin, 2007; Djankov and Reynal Querol, 2010; Kung and Ma, 2014; Janus and Riera-Crichton, 2015).

We began our analysis by using a standard differences-in-differences (DD) strategy. Specifically, we compared the relative change in the presence of rebellions between counties bordering the canal and those far from it before and after the abandonment of the canal in 1826. Our finding reveals that the abandonment of the canal had a significant effect on rebellions: compared to counties away from the canal, counties bordering the canal on average experienced 0.009 higher rate of rebellions after the abandonment. The effect represents a 122% increase relative to the sample mean, and is significant at the 95% confidence interval.

To further test if the treatment effect is specific to the canal and its abandonment, we generalized the standard DD specification by allowing continuous measure in both treatment intensity and time periods. Results show that the incidence of rebellions was an increasing function of the canal length, and a decreasing one of the distance to it. We also estimated the treatment effects region by region, and found the impact of the reform spread over a range of $150km$ from the canal. In terms of time, the canal's impact arose immediately after its abandonment, and kept increasing throughout the next 30 years. There is no evidence of pre-existing trends in rebellions between the treated and the control groups.

To address the concern that our results might be biased by omitted variables, we included a bunch of controls that might be simultaneously correlated with rebellions and the canal, as suggested in the literature. The controls include topographic features, climate shocks, state capacity, agricultural technological change and other corresponding historical events. Our results are robust to including all these variables. In addition, we performed a random assignment of the treated groups to show that our result was very unlikely to be driven by chance.

The abandonment of the canal might affect rebellions through three distinguishable mechanisms. First, it might undermine the state capacity and therefore arouse rebellions by making the canalside counties more vulnerable to attack. Second, it might deteriorate the irrigation system and thus cause agricultural productivity shocks. Third, it might also affect the trade sector by depriving the access to market. We compared the relative explanatory power of the competing theories by checking the validity of their predictions. It turned out that the hypotheses of state capacity and agricultural productivity were not consistent with the data, whereas the loss of trade is most likely to explain our results.

Besides the causal inference, this paper makes several additional contributions to the literature on the sources of conflict. First, the existing literature primarily focuses on the shocks to agricultural sectors. Most of the shocks come from climate changes, while others are from changes in technology and global agricultural commodity prices. However, shocks to urban sectors have been overlooked by the conflict literature. Our research thus contributes to the literature by investigating the effects of economic shocks that are more related to trade. We have presented evidence that the loss of access to trade can also generate social instability. Second, most of the studies in the literature focus on the transitory shocks, while our research sheds light on the effects of permanent shocks to the economy. We found that the impact of the shock kept increasing over at least 30 years, and began to converge after that. To the best of our knowledge, this is the first paper that investigate the effects of permanent economic shocks on social conflicts. Finally, compared to the existing literature that employs variations in climate and global prices, our research offers more direct policy implications. It suggests the possibility for governments to reinforce social stability by providing better access to trade to the targeted regions.

This paper is also related to the literature on transportation infrastructures. There is substantial evidence that transportation infrastructures have significant impact on the social economy (Fogel, 1979, 1994; Fernald, 1999; Haines and Margo, 2006; Baum-Snow, 2007; Atack et al., 2008; Michaels, 2008; Atack et al., 2010; Duranton and Turner, 2012; Dave, 2014), yet the effects of their closings are rarely discussed. This paper contributes to the literature by revealing a significant closing effect of transportation infrastructures on social stability in the context where substitutions such as the railways had not been available. It also adds to our understanding of the non-economic consequences of transportation infrastructures, which have not been widely recognized until recently (Sokoloff, 1988; Burgess and Donaldson, 2010; Agrawal et al., 2014; Perlman, 2015).

For those who are specifically concerned with the social economic dynamic of China, this paper offers a new explanation to the waves of its substantial social unrest. Recently, a growing literature shows that the overall conflict in historical China was significantly related to variations in climate (Bai and Kung, 2011; Chen, 2015), technology (Jia, 2014) and social norms (Kung and Ma, 2014). This paper suggests that policies chosen by the Qing government were also responsible. In this sense, our research is more closely related to Bai and Jia (2015), which attributes the political instability in the early twentieth century to the 1905 abolition of the Civil Service Exam.

The remaining parts of this paper is organized as follows. The next section presents the background of the Grand Canal as well as its abandonment. Then, Section 3 presents the data. Section 4 formalizes our empirical strategy and demonstrates the baseline results. Section 5 is the robustness checks. Section 6 discusses the possible mechanisms. Concluding remarks are offered in Section 7.

2 Background

2.1 The Grand Canal

The Grand Canal is the longest and oldest artificial waterway in the world. Located in the north-eastern and central-eastern plains of China, it runs 1,776 kilometers (1,104 miles) through the provinces of Zhili (now Hebei), Shandong, Jiangsu and Zhejiang, linking the capital Beijing in the north and the city of Hangzhou in the south (see Figure 1). The first parts of the canal dated back to the fifth century BC, while the various sections were finally integrated into a nationwide system during the Sui Dynasty (581-618 AD). As noted by Elvin (1973), it was probably an engineering feat without parallel in the world of its time in terms of scale. More than 126 million people lived in this area in 1820, which accounted for about 15% of the world population.

The Grand Canal served as the main artery for the tribute grain system, which was the second largest revenue source of the Qing Dynasty (Hinton, 1952). The grain was collected as a rice tax from eight provinces in south and central China and was normally devoted to the food supply of the capital city (Fairbank, 1978). The system fed about one million official personnel in Beijing and nearby in terms of the supply of imperial household and court, the salary of the officials and scholars, and the commissariat for the army (Morse, 1913; Chi, 1936). In the early nineteenth century, approximately three and a half million piculs of rice (roughly 560 million lb) was delivered to the capital annually (Huang, 1918). Therefore, the well functioning of the Grand Canal was crucial for the Qing Dynasty. The emperors generally considered the transport of tribute grain as one of the major tasks during their reigns and implemented various strategies in the canal management in order to support the successful operation of the system. (Hummel, 1991; Leonard, 1988; Cheung, 2009).

Along with its crucial role in the tribute grain system, the Grand Canal benefited the adjacent regions by reducing the transport cost for long-distance trade. The government allowed the grain junks to carry certain amount of duty-free commodities during their service. Historians estimated that these grain junks shipped approximately 1.26 million piculs of duty-free commodities (roughly 200 million lb) annually in the early nineteenth century (Ni, 2005). In addition, traffic on the Grand Canal was used extensively by private junks for trade, travel and pleasure (Gandar, 1894; Hinton, 1952). Thus the Grand Canal established its significance as one of the most popular trade route within China.

The prosperity of trade further stimulated the overall growth in those areas. As a result, the corridor along the canal developed into an important economic belt. [1] In 1820, the population density per kilometers in prefectures that were along the canal was 45% higher than in prefectures that were not.

2.2 Abandonment of the Grand Canal

In 1825, the Daoguang Emperor abruptly announced the abandonment of the Grand Canal, and implemented the first sea shipping the next year. In that year, the government shipped 1.63 million piculs (roughly 260 million lb) of tribute rice by the sea. The rice was first shipped from Shanghai to Tianjin in 1,562 chartered ships, and then conveyed to the capital city of Beijing (Hinton, 1952).

It is important that the abandonment of the canal was an exogenous shock to the local economy. First, it was very unlikely to be related to any technological change in sea transportation. This makes sense because China had already acquired such techniques by the time of the reform [2]. More importantly, the reform tended to be subject to the turnover of emperors. The Qing government was characterized by a highly centralized system, where all decisions were arbitrarily made by the emperor. In such a system, one strategy extensively used by emperors who succeeded to the throne was to change some policies implemented by their predecessors to establish their own authority. Although the true decision making process remains a mystery, it served the purpose well for the Daoguang emperor to abandon the Grand Canal, since his predecessor Jiaqing had strongly insisted on the canal and required any proposal for the sea transportation to be prohibited (Ni, 2005).

The successful sea shipping experiment in 1826 marked the beginning of the decline of the Grand Canal. Since the significance of the canal was decreasing, the government invested less money and efforts in its maintenance. The negligence of water conservancy worsened the condition of the canal. It became more and more clogged with silt from the Yellow River and much of its length was no longer navigable by the early twentieth century.

[1] One example is Linqing, which was initially a minor county before the construction of the canal. However, it had developed into a trade center by early Qing dynasty, and was promoted to a municipality in 1777.

[2] One prominent example is the treasure voyages that took place between 1405 and 1433. During the series of seven maritime voyages, the Chinese expeditionary fleets carried great amount of treasures and reached as far as the Arabian Peninsula and East Africa. In addition, the same chartered ships that were employed in sea shipping had already been extensively used long before the reform. In the late eighteenth century, the number of such ships had reached 3,0000, twice as many as the ships used in the first sea shipping experiment.

The decline of the Grand Canal inevitably led to the decline of the economic belt along it. The access to trade became more difficult and costly. As a result, the regions around the canal lost their previous advantage over other regions. One notable example is the city of Linqing, whose population decreased dramatically from over 200 thousand in the late eighteenth century to less than 50 thousand early twentieth century (Cao, 2001). Other regions along the canal also witnessed similar patterns. As shown in Figure 2, the annual population growth rate between prefectures along the canal and the others was very similar in the early nineteenth century. However, it diminished dramatically during the second half of the century in regions adjacent to the canal and did not recover until the early twentieth century.

3 Data

This section presents the sources of the dataset. Basically, our dataset consists 575 counties from 1650 to 1911. The sample covers the six provinces where the Grand Canal winds through (Zhejiang, jiangsu, Shandong, Zhili, Henan and Anhui). Following Kung and Ma (2014), we began our analysis from 1650 onward to exclude those social unrest carried over from Ming dynasty. Similarly, we ended our analysis in 1911 to avoid the complicated political circumstances after the establishment of the Republic of China.

3.1 Dependent Variable

Our main dependent variables are the presence and number of rebellions reported in each county and year. The information comes from Qing Shilu (Veritable Records of the Qing Emperors), the official record of imperial edits and official memorials about events of national significance. It provides detailed records on the place and time of rebellions meticulously complied by the Qing court. According to Chinese historians, Qing Shilu is the most complete and systematic source of original information on social unrest occurred during the Qing dynasty.

We search for the Chinese character “fei” (bandit) – to which the government always referred the rebellions – in Qing Shilu to locate the records on rebellions. Typically, such records cover the time, location, process of a specific rebeling case, and the command issued by the emperor as well. The following example illustrates the typical format of the records:

> The 26th year of Guangxu Emperor (1900), July:
>
> As reported by Shikai Yuan, there is a group of rebels originated in the county of Jiangshan in Zhejiang Province. The leader is Laitou Wu and Jiafu Liu. They have concurred the counties of Jiangshan and Changshan. Eliminate them as soon as possible. (Guangxu Shilu, Vol. 266)

We focus our analysis on the places where the rebellions first took place. Such places are identified by key words such as "shuqi" (raise their flag), "qishi" (uprising), "huyou" (burst out), "qiyu" (originated in), etc. [3]. The advantage of such practice is to exclude wars that spread across regions and lasted for years, and hence avoid the violation of the assumption of independent and identically distributed (i.i.d) observations [4].

3.2 Treatment Variables

We define our treated groups primarily by the geographic location of the counties. The location is obtained from the digital maps available at China Historical GIS Website [5] created by historians at Harvard University and Fudan University. The treatment in our baseline is defined as a dummy indicating if the county bordered the canal. We then extend it into continuous intensities by the length of canal and the distance to it. The geoprocessing was conducted using the ArcGIS 10.3 tools.

3.3 Control Variables

We included a bunch of controls to eliminate certain omitted variables. The controls are grouped into five distinguishable categories: topographic features, state capacity, climate, technological change, and other corresponding historical events.

Topographic Feathers The primary topographic feature we consider here is the terrain ruggedness index, as suggested by Nunn and Puga (2012). To construct the index, we first obtained an elevation data at 30×30 arc seconds from GTOPO30 (Survey, 1996), and then followed the same strategy devised by Riley et al. (1999) to calculate the square root of the sum of the squared differences in elevation between one central point and the eight adjacent points. We define the terrain ruggedness index of each county as the average ruggedness index of all the elevation points the county contains. In the analysis, we interacted it with the the post reform dummy to offer variation in time.

Climate Another well-documented factor for conflict in the literature is climate shocks (Miguel et al., 2004; Miguel, 2005; Hsiang et al., 2011, 2013). Because the historical records of regional climate are very rare, we made use of the temperature reconstructed by Mann et al. (2009). The reconstruction was conducted at 5×5 arc degrees based on 1209 geological proxy records over the past 1500 years (e.g., tree-ring, coral,

[3]For example, we registered the above case in the county of Jiangshan rather than that of Changshan. Nevertheless, Changshan is registered under this case as being attacked. We will make use of this information to identify the alternative mechanisms, as discussed later.

[4]We are well aware that the onset cases can also violate the i.i.d assumption if information on rebellions can flow among regions. Therefore, we will nevertheless incorporate spatial analysis into our baseline models to further avoid spatial correlation bias.

[5]http://www.fas.harvard.edu/ chgis/

sediment, ect.). We assigned the reconstructed value to counties in our sample by the grid cells in which they are located. We define temperature anomaly if the temperature is beyond 1 standard error of the mean over the 262 years in our sample.

The defect of Mann et al. (2009) reconstruction is the lack of spatial variation: our sample only spread over 11 grid cells in the reconstruction. Therefore, we also include an alternative measure of climate using the records flood from the archive. The cases are obtained from the local gazettes.

State Capacity A third set of control variables we included is the state capacity. We measured it in two ways. First, the number of soldiers stationed at the county; and second, the indicator of being adjacent to province boundaries. The source of soldier data is recorded in Luo (1984). Because the document only recorded the institutionalized number of soldiers assigned to each military camp without time-variation, we interacted it with the post reform dummy to capture changes. The province boundary is calculated using the digital map downloaded at China Historical GIS Website.

Technological Change Recent research suggests that social conflicts are also subject to technological changes in the agricultural sector, especially the introduction of New World crops (Jia, 2014; Iyigun et al., 2015b). This may also lead to inconsistent estimates as long as the crops spread along the canal. Therefore, we also controlled for the introduction of maize and sweat potato, the two most important New World crops in China (Jia, 2014; Chen and Kung, 2016).

Other Historical Events Finally, we controlled for other major events happened in our sample. The most important concern is the Taiping Heavenly Kingdom that also aroused social disturbance. We included the regions affected by the Taiping campaign with different level of intensity to eliminate the possibility that our results captured its impact. The data is obtained from Li and Lin (2015).

3.4 Additional Variables to Test the Mechanisms

Some additional variables are used in Section 6 to help identifying mechanisms linking the abandonment of the reform to subsequent waves of rebellions. We briefly summarize here the definition and source of these variables. The first set of variables are the number of towns in 1820 and 1911 respectively. It helps to measure the spatial distribution of trading markets before and after the abandonment of the canal. The data is obtained from China Historical GIS Website. The second useful variable is the location of courier routes in the Qing Dynasty, also available at China Historical GIS Website. It is included as a substitution for the canal in facilitating trade after the abandonment. The third set is the suitability for wheat and wetland rice plantation, the two major crops in eastern China. The suitability index at arc degrees is obtained from the Food and Agriculture Organization (FAO)'s Global Agro-Ecological Zones (GAEZ) 2012 database., and we define a county to be "suitable" for planting the crop if the mean suitability index of all grid cells within the county falls in the category of "good" or better as defined by the FAO.

3.5 Suggestive Evidence

Before proceeding to more formal analysis, we demonstrate some descriptive evidence that suggests the intuition. We begin by presenting the descriptive statistics of the sample in Table 1. Our sample contains 575 counties over 262 years, from 1650 to 1911. On average, there were 4.35 rebeling cases reported each year, which took place in 4.22 counties. The most disordered year is 1861, when there were 88 cases reported in 82 counties. As for the independent variables, 73 out of the 575 counties were along the canal boundary. The average distance from the canal is 118 kilometers (roughly 73 miles), while the farthest county is 499 kilometers (310 miles) away from it.

Figure 4 shows the distribution of rebellions overtime. The early years in the Qing dynasty were quite peaceful, despite several adventitious reports. The number of rebellions began to increase dramatically after 1825 and peaked in 1861, which coincides with the abandonment of the canal. The total number of rebellions in the post-abandonment period was larger than that in the pre-abandonment period, although the number began to decrease after the 1870s.

Figure 5 shows the spatial distribution of rebellions before and after 1826. The left panel shows the distribution of rebellions in the pre-abandonment period, while the right panel shows that in the post period. The color intensity represents the number of rebellions reported. In the pre-abandonment period, the rebellions were less frequent but more dispersed. In the post abandonment, the total number of rebellions increased, yet the relative change was larger in areas near the canal. This gives us the intuition that the abandonment of the canal should significantly contribute to the overall upheaval of rebellions in the mid nineteenth century.

Table 2 translates the above intuition into a precise but naive calculation. We calculated the relative change in the number of rebellions before and after the abandonment in both areas and performed the standard t test. The first difference shows that rebellions were more frequent in counties that border the canal, or in the post-abandonment years. The second difference is what we are primarily concerned with: the relative change in the annual rate of rebellions was 0.0094 higher in counties that bordered the canal than those that did not. Given the sample mean of rebellions is 0.0076, this implies that the abandonment of the canal triggered the frequency of rebellions by 124%.

4 Empirical Strategies and Results

This section estimates the impact of the abandonment of the Grand Canal on rebellions. Our baseline estimation follows the standard differences-in-difference (DD) strategy, where we compare the relative change in the presence of rebellions before and after the abandonment. The specification and results are presented in Section 4.1. Section 4.2 generalizes the standard DD estimation by using continuous measures of intensity in both dimensions, and hence captures more spatial and chronological variations.

4.1 Baseline Specification and Results

In the baseline, we seek to examine the influence of the abandonment of the Canal on rebellions using the standard DD strategy. Here, the treated group contains counties that bordered the canal, while the control group contains counties that did not. Specifically, we estimate the following equation:

$$Y_{ct} = \beta Bordering_c \times Post_t + \delta_c + \sigma_t + \chi + \varepsilon_{ct} \tag{1}$$

where c indexes counties, p provinces and t years. The outcome of interest, denoted Y_{ct}, is a dummy variable indicating the presence of rebellions for county c in year t. $Bordering_c$ is a dummy variable that equals one if a county is located adjacent to the canal and zero otherwise. $Post_t$ is a dummy variable that equals one for the years after the abandonment. The equation also controls for county and year fixed effects, δ_i and σ_t; χ denotes other controls. The coefficient of interest in equation (1) is β, which is the estimated impact of the abandonment of the canal on rebellions. A positive coefficient indicates that counties adjacent to the canal witnessed a greater increase in the number of rebellions after its abandonment.

The results are reported in Table 3, where the dependent variables are the presence of rebellions [6]. The specifications in each column are consistent, but differ in their controls. For each column, we clustered the standard errors at the prefecture level (as reported in the parentheses). We also include Conley standard errors in the square brackets following the approaches suggested in Conley (1999) and Conley (2008) to adjust for spatial correlations.

Column (1) reports the baseline estimates of Equation (1). We include county fixed effects and year fixed effects to account for time-invariant county features (e.g. location) and unanimous year shocks (e.g. macro economic growth),respectively. The estimated coefficient of the interaction term, $Bordering_c \times Post_t$, reveals the average increase in our outcome of interest arising from the abandonment of the Grand Canal in 1826. The result suggests a positive correlation between the abandonment and social unrest: the presence

[6] We also estimated the same equations on the number of rebellions, and the results are almost the same

of rebellions experienced by counties that bordered the canal (relative to those did not) increased by 0.009 on average after the reform (relative to before). The effect represents a 122% increase relative to the sample mean, and is significant at the 95% confidence interval.

Columns (2) - (3) further include province-emperor fixed effects and prefecture specific year trends, whereas column (4) includes both simultaneously. They are used to control for heterogenous effects of the emperors and differences in time trends, respectively. The results unanimously shown that the abandonment of the canal was associated with the subsequent rise of rebellions.

Column (5) reports the result for the number of rebellions. Consistent with the previous analysis on the rebeling indicator, the abandonment of the canal on average increased the number of rebellions by 0.0076, about 100% of the sample mean.

4.2 Generalized Estimation

Our baseline assumes binary treated groups and time periods. In this section, we generalized the standard DD specification by allowing continuous measure in both dimensions. We begin by exploring heterogeneity among counties with different treatment intensity. The intensity is measured in two ways: a) the length of the canal within a county, and b) the distance to the canal. Then we turn to estimating the treatment effect on the number of years after the initial reform. We also combine the generalization in both dimensions simultaneously to obtain more variation. The results reinforced that the treatment effect is specific to the canal and its abandonment.

Canal Length First, we explored variation in treatment intensity using the length of the canal within a county. Specifically, we conducted the regression analysis on the following specifications:

$$Y_{ct} = \beta Length_c \times Post_t + \delta_c + \sigma_t + \chi + \varepsilon_{ct} \tag{2}$$

$$Y_{ct} = \sum_{\iota=0}^{80} \beta_\iota Post_t \times Length_\iota + \delta_c + \sigma_t + \chi + \varepsilon_{ct} \tag{3}$$

where Equation (2) assumes a linear function of canal length, while Equation (3) uses a more flexible specification to estimate a separate coefficient for each length interval. We shall expect the coefficient β in Equation (2) to be positive as the impact of the canal should be larger in counties containing more section of the canal. Correspondingly, the estimated coefficients β_ι should increase with ι if the effect we observed was specific to the canal.

The estimated coefficients for Equation (2) are presented in the first column of Table 4 with county, year and province-emperor fixed effects. It suggests that one additional kilometer of the canal accounted for 0.0003 higher incidence of rebellions, and is significant at the 99% confidence interval [7]. In other words, a county containing an additional $25km$ of the canal would have more than 0.008 higher rate of rebellions, more than 100% of the sample mean.

For further illustration, we plotted in Figure 6 the estimated coefficients of Equation (3) using the $10km$ length intervals. The reference groups are all the other counties off canal. The coefficients are gradually increasing with the canal length, but does not reach statistical significance until there are $40km$ contained. This is consistent with our hypothesis that the effect was specific to the canal.

Distance to Canal Now we turn to explore variation within the control groups in the baseline. Specifically, we regress the presence of rebellions on the continuous measure of distance to the canal. The equations take the following form:

$$Y_{ct} = \beta Distance_c \times Post_t + \delta_c + \sigma_t + \chi + \varepsilon_{ct} \tag{4}$$

$$Y_{ct} = \sum_{\rho=0}^{400} \beta_\rho Post_t \times Distance_\rho + \delta_c + \sigma_t + \chi + \varepsilon_{ct} \tag{5}$$

where $Post_t$ is interacted with $Distance_c$, the distance to the canal, and each of the distance range, respectively [8]. The estimated coefficient of Equation (4) is expected to be negative while those of Equation (5) to decrease with distance.

We presented the result of Equation (4) in Column (2) of Table 4, and plotted the estimated coefficients of Equation (5) in Figure 7. Column (2) of Table 4 suggests that the incidence of rebellions was 0.0005 lower per 10 kilometers away with 1% level of significance. The more flexible specification in Figure 7 further reveals that the effect preserves significance until $150km$ away (counties over $400km$ away being the reference groups). We shall interpret this as the range for the reform to spread over.

Number of Post-reform Years Then we expand the variation in time periods using the following specifications:

$$Y_{ct} = \beta Bordering_c \times PostYears_t + \delta_c + \sigma_t + \chi + \varepsilon_{ct} \tag{6}$$

$$Y_{ct} = \sum_{\tau=-100}^{60} \beta_\tau Bordering_c \times Period_\tau + \delta_c + \sigma_t + \chi + \varepsilon_{ct} \tag{7}$$

where we interact the treatment indicator with $PostYears_t$, the number of years after the reform. The result is reported in column (3) of Table 4 with all fixed effects. The significantly positive coefficient suggests that

[7] We also normalized the length of canal into a density measure by dividing the county's land area.

[8] We measured the distance by the least distance between the location of the county seat and the canal. The results are robust to using the least distance between county boundary and the canal as well.

the impact of the canal increased gradually after its abandonment. This is consistent with the historical background we summarized in Section 2 that the process of the abandonment took almost 80 years.

Figure 8 plotted the coefficients of Equation (7) to estimate the treatment effects decade by decade. One shall be aware that this figure is critical in a standard DD context. First, it verifies the key assumption of common trends which establishes the validity of a DD design. It is easy to confirm that our data satisfies the common trends requirement by the fact that the treatment effects in the pre-reform periods were indifferent. Second, it reveals the rebeling dynamics after the implementation of the reform. The canal's impact on rebellions arose immediately after its abandonment, and kept increasing throughout the next 30 years. Then the magnitude of the effects vanished yet still preserved the 5% level of significance. We shall conclude from the results that the treatment effect we observed in the baseline shall be specific to the canal's abandonment in 1826.

Continuous Treatment in Both Dimensions Finally, we combine Equation (2) and Equation (6) to allow continuous treatment intensity in both dimensions simultaneously. Specifically, we interact $Length_c$ with $PostYears_t$ and present the result in column (4) of Table 4. The estimated coefficient is positive and significant at the 95% confidence interval, as expected. Taken together, the results in Table 4 reveal that the impact of the abandonment was larger where the canal was longer, and was increasing gradually as the reform was implemented. This reinforced our baseline findings that the reform was associated with the subsequent wave of rebellions.

5 Robustness

5.1 Including More Controls

There might be concerns that our results suffer from omitted variables, i.e., other factors affecting social conflict may also be correlated with the canal. Although the DD estimator in our baseline has helped to rule out certain factors invariant over time and uniform across counties, there might be other time-variant factors that bias our results. We address this concern here by controlling for as much as possible observable factors that may be simultaneously correlated with social conflict and the canal.

We select our control variables based on factors suggested by the existing literature. First, land ruggedness (Nunn and Puga, 2012) interacted with the post-reform indicator; second, climate shocks (Miguel et al., 2004; Miguel, 2005; Hsiang et al., 2011, 2013) as measured by temperature anomaly and flood; third, agricultural technological change (Jia, 2014; Iyigun et al., 2015b) as measured by the introduction of maize and sweet potatoes; and fourth, state capacity (Besley and Persson, 2010, 2011) as measured by the number of imperial soldiers and the province boundaries, both interacted with post-reform indicators. We also controlled for regions conquered by the Taiping Heavenly Kingdom to rule out its impact.

The results are reported in Table 5. Column (1) - (8) add the set of controls successively, while Column (9) simultaneously include all controls. Our main coefficient of interest, $Bordering_c \times Post_t$, preserves its significance across all specifications. The magnitude of the effects is also stable, ranging from 0.0074 to 0.0105, around 100% to 144% of the sample mean.

In terms of the control variables, the results show that land ruggedness was associated with less frequent rebellions during the post reform period. This is consistent with the findings in Nunn and Puga (2012) that terrain ruggedness benefited the African countries by avoiding the slave trades. None of the other factors present significant impact in our sample.

5.2 Placebo Test

Because the number of treated observations is relatively small in our sample (73/575), there might be concerns that our results are simply driven by chance. To address this concern, we compared the treatment effects we had estimated to the distribution of placebo treatment effects when randomly assigning county locations. Specifically, we randomly assigned counties to the polygons on our sample map representing county locations, without replacement. Thus the number of placebo counties bordering the canal was the same as that of the actual ones, but the selection of counties was random. Then we estimated the placebo treatment effects using Equation 1 and compare the result in Column (1), Table 3 to them.

In Figure 9, we plotted the distribution of t-statistics from the placebo treatment effects for $1,000$, $5,000$ and $10,000$ times. The vertical lines mark the location of the t-statistic of the actual treatment effect (as in Column (1), Table 3). The share of the placebo t-statistics that is larger than the actual statistic ($P(t \leq T)$) can be interpreted as analogous to a p-value. It suggests the probability for a randomly assigned treated group to present a effect at the same or higher level of significance as the actual ones. In other words, we can reject the null that our result is indifferent to the placebo ones at about 1% level of significance.

6 Discussion of Mechanisms

In previous sections we have presented evidence that relate the abandonment of the Grand Canal to the subsequent emergence of rebellions. Now we turn to discussing the mechanisms behind the correlation. Theoretically, the abandonment of the canal may affect subsequent rebellions in three distinct ways. First, the abandonment of the canal could undermine the state capacity of the canalside counties, which aroused the rebels by increasing their chance to succeed (Besley and Persson, 2010, 2011). Second, the reform could affect the irrigation system and thus cause shocks to agricultural productivity (Jia, 2014; Iyigun et al., 2015b). Third, it might also affect the trade sector by depriving the counties of access to market (Besley and Persson, 2008; Brckner and Ciccone, 2010; Dube and Vargas, 2013; Bazzi and Blattman, 2014). Unfortunately, we do not have very detailed data to directly test the competing theories. However, it is possible to compare their explanatory power indirectly by checking the validity of their predictions. We found that state capacity and agricultural productivity had very limited power in explaining our results, whereas there was substantial evidence in support of the market access hypothesis. We conclude that the reform is more likely to arouse rebellions by the market access hypothesis.

6.1 Shocks to State Capacity

We first test if the abandonment of the canal could have facilitated rebellions by weakening the state capacity alongside. Suppose the state capacity was weakened by the reform, the counties would not only be vulnerable to local rebellions, but be attractive to external attacks. Rebels might also seek security in such regions if they were defeated by the government elsewhere. Therefore, we check the validity of the hypothesis by testing the treatment effects on the frequency of being attacked or fled into (after being defeated). To be precise, we test the impact of the abandonment on two dependant variables: the incidence of being attacked, and that of being fled into by the defeated armies [9].

The results are reported in Table 6. Column (1) - (2) test the treatment effects on the incidence of being attacked, while column (3) - (4) test the effects on the incidence for defeated armies to flee into. The treatment is measured by the bordering indicator and the length of the canal as well. All of the coefficients are relatively small compared to the sample mean, and cannot be significantly differentiated from zero. It suggests that the canalside counties became neither easy targets nor safe havens for the rebel groups. Therefore, our data does not support the hypothesis that the reform aroused rebellions by weakening the state capacity alongside.

6.2 Shocks to Agricultural Productivity

An alternative hypothesis states that the reform might have triggered rebellions by deteriorating the agricultural productivity. For example, the irrigation system might lose efficiency because of reduced investment. If this is the case, we would expect stronger treatment effects in regions more favorable for agriculture. We test this prediction by investigating heterogeneity among crop suitability. Specifically, we interact the

[9] The validity of this test requires the indicators to be sensitive to variations in state capacity. We test this assumption by regressing the attacking and fleeing indicator on the number of soldiers and the province boundary indicator, both interacted with the post-reform dummy.

main treatment with the suitability indicator for wheat and wetland rice, the two most important crops in our sample area (Talhelm et al., 2014).

The results are reported in Table 7. The first two columns investigate if the treatment effects show heterogeneity in regions suitable for wetland rice, whereas the last two columns in regions suitable for wheat. We employed both the binary and the continuous measure of treatment as before. The results suggest two conclusions. First, the main treatment effects, denoted by $Bordering_c \times Post_t$ and $Length_c \times Post_t$ respectively, preserve their significance across all the specifications. Second, whether a county is suitable for rice or wheat plantation showed no significant difference in either treatment effect (although the coefficients are positive). Therefore, we can infer that the reform might not affect rebellions by the agricultural productivity shocks.

6.3 Shocks to Trade

We present three pieces of evidence that the reform was very likely to deliver trade shocks by depriving the access to market. To be specific, we first checked the reform's direct effect on market redistribution. Then we tested whether the treatment effects were subject to the extent of trade dependence on the canal. We also verified that our results were consistent with historical records.

The Effect on Market Redistribution To start with, we checked the reform's effect on market redistribution using the number of towns within each county in 1820 and 1911. This indicator serves as a measure of the development of local markets. Specifically, we perform similar regression analysis as in the baseline with the dependant variable being the ln number of towns. The result is reported in Column (1) of Table 8. It suggests that the growth in towns was 52% lower in counties along the canal (relative to those not) after the reform (relative to before), and was significant at the 99% confidence interval. In other words, the development of local trading market along the canal was greatly hampered by the implementation of the abandonment. It directly verified that the reform had significant adverse effect on trade.

Variation in Trade Dependence on the Canal We then investigate whether the treatment effects are subject to the extent of trade dependence on the canal. The underlying assumption for this test is that, if trade being a valid channel, the reform should exhibit stronger effect for counties relying more on the canal for trade. We employed two separate strategies to measure the extent of dependence.

One measure of the extent to which a county's trade relied on the canal is the concentration of trading markets along the canal prior to the abandonment. Specifically, we measure it by the share of towns within $10km$ to the canal (relative to the number of towns within the county) in 1820. The result is reported in

Column (2) of Table 8. We found that the initial share of canal towns was significantly associated with rebellions, whereas the the baseline treatment lost its significance. The interpretation of this seemingly anomalous result actually verified our trade hypothesis. It suggests that a canalside county might not be affected by the reform unless much of its trading markets were distributed along the canal.

Another way to measure the trade dependence on canal is to explore the existence of alternative trade routes across the county. Suppose the reform had affected rebellions by discouraging trade, it should produce less effect where there were substitutions. To test this prediction, we interact our baseline treatment with the indicator of courier routes, the most important routes for land transportation in Qing Dynasty. The result is reported in Column (3) of Table 8. Several estimated coefficients worth attention. First, the baseline treatment effect is robust to including the courier routes. Second, the interaction between the courier routes indicator and the reform dummy is not correlated with subsequent rebellions at all, which serves as an additional placebo that the treatment effect is specific to the canal. More importantly, the significantly negative coefficient of the triple interaction suggests the substitutional role of alternative trade routes: the treatment effect would be 0.0064 lower where the courier routes passed, almost a half of the main effect. Taken together, Column (2) - (3) verifies the prediction that the reform produced stronger effect in regions relying the canal for trade.

Historical Documents Historical records also provide abundant evidence in support of the Opportunity Cost Hypothesis. One direct consequence of the canal's abandonment was the unemployment of sailors and boat trackers on the canal. Historians estimated that the tribute grain transportation alone provided more than 100 thousand jobs along the canal in early nineteenth century. Taking employment in private trade and other related industries into consideration, millions of people relied on the canal for their living (Martin, 1996). After the abandonment of the canal, most of them lost their regular employment. As recorded in historic archives, large numbers of the unemployed boatmen joined various rebel groups such as the Nian and the Red Turbans. Others began to organize into what was called the Anqing Daoyou, which was the direct precursor to the Green Gang in the early 20th century (Martin, 1996).

7 Conclusion

In this paper, we used the abandonment of China's Grand Canal – perhaps the largest infrastructure project in the pre-modern world – as a natural experiment to study the link between economic shocks and social conflicts. This setting is ideal for our research purpose because the reform was primarily a political issue driven by the turnover of emperors, and thus exogenous to the social economic conditions in local areas.

Using a dataset covering 575 counties from 1650 to 1911, we have found that the negative economic shock significantly generated social instability: compared to counties away from the canal, counties bordering the canal on average experienced 0.009 higher rate of rebellions after the abandonment of the canal. The effect represents a 122% increase relative to the sample mean, and is significant at the 95% confidence interval. The effect spread over a range of $150km$, and kept increasing throughout the next 30 years. Our findings are robust to controlling additional variables and alternative model specifications.

The abandonment of the canal might affect rebellions through three distinguishable mechanisms. We compared the relative explanatory power of the competing theories by checking the validity of their predictions. It turned out that the hypotheses of state capacity and agricultural productivity were not consistent with the data, whereas the loss of trade is most likely to explain our results.

This paper contributes to the literature on the sources of conflicts in three dimensions. First, unlike the existing literature that employs exogenous variations in climate changes and global commodity prices, it uses a new source of variation related to trade. This allows us to investigate the effects of economic shocks on conflict beyond the agricultural sector. Second, this paper tries to look into the effects of permanent shocks rather than contemporary shocks extensively studied in the literature. Third, this paper offers direct policy tools for governments to take: it suggests that governments can mitigate social conflicts and reinforce stability by expanding the access to trade in targeted areas. Besides, it also adds to our general understanding of transportation infrastructures and the wave of social unrest in the history of China.

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Figures

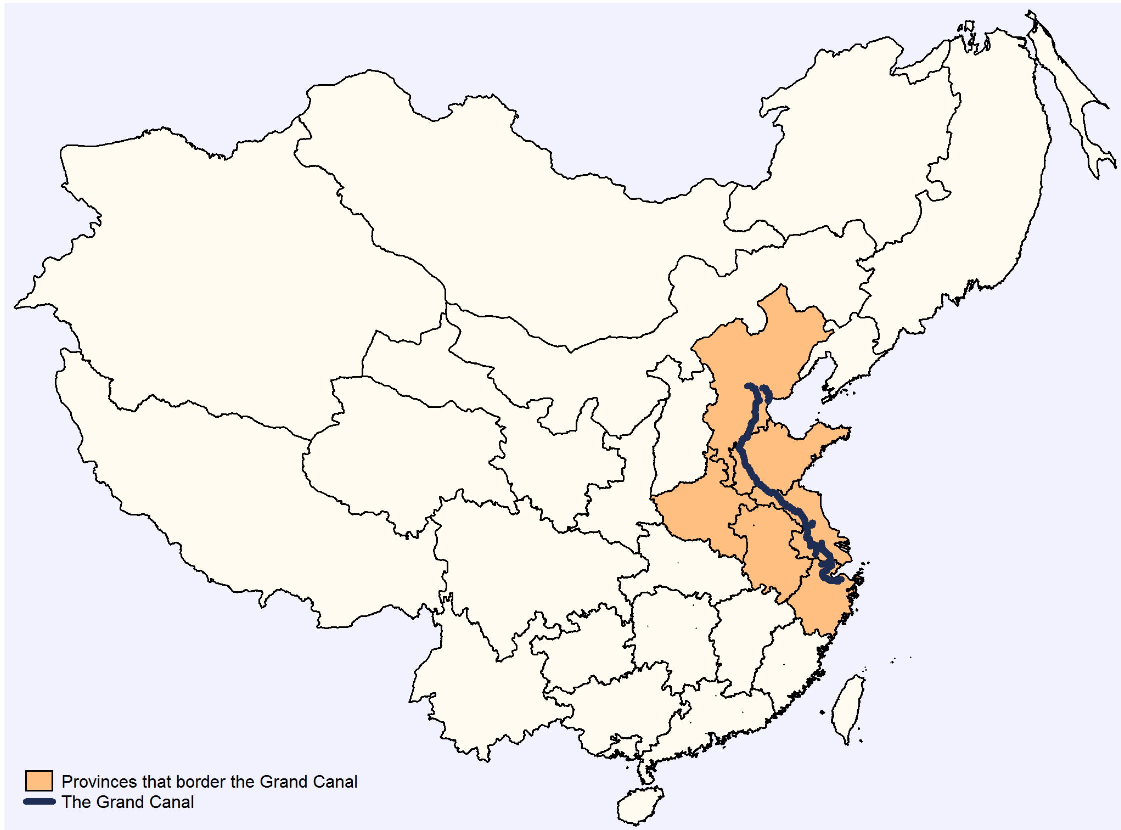

Figure 1: Location of the Grand Canal

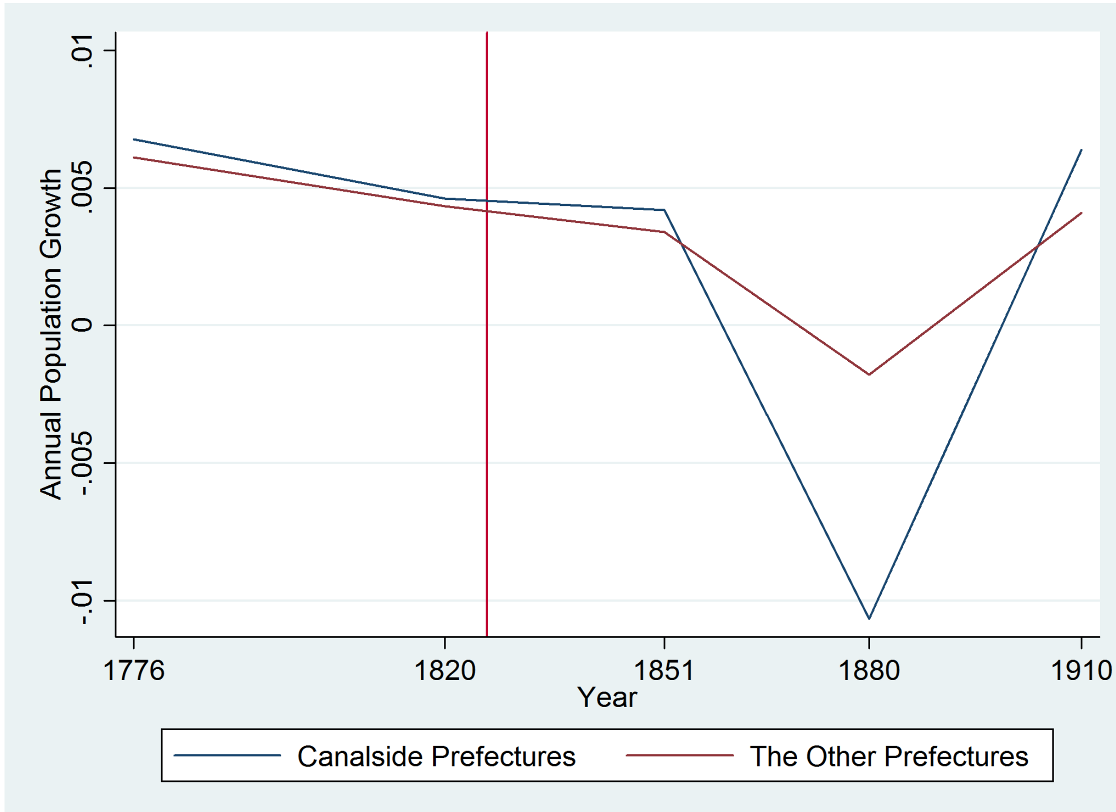

Figure 2: Annual Population Growth at the Prefecture Level

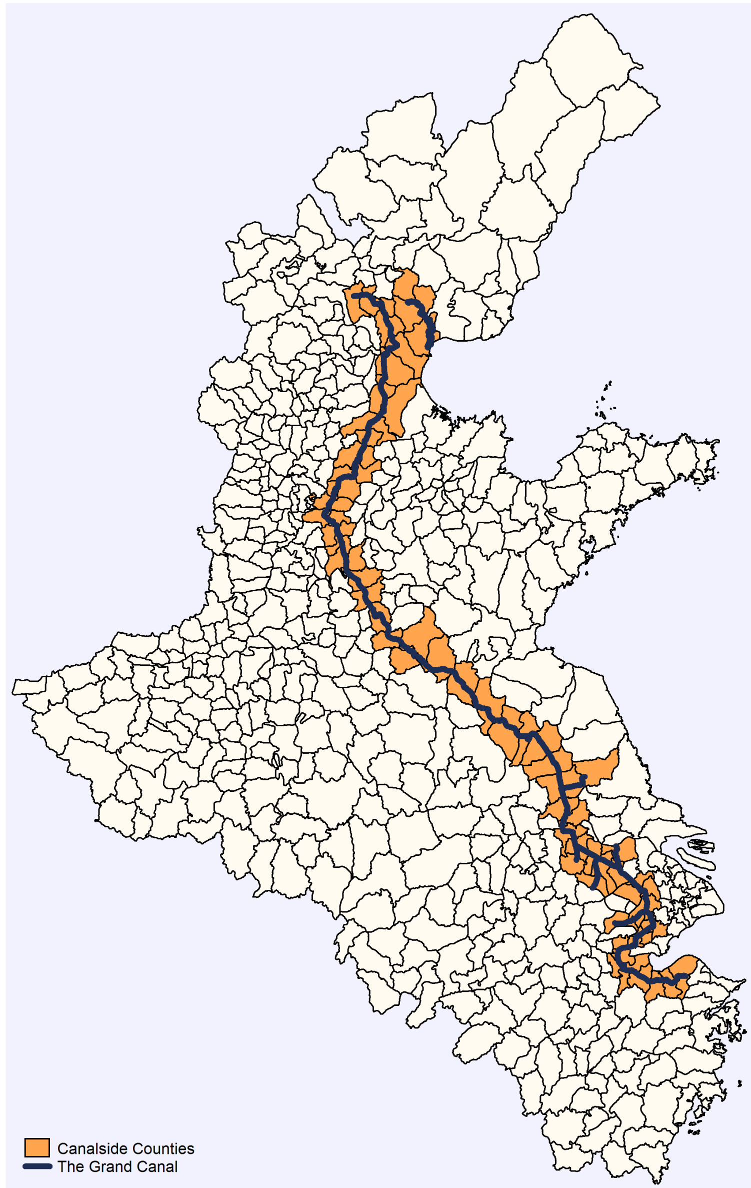

Figure 3: Counties Contained in the Sample

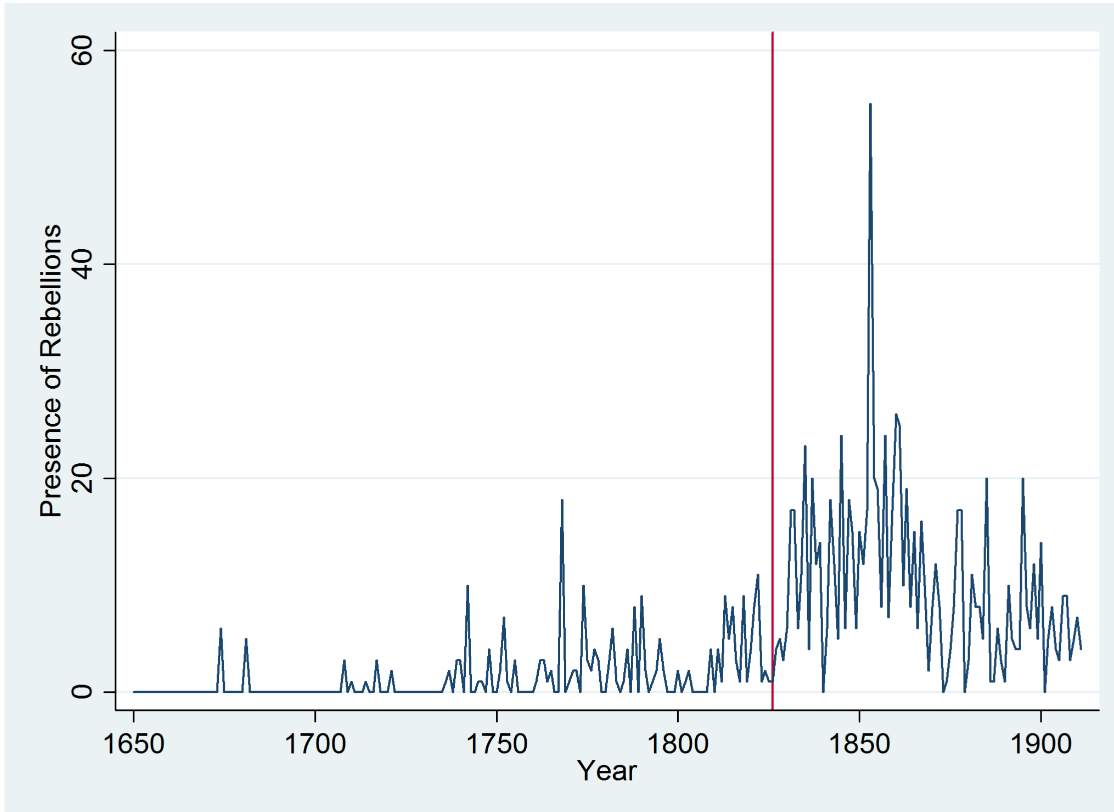

Figure 4: The Dynamics of Rebellions over Time

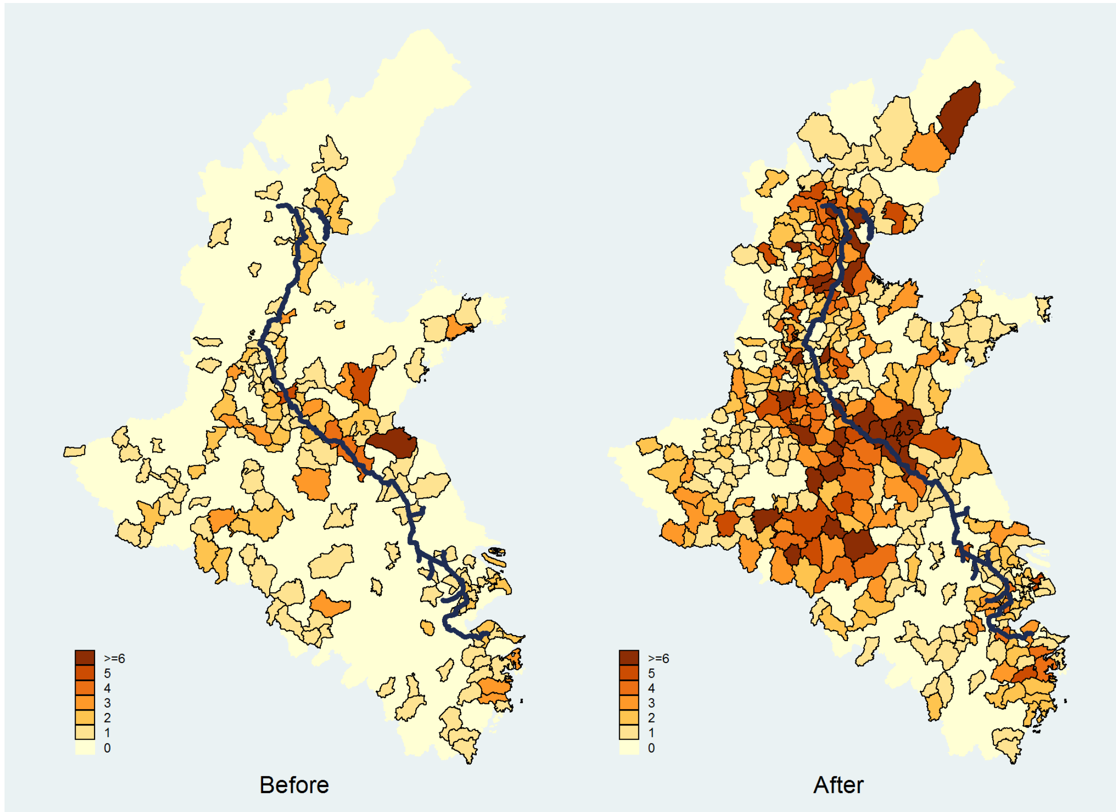

Figure 5: The Spatial Distribution of Rebellions before and after the Abandonment

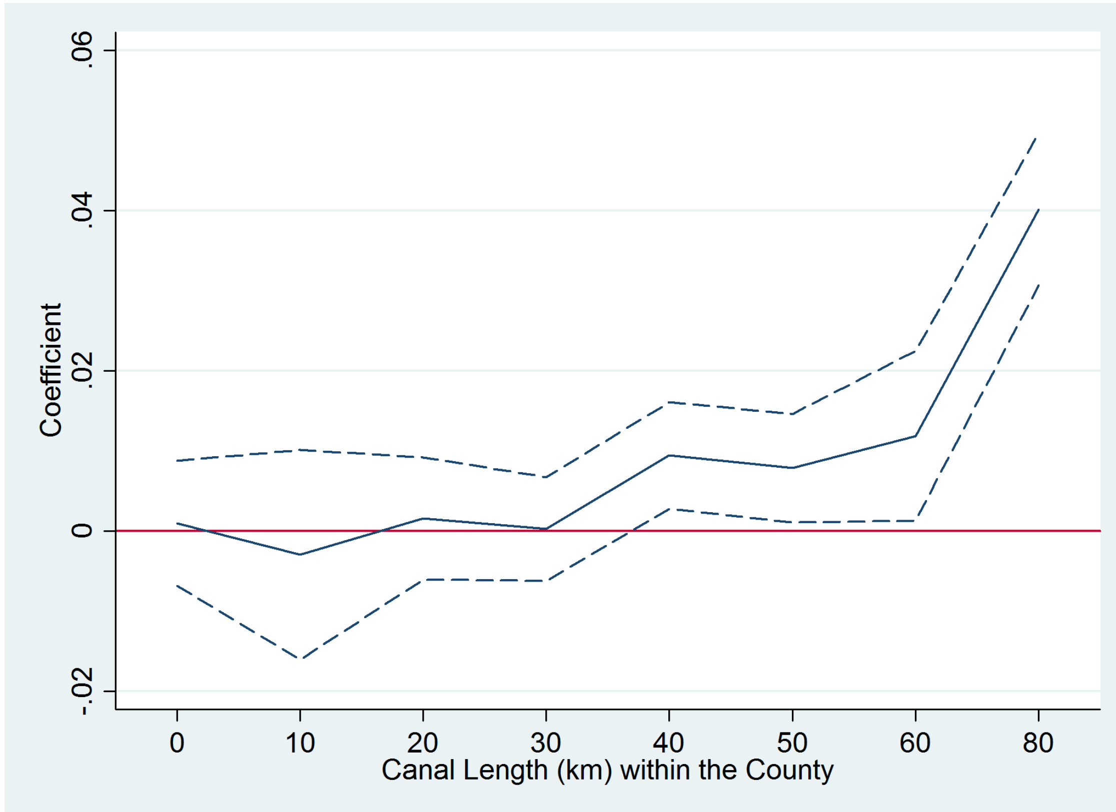

Figure 6: More Flexible Estimation of the Treatment Effects by Canal Length

Figure 7: More Flexible Estimation of the Treatment Effects by Distance to the Canal

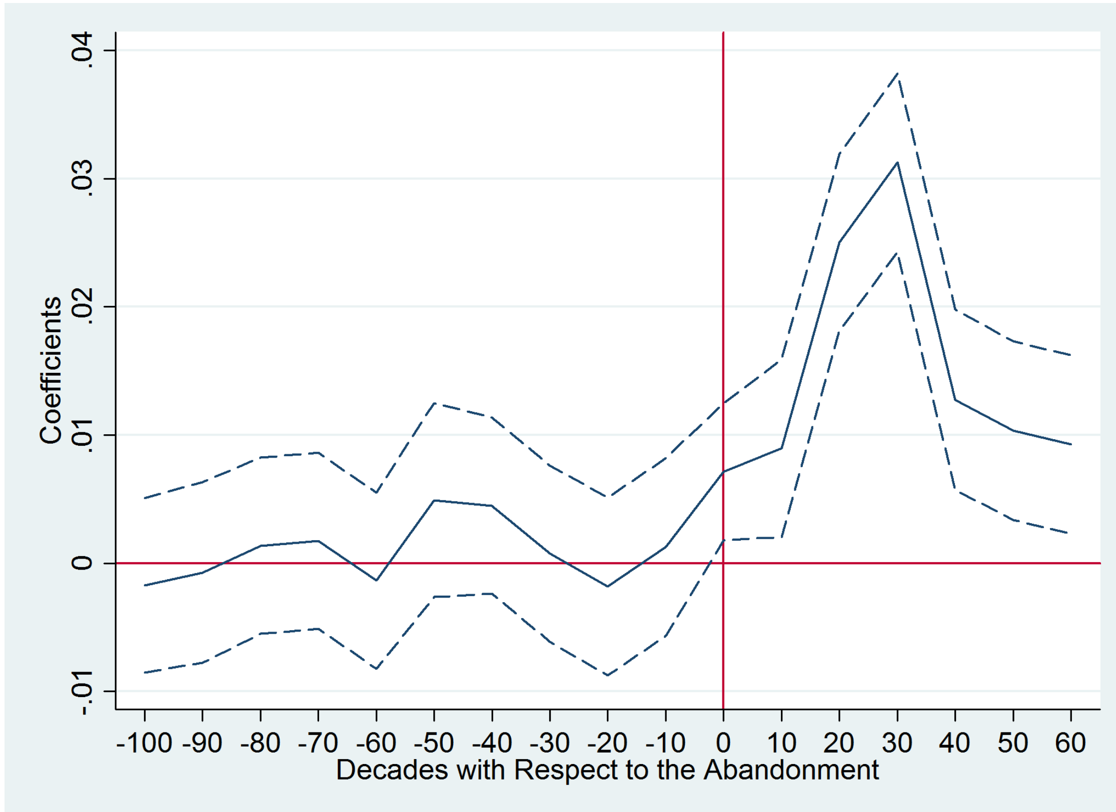

Figure 8: More Flexible Estimation of the Treatment Effects by Decades

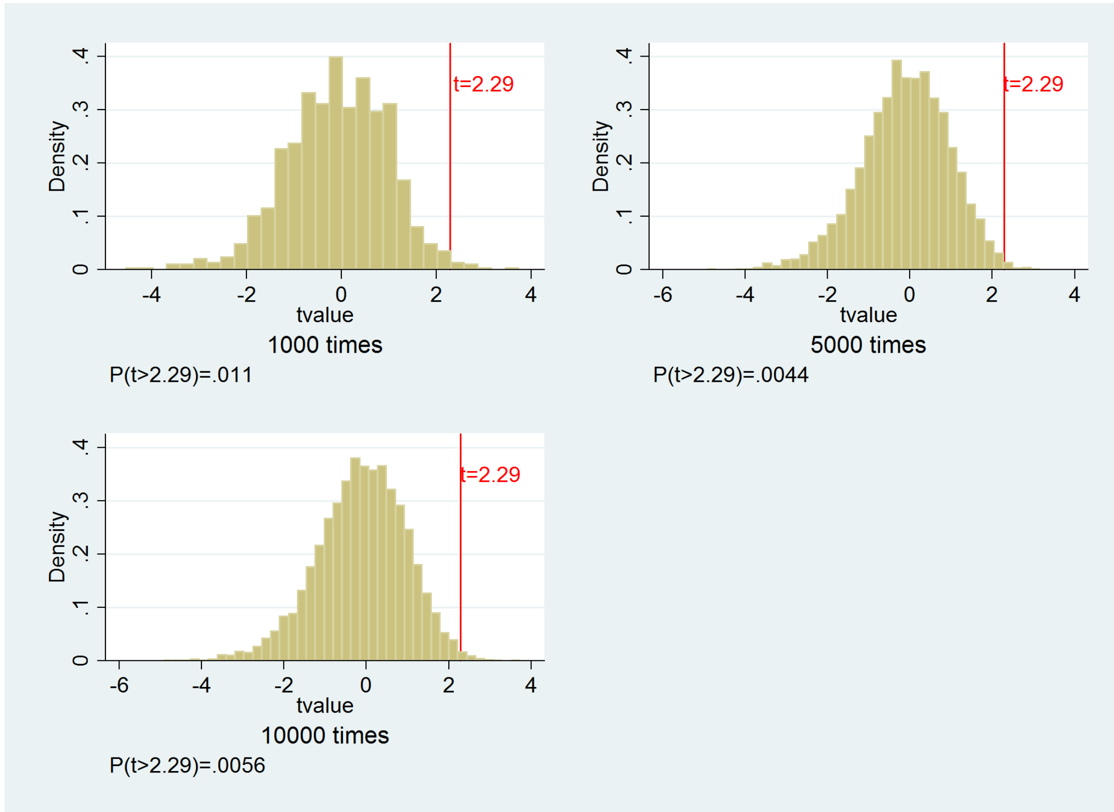

Figure 9: The Distribution of t-statistics from Randomly Assigned Placebo Treatment Effects

Tables

Table 1: Descriptive Statistics

	(1) Treated Group			(2) Control Group			(3) Difference	
	count	mean	sd	count	mean	sd	b	se
Dependents								
Presence	19126	0.0123	0.1104	131524	0.0066	0.0811	0.0057***	(0.0007)
Number	19126	0.0127	0.1152	131524	0.0068	0.0850	0.0059***	(0.0007)
Independents								
Being Along the Grand Canal	73	1.0000	0.0000	502	0.0000	0.0000	1.0000	(0.0000)
Length of Canal	73	32.4488	21.9727	502	0.0000	0.0000	32.4488***	(0.9756)
Distance from the Grand Canal (km)	73	0.0000	0.0000	502	135.1998	111.4449	-135.1998***	(13.0534)
Controls								
Ruggedness Index	73	16.9212	19.5289	502	80.8697	101.7660	-63.9485***	(11.9512)
Temperature Anomaly	19126	0.2988	0.4577	131524	0.3528	0.4778	-0.0540***	(0.0037)
Flood	19126	0.0018	0.0421	131524	0.0011	0.0341	0.0007**	(0.0003)
Year of Maize Adoption	73	1727.4110	86.3774	490	1717.0633	96.9254	10.3477	(11.9983)
Year of Sweet Potato Adoption	32	1778.1875	48.3818	199	1751.2864	50.8154	26.9011***	(9.6169)
Number of Soldiers Stationed	73	253.2877	394.6870	502	139.8028	336.1779	113.4849***	(43.0999)
Along Province Boundary	73	0.4932	0.5034	502	0.4402	0.4969	0.0529	(0.0623)
Taiping Heavenly Kingdom Severity	73	1.9178	1.1517	502	1.1534	1.1678	0.7644***	(0.1460)
Supplementation								
Number of Towns in 1820	73	7.0137	4.8833	502	4.3367	4.4119	2.6770***	(0.5604)
Number of Towns in 1911	73	19.2603	8.4212	502	20.4681	9.5526	-1.2079	(1.1797)
Along the Qing Courier Routes	73	0.5342	0.5023	502	0.2430	0.4293	0.2912***	(0.0550)
Suitability Index for Wheat (Irrigation, M Input)	73	4944.7827	1786.1936	502	4770.9345	1844.8759	173.8482	(230.1828)
Suitability Index for Wetland Rice (Irrigation, M Input)	73	4507.3127	782.0769	502	3649.4454	1247.6443	857.8673***	(150.2040)
Observations	19126			131524			150650	

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

Table 2: Comparing the Presence of Rebellions between the Treatment and the Controls

	Before 1825	After 1825	Difference
Counties Along the Grand Canal	0.0048	0.0288	0.0240***
	(0.0704)	(0.1730)	(0.0018)
Counties not Along the Grand Canal	0.0020	0.0166	0.0146***
	(0.0462)	(0.1322)	(0.0004)
Difference	0.0028***	0.0122***	0.0094***
	(0.0005)	(0.0019)	(0.0015)

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

Table 3: The Effects of the Abandonment of the Canal on the Presence and Number of Rebellions

	(1) Presence	(2) Presence	(3) Presence	(4) Presence	(5) Number
Along Canal × After Abandonment	0.0090**	0.0097**	0.0071*	0.0071*	0.0076*
	(0.0041)	(0.0038)	(0.0039)	(0.0037)	(0.0040)
	[0.0025]	[0.0025]	[0.0025]	[0.0025]	[0.0026]
Constant	0.0121***	-0.0062***	-0.0074	-0.4471***	-0.4522***
	(0.0006)	(0.0018)	(0.0287)	(0.1538)	(0.1576)
County FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Province × Emperor Fixed Effects	No	Yes	No	Yes	Yes
Prefecture Year Trend	No	No	Yes	Yes	Yes
Mean of the Dependent Variable	0.0073	0.0073	0.0073	0.0073	0.0076
No. of Observations	150650	150650	150650	150650	150650
No. of Counties	575	575	575	575	575
No. of Clusters	79	79	79	79	79
Adjusted R-squared	0.0239	0.0253	0.0265	0.0278	0.0290

Note: *, **, and *** denote significance at the 90%, 95%, and 99% levels respectively. Standard errors in parentheses are clustered at the prefecture level. Standard errors in square brackets are Conley standard errors robust for spatial correlation.

Table 4: Continuous Treatment Effects of the Abandonment of the Canal on the Presence of Rebellions

	(1) Presence	(2) Presence	(3) Presence	(4) Presence
Canal Length × After Abandonment	0.0003***			
	(0.0001)			
Distance to Canal × After Abandonment		-0.0001***		
		(0.0000)		
Along Canal × Years after Abandonment			0.0001**	
			(0.0001)	
Canal Length × Years after Abandonment				0.0000**
				(0.0000)
Constant	-0.0062***	-0.0087***	-0.0062***	-0.0062***
	(0.0018)	(0.0021)	(0.0018)	(0.0018)
County FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Province × Emperor Fixed Effects	Yes	Yes	Yes	Yes
Mean of the Dependent Variable	0.0073	0.0073	0.0073	0.0073
No. of Observations	150650	139384	150650	150650
No. of Counties	575	575	575	575
No. of Clusters	79	79	79	79
Adjusted R-squared	0.0255	0.0254	0.0251	0.0252

Note: *, **, and *** denote significance at the 90%, 95%, and 99% levels respectively. Standard errors are clustered at the prefecture level.

Table 5: The Effects of the Abandonment of the Canal with Multiple Controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Presence	Presence	Presence	Presence	Presence	Presence	Presence	Presence	Presence
Canal × After	0.0074*	0.0097**	0.0097**	0.0095**	0.0097**	0.0097**	0.0097**	0.0105***	0.0081**
	(0.0038)	(0.0038)	(0.0038)	(0.0038)	(0.0038)	(0.0037)	(0.0037)	(0.0038)	(0.0039)
Ruggedness × After	-0.0000***								-0.0000***
	(0.0000)								(0.0000)
Temperature Anomaly		-0.0016*							-0.0016*
		(0.0008)							(0.0009)
Flood			0.0017						0.0020
			(0.0066)						(0.0067)
Maize Adopted				0.0018					0.0015
				(0.0018)					(0.0017)
Sweet Potato Adopted					-0.0003				0.0000
					(0.0021)				(0.0020)
Soldiers × After						-0.0000			0.0000
						(0.0000)			(0.0000)
Province Boundary × After							0.0035		0.0034
							(0.0023)		(0.0023)
Taiping Region × After								-0.0011	-0.0012
								(0.0014)	(0.0015)
Constant	0.0003	-0.0057***	-0.0062***	-0.0059***	-0.0062***	-0.0022	-0.0067***	-0.0021	-0.0012
	(0.0017)	(0.0018)	(0.0018)	(0.0020)	(0.0018)	(0.0019)	(0.0018)	(0.0017)	(0.0019)
County FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × Emperor FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean of the D.V.	0.0073	0.0073	0.0073	0.0074	0.0074	0.0073	0.0073	0.0073	0.0074
No. of Observations	150650	150650	150650	147506	147506	150650	150650	150650	147506
No. of Counties	575	575	575	563	563	575	575	575	563
No. of Clusters	79	79	79	76	76	79	79	79	76
Adjusted R-squared	0.0256	0.0253	0.0253	0.0256	0.0256	0.0253	0.0254	0.0253	0.0261

Note: *, **, and *** denote significance at the 90%, 95%, and 99% levels respectively. Standard errors are clustered at the prefecture level.

Table 6: Testing the Shocks to State capacity

	(1) Attacking	(2) Attacking	(3) Fleeing	(4) Fleeing
Along Canal × After Abandonment	-0.0010		-0.0010	
	(0.0026)		(0.0022)	
Canal Length × After Abandonment		0.0000		0.0000
		(0.0001)		(0.0001)
Constant	0.0104***	0.0105***	0.0045***	0.0045***
	(0.0005)	(0.0005)	(0.0004)	(0.0004)
County FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Mean of the Dependent Variable	0.0048	0.0048	0.0031	0.0031
No. of Observations	150650	150650	150650	150650
No. of Counties	575	575	575	575
No. of Clusters	79	79	79	79
Adjusted R-squared	0.0974	0.0974	0.0804	0.0804

Note: *, **, and *** denote significance at the 90%, 95%, and 99% levels respectively. Standard errors are clustered at the prefecture level.

Table 7: Testing the Shocks to Agricultural Productivity

	(1) Presence	(2) Presence	(3) Presence	(4) Presence
Along Canal × After Abandonment	0.0091***		0.0082***	
	(0.0015)		(0.0019)	
Canal Length × After Abandonment		0.0003***		0.0003***
		(0.0000)		(0.0001)
Along Canal × After Abandonment × Suitable for Wetland Rice	0.0007			
	(0.0045)			
Canal Length × After Abandonment × Suitable for Wetland Rice		0.0002		
		(0.0002)		
Along Canal × After Abandonment × Suitable for Wheat			0.0009	
			(0.0028)	
Canal Length × After Abandonment × Suitable for Wheat				0.0000
				(0.0001)
Constant	0.0121*	0.0121*	0.0131**	0.0131**
	(0.0063)	(0.0063)	(0.0063)	(0.0063)
Basic Interactions	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Mean of the Dependent Variable	0.0073	0.0073	0.0073	0.0073
No. of Observations	150650	150650	150650	150650
No. of Counties	575	575	575	575
Adjusted R-squared	0.0239	0.0242	0.0243	0.0246

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

Table 8: Testing the Shocks to Trade Accessibility

	(1) Town Number	(2) Presence	(3) Presence
Along Canal × After Abandonment	-0.5170***	-0.0001	0.0122***
	(0.1692)	(0.0047)	(0.0020)
Share of 1820 Towns within 10km to Canal × After Abandonment		0.0179**	
		(0.0087)	
Along Canal × Along Courier			0.0133*
			(0.0074)
After Abandonment × Along Courier			0.0005
			(0.0012)
Along Canal × After Abandonment × Along Courier			-0.0064**
			(0.0028)
Constant	1.2138***	0.0120***	0.0120*
	(0.0298)	(0.0004)	(0.0063)
County FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Mean of the Dependent Variable	2.1228	0.0075	0.0073
No. of Observations	1104	138598	150650
No. of Counties	575	529	575
Adjusted R-squared	0.6526	0.0249	0.0239

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