Eclipses and the Memory of Revolutions: Evidence from China

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Abstract

We study the historical roots of anti-government protests in China. We document that Chinese counties with a higher incidence of peasant uprisings against local government officials during the Qing dynasty period (1644-1912) had a higher participation in the protests that led to the 1911 Revolution and the fall of the imperial rule. To generate exogenous variation in the incidence of past protests, we exploit differences in the visibility of solar eclipses across counties. In the Confucian tradition, solar eclipses were considered negative divine signals on the legitimacy of rulers, facilitating the coordination of anti-government actions.

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I Introduction

Throughout history, social protests have brought issues at the forefront of public debate, influenced policy-makers' agendas, and, in some instances, forced regime changes. The last decade has witnessed a large number of social protests in authoritarian regimes. Although many communities within a country often share similar grievances towards their government, protests do not erupt with the same intensity everywhere. Existing research has focused on the type of grievances more likely to drive people on the street, and on how individuals' decision to participate in protest actions interacts with their beliefs about participation by others.[1]

In this paper, we bring evidence on a specific determinant of observed differences in the incidence of protests: the existence of a historical tradition of anti-government actions within a given community. We focus on the wave of protests that erupted across China in the first decade of the 20^{th} century and that culminated with the 1911 Revolution and the consequent end of the Chinese Empire. The last ruling dynasty of the Chinese Empire, the Qing, had been in power since 1644 and, during almost three centuries, had faced numerous episodes of local unrest – often in the form of uprisings by farmers against local government officials. We investigate whether a local tradition of social uprisings built over centuries of Qing rule affected the local participation in the wave of protests that culminated in the 1911 Revolution.

The main identification challenge is that unobservable characteristics that make certain communities more rebellious in the past, might also make them more rebellious decades, or even centuries later. We overcome this challenge by exploiting plausibly exogenous variation in the incidence of rebellions generated by the visibility and magnitude of solar eclipses across Chinese counties during the Qing dynasty period. In the Confucian tradition, solar eclipses were considered a negative divine signal on the legitimacy of rulers. We argue that eclipses acted as a salient and observable signal with a shared interpretation among the local population, facilitating the coordination of anti-government actions and thus increasing the probability of local protests in communities that observed them.

We construct a new dataset containing the date and location of peasant uprisings that occurred during the Qing dynasty period starting from county chronicles. County chronicles record all major events that took place in a given county – including insurgency actions – and were compiled by independent, reputable local intellectuals. Our dataset includes 1,956 rebellions that occurred under the Qing dynasty between 1647 and 1911. Rebellions were frequent in rural China and played an important role in several major

[1] See Gehlbach et al. (2016) for a recent review. See Autor et al. (2020), Algan et al. (2017), Fetzer (2019), Ponticelli and Voth (2020) for evidence on drivers of social unrest. See Cantoni et al. (2019) for experimental evidence on strategic substitutability in protest participation, and Manacorda and Tesei (2020) and Enikolopov et al. (2020) for evidence on the role of social media and telecommunication technologies as coordination mechanisms facilitating protest participation.

political changes in Chinese history. Poverty and hunger were the primary causes of peasant uprisings, which targeted local elites and government officials for their unrestrained exploitation of local farmers via over-taxation (Long, 2016; Wang, 1884).

We merge data on the year and location of rebellions during the Qing dynasty period with geo-located historical data on the areas of visibility and magnitude of solar eclipses from the US National Aeronautics and Space Administration (NASA). Solar eclipses are a plausibly exogenous source of variation because their magnitude, areas of visibility and timing are solely determined by the relative position of the sun, the earth, and the moon. In addition, different from natural disasters, solar eclipses have no direct destructive impact on physical capital or agricultural productivity. Consistently, we show that their timing is uncorrelated with local climatological or economic shocks – such as droughts or famines.

In the first step of our empirical analysis, we test whether the visibility of solar eclipses affects the incidence of peasant uprisings during the Qing dynasty period in a panel specification. We find that counties in the totality zone of a solar eclipse – i.e. the relatively thin strip of land in which the view of the sun is completely blocked by the moon – are between 15 and 18 percentage points more likely to experience a rebellion in the eclipse year relative to counties outside of the totality zone but located within the same province. Eclipses affect the contemporaneous probability of uprisings, with no visible pre-existing trends. The effect is significantly larger in counties with a Confucian temple, which we use as a proxy for the local diffusion of Confucianism.

Next, we study the effects of a historical tradition of anti-government rebellions on participation in the 1911 Revolution. While scholars of Chinese history have argued that a legacy of peasant rebellions might have constituted fertile ground for local participation in the revolution that ended the Qing dynasty, establishing a causal relationship is challenging from an identification standpoint.[2] We provide direct empirical evidence of such a connection by exploiting plausibly exogenous variation in the incidence of past rebellions generated by solar eclipses. Our findings indicate that past incidence of social unrest was indeed an important driver of participation in one of the key regime changes in China's history. The estimates indicate that Chinese counties with a standard deviation larger number of past rebellions per capita had about 1.5 more social protests per 1000 people recorded in the decade that led to the revolution, between 1902 and 1911.

How long do the effects of past protests persist over time? We test for persistence in the very long run using detailed data on social protests in the 2001-2013 period that was recently made available by the China Academy of Social Sciences (CASS). In the century that followed the 1911 Revolution, China experienced important political changes, profound economic transformations and massive internal migration. We expect these forces to attenuate any long run impact of a local tradition of peasant uprising that

[2]See Perry (1980) for a detailed discussion of this literature.

emerged during the Qing period. Still, we find that variation in past rebellions explain the incidence of social protests in China during the first decade of the 20th century and up to 2013. The magnitude of our estimates indicates that the effect is about half of what was observed a century earlier.

Why should the incidence of past rebellions have long run effects on the inclination of a certain community to protest? We explore two potential mechanisms. First, we investigate the role of local collective memory. A large empirical literature has documented that cultural norms and beliefs can persist within certain communities over long periods of time.[3] To test this mechanism, we collect new data on measurable signs of inter-generational transmission of the memory of anti-Qing rebels of the past. These include physical structures – such as temples and memorials – celebrating prominent individuals that fought the initial Qing invasion of China, and the presence of a positive recorded memory of these early anti-Qing leaders as captured by the description of their actions in local chronicles.[4] We find that the long-run effect of past rebellions is larger in areas that celebrated early anti-Qing leaders via temples or where such stories were recorded in local chronicles, thus preserving their memory for future generations.

How does the preservation of collective memories about past rebellions translate into a higher propensity to protest decades later? The empirical literature has shown evidence that collective memories from the past can be re-activated by current events, even after being dormant for long periods of time.[5] This mechanism is consistent with models of choice such as Bordalo et al. (2020), where the memory of past experiences serves as an anchor for individual decisions and influences how they react to new information. We test this mechanism by comparing the protest response of counties exposed to the same source of grievances but with different past protest experiences. In particular, we study differences in the propensity to protest in response to a local increase in air pollution levels, which has been shown to significantly affect public satisfaction with local government (Alkon and Wang, 2018). Our findings indicate that, for the same increase in air pollution measured by $PM_{2.5}$, counties that – for plausibly exogenous reasons – have a larger historical experience of anti-government rebellions, are more likely to respond with protest actions.

A second potential mechanism behind persistence is that higher intensity of past protests can affect the economic development of a given community. For example, because

[3]See Voth (2021) for a recent review. Voigtländer and Voth (2012) document that German towns with a higher incidence of pogroms against Jews in the Middles Ages displayed significantly more anti-Semitic attitudes in the interwar period of the 20^{th} century. They argue that persistence might be partly explained by local anti-Semitic traditions and symbols that remained in the local culture for centuries.

[4]See on this the related work by Michalopoulos and Xue (2018), which study the role of oral traditions (folklore) in explaining why certain social and cultural attitudes persist within a given community.

[5]For example, Ochsner and Roesel (2017) document that Austrian municipalities that were pillaged by Turkish troops between the 16^{th} and the 17^{th} century were more responsive to a 2005 right-wing populist campaign against Turks and Muslims. On the role of memory in shaping local collective action see also the related work by Marchais et al. (2021) and Dell and Querubin (2018).

of their higher social instability, counties with more rebellions during the Qing dynasty period might have experienced lower economic growth. Lower economic development, in turn, decreases the opportunity cost of protest participation, making such locations more prone to anti-government protests in future years, independently from the collective memory of past rebellions. We test this channel by studying the impact of past rebellions on several measures of economic development both in the early 1900s and in the early 2000s, including measures of population and GDP per capita. Overall, we find imprecise estimates of the effects of past rebellions on economic development, suggesting that this channel is unlikely to be a primary driver of persistence.

Related Literature

Our paper is related to several streams of the literature. First, the mechanism linking solar eclipses to the probability of protests is related to the literature on coordination in protest actions and on how individuals' decision to participate in protests is influenced by the decision of others. Several papers postulate that the actions of a "pilot" of revolutionaries can act as a signal for other people to join. De Mesquita (2010) studies how a small number of rebels ("vanguard") can use violence as a form of public information, signaling to others that there are strong feelings of opposition to the government. Similarly, Lohmann (1994) exploits the events preceding the fall of the Berlin Wall to study how potentially costly (but peaceful) public demonstrations can result in an informational cascade, drawing additional participants as they observe fellow citizens demonstrating in increasing numbers. Cantoni et al. (2019) use a field experiment in Hong Kong to study how information about others' plans to protest affects an individual's decision to participate, and find evidence of strategic substitutability, namely that information of higher-than-expected planned participation by others has a negative effect on an individual's own participation. Our paper exploits the insight of this literature to rationalize the empirical link between solar eclipses and rebellions during the Qing dynasty period.[6]

Our work is also related to the literature on persistence in political engagement. In recent work, Bursztyn et al. (2021) have studied the short-run persistence in protest participation at the individual level. This is an important question because the success of a political movement often depends on its ability to sustain political engagement over time. Bursztyn et al. (2021) use a field experiment during the Hong Kong anti-authoritarian movement to show that individuals participating in the 2017 protests were significantly more likely to also participate in the following year's protests. In other related work,

[6] A literature of coordination and coordination failure is vast and applies to a wide range of economic phenomena, from bank runs (Diamond and Dybvig, 1983; Shiller et al., 1984; Hertzberg et al., 2011) to asset price fluctuations (Azariadis, 1981; Cass and Shell, 1983; Obstfeld, 1984; Tirole, 1985; Grandmont, 1985; Azariadis and Guesnerie, 1986; Guesnerie, 1986; Woodford, 1986, 1990; Farmer and Guo, 1994; Benhabib and Farmer, 1999; Morris and Shin, 2002). For evidence on the coordination mechanism from lab experiments see Mehta et al. (1994a,b); Duffy and Fisher (2005); Fehr et al. (2019); Arifovic and Jiang (2014).

Madestam et al. (2013) use weather shocks to instrument for attendance at tea party protests in 2009 and find that participation in such protests in 2009 affected votes for the republican party in the 2010 US presidential elections. See also Aidt and Franck (2015) and Collins and Margo (2007) for evidence on the effect of protest participation on voting behavior and economic outcomes. Our paper contributes to this literature by providing evidence on the persistence of protest actions at the community level, and that such effects can materialize even after long periods of time.

Our paper is also related to the large literature in history, sociology and economics studying the determinants of the fall of the Qing dynasty. Such determinants included a series of military defeats with the consequent burden of reparations in the early 20th century, an economy characterized by high inflation, a weakening of the central government capacity and a series of hurried reforms which generated broad discontent (see Esherick and Wei (2013) and Zheng (2018) for a discussion). One of such reform was the elimination of the imperial examination to recruit civil servants, the traditional mean of social mobility during over a millennium of imperial rule (Franke, 1960, 1970). Bai and Jia (2016) provide direct evidence that the abolition of the imperial civil service exam by the Qing court in 1905 fostered participation in subsequent social protests due to the increase in resentment of individuals that aspired to use the exam to become part of the imperial bureaucratic elite.[7] We document that our results are robust to controlling for exposure to the elimination of the imperial examination as captured by local quotas in the Keju exam, indicating that the two channels capture independent variation.

Finally, our identification strategy is related to the literature using natural phenomena as a catalyst for change in religious and political power (Lipset, 1959; Barro, 1999; Acemoglu and Robinson, 2006). Chaney (2013) analyzes the relationship between the flooding of the Nile and related shifts of political power in Egypt. He suggests that a religious figure's power increases during perilous economic circumstances brought by the Nile, and that this figure is less likely to be replaced, mainly due to their potential for coordinating a revolt. Belloc et al. (2016) find a similar result in the case of mild earthquakes in the south of Italy between 1000 and 1300, which led to an increase in the perceived power of politico-religious leaders to restore social order, delaying the transition to communal institutions. In the context of China, Bai (2023) shows that mild earthquakes generated higher political instability – as proxied by conflicts – between the XIV and XIX century. Ticku et al. (2018) offer a complementary explanation for the relationship between negative weather shocks in India and recorded temple desecration, a preemptive measure by a Muslim ruler to avoid such coordinated revolutions within their Hindu constituencies.

The rest of the paper is organized as follows. Section II provides the historical background. In this section we discuss the interpretation of solar eclipses in Confucianism,

[7] See, on this, also Hao et al. (2022), which argues how the abolition of the civil service exam led to a deterioration in the quality of local governance, and a consequent increase in protests against local elites.

and their potential as a coordination device for protest actions. We also discuss the type of rebellions and the motives behind them during the Qing dynasty period and the 1911 Revolution. Section III describes the data sources. Section IV presents the empirical strategy and discusses the identification assumptions. Section V describes the main empirical results of the paper. Finally, section VI discusses potential mechanisms.

II Historical Background

II.A Solar Eclipses as a Coordination Device

Previous literature has argued that random and otherwise irrelevant events ("sunspots") can act as a coordination device among agents as long as: the signal is salient and observable by many agents (Shelling, 1960), and a common belief about the meaning of the signal exists among the agents (Duffy and Fisher, 2005). We argue that solar eclipses observed during the Qing dynasty period fit these two criteria: they are both a salient signal from the perspective of observers on the earth, and have a shared interpretation as the manifestation of the heavens' opinion about a ruler.

Solar eclipses occur when the paths of the sun and the moon intersect so that the sunlight is temporarily blocked by the moon, casting shadows on earth. A total eclipse, in which the sun is completely blocked, can only be observed in a certain area of the earth at any given time during an eclipse event. Referred to as the zone of totality, these areas are usually several thousand kilometers long and less than one hundred kilometers wide, with individuals inside the zone of totality observing the eclipse within the same day, several hours apart. During a total eclipse, the sun is blocked, day becomes night, and stars become visible for as long as one hour.

Confucianism was the dominant ideology in ancient China, including the Qing dynasty period, and continues to play a major role in shaping the minds and actions of Chinese society today. In the Confucian tradition, a solar eclipse is a signal regarding the legitimacy of the ruler. An important saint in Confucianism, Mencius, believed the legitimacy of emperors to come by endorsement from heaven, under the condition that the emperor takes care of his people.[8] Those rulers who failed to do so would be abandoned by heaven, leaving the people with the right to overthrow them.

According to Confucianism, also other natural anomalies such as natural disasters and celestial phenomena are all indications of the heavens' opinion about the ruler. However, a solar eclipse represents the most serious condemnation from the heavens. As the sun is

[8]Mencius proposed three intersections between Confucianism philosophy and politics: 1) That heaven is what grants an emperor's power (Mengzi 5A5), 2) That an emperor needs to exercise benevolent governance in accordance with the will of heaven (Mengzi 1B6, 2A5, 2B1), and 3) That an emperor who does not govern accordingly will be condemned by heaven, warning that righteous fury can come by way of natural anomaly. At those times, any consequent revolutions and regional-overthrow are legitimate (Mengzi 1B8, 2B9).

regarded as the sign of the emperor (Li, 1990), an eclipse of the sun can be related to his moral faults. This idea dates back to the earliest books compiled by Confucius himself during the spring and autumn period of China. For instance, "The state without good governance could bring in the disaster of the solar eclipse"(Zuozhuan, Zhao, 7) or "The sun and moon did not follow common rules because the governance of the state was not good"(Shijing, Xiaoya, In October). During the Han and later dynasties, warnings of the eclipse were also common: "The most notable is Heaven and the ultimate change that could happen to the emperor is the solar eclipse" (Wuxing, Houhan, Ji, 2003, book 7, PP429).

The association between solar eclipses and ruler's illegitimacy was popularized in the era of Keju examinations. Keju examinations were the device used in imperial China to select civil servants, and the main, if not the only, channel of social mobility. The interpretation of solar eclipses appears in all nine works of the Confucian canon, which constitutes a large portion of the question pool at all levels of the Keju examinations. This means that more than 5% of the population, attracted by the economic and social benefits associated with passing the imperial examination, would spend a large share of their adult lives memorizing and understanding the Confucian canon and were therefore familiar with this interpretation of solar eclipses. Moreover, the candidates, whether successful or not, usually enjoyed a high social status and had a strong voice in local affairs due to their ability to read and write. In this sense, when commoners had difficulty understanding what an eclipse meant, the eclipse-illegitimacy interpretation they heard from respectable local intellectuals was likely to be both intuitive and convincing to them.

Because of their shared interpretation, solar eclipses were feared by emperors. As a pre-emptive measure, it was an established tradition for emperors to issue "self-condemnation" scripts, asking for the pardon of the heavens whenever a solar eclipse was observed. The first self-condemnation script ever issued by an emperor in the history of China was made by emperor Wen during the Han dynasty, who witnessed two eclipses during his reign. In a famous script, emperor Wen declares, "I am incapable of ruling and taking care of my entire population and therefore bring about a solar eclipse that illustrates how large my sins are". The practice of issuing self-condemnation scripts after the sight of a solar eclipse became a royal practice passed down to later generations of emperors. In addition to these scripts, emperors usually took measures to improve their administration, please their subjects and prevent local rebellions. Those measures included cutting local taxes, forgiving inmates of milder crimes, allowing people to bring their petitions to the capital, or increasing local quotas for the civil service exam (Zang, 2015).

Due to its political sensitivity, the study of astronomy was largely monopolized by the imperial court via the Bureau of Astronomy. Access to instruments and books was restricted to affiliated astronomers, who held lifetime and hereditary appointments. This might explain why the predictions of lunar and solar eclipses – one of the most important

tasks the Bureau of Astronomy was in charge of – were still very inaccurate even in late Qing China (Lu and Shi, 2003a,b). Although astronomers had a clear understanding of the natural causes of solar eclipses, such events kept being considered an ominous event among the population. Due to the high levels of illiteracy and the absence of modern science education, the vast majority of Chinese people during the Qing dynasty period had scarce knowledge of astronomy.[9]

II.B Social Protests during the Qing Dynasty period

Social protests were frequent in Chinese history and played an important role in politics. In fact, almost every dynasty's collapse in Chinese history was linked to violent protests in either a direct or indirect way. Poverty and hunger were the primary causes of such protests, that mostly took the form of peasant uprisings (Long, 2016; Wang, 1884). Perry (1980) suggests that violence and banditry were a survival strategy for desperate farmers, especially in regions hit by bad harvests. Uprisings were also linked to the unrestrained behavior of local elites and government officials, who relentlessly exploited the local peasants. The local elites, powered by their economic and social superiority, usually encroached on the private lands of peasants and profited from the manipulation of local the silver-money exchange rates to exploit them. Local officials, who were usually in debt due to the large investment they had to make to prepare for the Keju exam, did not hesitate to levy additional taxes on peasants (Miao et al., 2020).

The peasant revolutionaries' dissatisfaction toward the local elite and officials was visible in their political slogans. For instance, during the Li Zicheng revolution at the end of the Ming dynasty, peasants raised the slogan of "equalize land ownership, exempt tax and debt of the poor" to express their anger toward over-taxation by the government, and toward exploitation by the local elite. Similar slogans were also used in the Taiping revolution during the Qing dynasty period.

Riots and uprisings of discontent peasants were justified by Confucian classics, especially those from Mencius (OuYang, 2009). From Mencius' point of view, there is no difference between ordinary people and rulers, and ordinary people could become legitimate rulers if they treat people with mercy ("Everyone can be a saint", Mengzi, 5A6, 6B2). This idea justified Chinese people's enthusiasm for uprisings. The leaders of peasant uprisings were often failed Keju examinees, probably due to their higher education and advantage in effective communication. However, the history of China is also characterized by revolutionary leaders coming from the lowest peasant class with almost no education, such as the founder of the Ming dynasty, Zhu Yuanzhang.

[9]It is interesting to note that the Qing emperors did not try to dispel the superstitious interpretation of solar eclipses. For example, the Qing's court stipulated that during predicted eclipses, all officials had to participate in a ritual to "save the sun". Officials in the capital were required to join the ritual at the gate of the Ministry of Rites, wearing white clothing (Shi and Lu, 2002).

II.C The Fall of the Qing Dynasty

The Qing dynasty officially ended in 1912, but the abdication of the last emperor was preceded by a decade of increasing discontent and social protests in China. In the early 20th century, the Qing government was struggling with the age-old "king's dilemma" of how to modernize a backward society – such as China at the time – while yet remaining in power (Huntington, 2006). In the last decade of the dynasty, the central government's authority had weakened after a series of military defeats, most notably the Sino-Japanese War and the boxers' rebellion and was saddled with large war reparations.

A set of reforms were hurriedly put into place by the ruling dynasty, sending China spiraling out of control. Some of the reforms resulted in appointments that gave the royal family total control over key political positions, leaving the population extremely dissatisfied. Talented young Chinese were sent to study abroad, but when they returned, they brought new revolutionary ideologies with them. The military started recruiting educated individuals, leading to a new army full of young literate soldiers whose opinions were influenced by revolutionary ideas and who resented the regime for the elimination of the civil service examinations. A series of changes aimed at establishing new institutions, such as the police, greatly increased the local fiscal burden. Local governments, which were not restrained by a weakening central government, took the opportunity to levy arbitrary taxes, which substantially increased public resentment (Hao et al., 2022). Inflation and high taxes started to force companies out of business, increasing unemployment.

Ultimately, social tensions during the first ten years of the 20th century translated into a wave of social unrest episodes, which were initially repressed by the government. Many of such episodes were started by merchants, workers, and farmers in response to deteriorating economic conditions, exploitation by local elites and discontent at the government's policies (Wang, 2008; Yang, 2010). In the October of 1911, revolutionaries in Wuchang were forced into an uprising as their plan of action was exposed due to a gunpowder explosion. Their action was successful and was quickly supported by other regions, leading to 15 out of 24 provinces declaring independence within a month. The Qing Dynasty's rule was overturned four months later, in February of 1912.

III Data

III.A Solar eclipses

Data on solar eclipses is sourced from the US National Aeronautics and Space Administration (NASA). The NASA database provides detailed information on all solar eclipses occurred in the last 5,000 years, including the timing and the magnitude of each observable eclipse in each region on earth. We focus on those eclipses whose zones of totality intersect the China territory. Figure I reports, as an example of the raw data, the zones

of totality for two eclipses, one occurred in 1742 and the other in 1760, that were visible from China. We define county borders during the Qing dynasty period using data from the China Historical Geographic Information System (CHGIS). We combine the CHGIS data on county borders and NASA information on solar eclipses to generate a panel data at county-year level reporting the magnitude of visible solar eclipses in each county and year.[10]

Figure II shows the geographical distribution of counties in the totality zone of solar eclipses during the Qing dynasty period. Figure III shows the number of counties in the totality zone of a solar eclipse by year between 1644 and 1912.

III.B Social protests

Data on peasant uprisings during the Qing dynasty period is manually extracted from the Chronology of Warfare in Dynastic China (China's Military History Editorial Committee, 2003). This collection includes all wars, conflicts and revolts in the history of China. We focus on the Qing's period (1644-1912). We manually analyzed all the records and include in our dataset only peasants uprisings. Figure A.1 shows one example of such records. This example describes a revolt taking place in 1813. The record provides information on the time, location, cause, name of the leader, and the total number of participants in the revolt. It also provides a brief description of how the revolt developed and the interactions between the rebels and the government.

The information used to compile the Chronology of Warfare in Dynastic China comes from both the central government and local chronicles. For most large-scale rebellions, there exists a very detailed central government record. The central government had a strong incentive to be informed of local rebellions in a timely fashion, because if they did not tackle such issues promptly, small insurgencies could turn into nation-wide rebellions. Therefore, local officials were required to report information about local revolutions to the central government. The failure to do so could lead to the removal of a local official.

The local chronicles, which record all major local events occurring in a given county, also recorded such insurgency actions. Most authors of the local chronicles were independent, reputable local intellectuals, who were not under the scrutiny of the government (Almond et al., 2019). Their relative freedom mitigates concerns that news relating to local insurgencies would be intentionally omitted.

Figure IV shows in gray bars the number of counties reporting at least one peasant uprising against the government in each year during the period between 1644 and 1912 according to the Chronology of Warfare in Dynastic China. As shown, peasant uprisings were relatively frequent during the Qing dynasty period. The peak in the number of

[10]Data used in our analysis is publicly available and can be downloaded from: `http://xjubier.free.fr/en/site_pages/solar_eclipses/5MCSE/xSE_2_Five_Millennium_Canon.html`

unrest episodes in the 1850s and 1860s is due to the Taiping rebellion (1851-1864) and the Nian rebellion (1853-1868). The Taiping rebellion in particular was the largest peasants' uprising in Qing China, with estimated casualties of between 30 to 50 million (Xu and Yang, 2018). Figure V (a) reports the geographical distribution of peasant uprisings recorded during the Qing dynasty period according to the Chronology of Warfare in Dynastic China.

We source data on protest events leading to the fall of the Qing dynasty from "The chronology of civil protests in the Late Qing Dynasty" (Ding and Zhang, 1982), which documents that protest events occurred between 1902 and 1911. The original source of information on protest events used in Ding and Zhang (1982) are national newspapers – including the Universal Gazette, Shun Pao, and Ta Kung Pao – and government archives. The data covers 1,511 protests in the final 10 years of the Qing dynasty, providing information on the date, location, and a short description for each event. A potential limitation of this data source is that newspapers and governments' reports tend to overlook riots that occur in border provinces and minority regions, potentially leading to omissions. We think this issue is attenuated in our empirical analysis by the use of province fixed effects, which which absorbs heterogeneity in coverage across Chinese provinces. See Hao et al. (2022) for an application of this data to the study of the effect of the abolition of the civil service exam on the incentives to misbehave of local elites. Figure IV shows in red bars the number of rebellions between 1902 and 1911 sourced from Ding and Zhang (1982). Figure V (b) reports the geographical distribution of the rebellions.

Data on social protests in present day China is sourced from the local unrest database of the China Academy of Social Sciences (CASS database hereafter). This database is collected by the institute of law of CASS, the top research institute and think tank in China. The database is designed to record all social unrest events involving more than 100 participants. It contains 916 observations taking place between 2001 and 2013 in Mainland China (Hong Kong SAR and Macao SAR excluded). All observations come from the coverage of newspapers published in mainland China and major online websites. For each unrest observation, the database reports detailed information on the location, the type of protest, the type and number of participants, the aim and duration of the protest event. Figure A.2 reports the distribution of social unrest episodes recorded in CASS over time between 2001 and 2013. As shown, there is a clear positive trend in the number of reported episodes during the first decade of the 2000s, which could be at least in part due to the increase in coverage by newspapers and media over time.[11]

[11] According to the World Development Indicators of the World Bank, the share of individuals using internet in China increased from 2.6% to 45.6% between 2001 and 2013, while the number of mobile phone subscriptions per 100 people increased from 11.1 to 88.3 during the same period.

III.C Data on martyrs, temples and legends

To explore the role of local anti-Qing memories over the long run, we collected data on temples and legends celebrating officials who died in the war against the Qing invasion (1644-1664). The list of names of anti-Qing martyrs comes from the "Emperor Designated Book of Pre-dynasty's Martyred Officials". This book was compiled and distributed by the Qing rulers in 1775. The reason to do so is mainly because the Qing court, as a minority ruler, constantly aimed at inspiring trust and loyalty among its majority subjects towards the incumbent regime, and to establish its own ruling legitimacy.[12] The book contains a comprehensive list of 1,600 civilians and military officials who died in the war against the Qing's invasion. The officials' names are ordered according to the princes they served and died with. Figure A.3 reports an example of an entry of the book, which mentions an official named Jie Chongxi who martyred with the Right Prince Lu.

As the actions of these early martyrs were described in a book issued by the Qing court, these rebels were officially recognized by the government. As a result, it was legitimate for the subjects to construct temples dedicated to them ("Martyrs' Shrine"), publicly worship them and tell their stories. On the other hand, worshiping and celebrating the leaders of peasant uprisings that happened during the Qing dynasty period may have triggered the intervention of the government. Over time, the temples dedicated to early anti-Qing martyrs became a symbol and a place to worship *all* anti-Qing martyrs and rebels, whether they were recognized by the government or not. This is consistent with the Chinese tradition of expressing discontent about the government in indirect ways.[13]

We extracted information on the location of temples dedicated to such martyrs from local county chronicles. Local chronicles contain a section ("geographic" section) whose main purpose is to report the location of the important sites of a given county. Temples were important not only because of their religious and cultural purposes, but also because the periodic markets held outside temples were usually the busiest ones and the most important gathering opportunities for rural residents in China. Figure A.4 provides an example of the description of a martyrs' temple as reported in local chronicles. As shown in the example, county chronicles usually provide the name of the temple, the location of the temple and a brief description of the individuals worshiped in the temple.[14] We collected information on 308 anti-Qing martyrs' temples. Figure VI, panel (a), shows the geographical distribution of such temples.

The accounts of martyrs' actions against the Qing's invasion were also recorded in the

[12] Interestingly, the Qing court compiled another book, called "Double-faced Ministers", at the same time. It collected all pre-dynasty's ministries who betrayed their own regime and served for the Qing court.

[13] In a famous case that happened in 1661, Chinese intellectuals cried in a Confucian temple as a way to express their anger towards the government's over-taxation.

[14] Often times, the temples themselves were named after the worshiped individuals. As a sign of respect, martyrs are usually introduced by their posthumous title rather than by their names. We hired graduate students from the History Department to find all the posthumous titles of martyred officials.

"memorabilia" section of local chronicles. This section recorded the important events that took place within the county, including the fight against the Qing's invasion, especially after the Qing court officially recognized the legitimacy of those actions. Notice that the heroic actions of local martyrs were reported in the chronicles even when the actual battle did not take place within the boundaries of the county. Figure A.5 presents an example of an account of a martyr's actions. The chronicle is from the county of Guichi, Jiangsu province, and provides a detailed description of the anti-Qing struggle of martyr Cao Dagao, which was from Guichin but whose actions mostly took place in the Jiangxi province. His associate and a non-local martyr, Jie Chongxi, was also mentioned in the local account because of his connection with Cao.

Again, we use both electronic and manual searches to collect all the legends of martyred anti-Qing officials in the chronicles. To isolate the effect of the local diffusion of anti-Qing sentiment, we focus in particular on written accounts that describe the rebels' actions with a positive tone. Our final dataset includes 1284 martyrs' legends in county chronicles. Figure VI, panel (b) shows the geographical distribution of counties with recorded anti-Qing legends in local chronicles.

IV Identification Strategy

Our identification strategy relies on the assumption that the timing and area of visibility of solar eclipses across Chinese counties are plausibly exogenous. This assumption is based on the fact that solar eclipses are solely determined by the relative position of the sun, the earth, and the moon, and not by geographic, demographic, economic or cultural characteristics of the area exposed to it on the surface of the earth. In what follows we present our two main specifications: a panel approach to study the short-run responses of peasant uprisings to solar eclipses, and a cross-sectional approach to study the long-run effects of eclipse-driven variation in the number of past peasant uprisings. For each specification, we discuss the main identification assumptions.

IV.A Panel approach to study short-run effects

To study the effect of solar eclipses on peasant uprisings during the Qing dynasty we estimate the following panel specification:

$$1(rebellion)_{ipt} = \alpha_i + \alpha_{pt} + \beta 1(eclipse)_{ipt} + \theta X_{ipt} + \Lambda_t G_{ip} + \varepsilon_{ipt} \quad (1)$$

The outcome variable $1(rebellion)_{ipt}$ is a dummy equal to one if a peasant uprising was recorded in county i, located in province p during year t. The independent variable $1(eclipse)_{ipt}$ is a dummy equal to 1 if county i was in the totality zone of a solar eclipse during year t. The totality zone of an eclipse is the area on the surface of the earth in

which the moon covers the totality of the sun disk. Notice that this measure is based on its theoretical visibility in perfect weather conditions – i.e. in the absence of clouds, fog or smoke – as reported by NASA.

The key identification assumption with this approach is that year-to-year variation in exposure to solar eclipses is plausibly random and thus allows us to estimate the causal effect of this celestial event on the probability of rebellions. County fixed effects (α_i) account for time-invariant unobservable characteristics at the county level, while province fixed effects interacted with year fixed effects (α_{pt}) capture any common macro shock at the province level. X_{ipt} are county-level time varying controls, while G_{ip} are county-level time invariant controls which we interact with year fixed effects. We describe these controls in detail below.

Even if the timing and location of eclipses is plausibly exogenous, a first potential concern with the interpretation of our results is that the timing of eclipses may be correlated with the timing of other local shocks – including natural disasters – which themselves might increase the probability of social unrest. Some scholars have argued that solar eclipses can increase the probability and intensity of El Niño and La Niña effects, weather phenomena that can cause extreme weather events (Lin et al., 1999). To investigate this concern, in Panel A of Table I, we study whether the incidence of total eclipses is correlated with the incidence of four types of natural disasters: earthquakes, droughts, floods, and insect infestations. These are among the most prominent natural disasters that could have affected the Chinese rural economy at the time, which mostly relied on agriculture. As such, local chronicles kept a detailed record of such events, from which we extracted our data. In addition, local chronicles report if a famine occurred in a given year. Overall, we find no systemic differences in the incidence of reported natural disasters and famines. In our empirical analysis, we show that the magnitude of the estimates in stable when including time varying county-level controls (X_{ipt}).

A second potential concern with the interpretation of the results is that eclipses could have been anticipated by the rebels or the central government. Anticipating the shock, local rebel leaders could have timed their coordination efforts in certain years. Similarly, the central government could have triggered preventive measures to avoid potential unrest. As discussed in section II, during the Qing period the study of astronomy was monopolized by the Qing court via the Bureau of Astronomy. Thus, it is plausible to assume that local leaders of peasant uprisings had no access to the scientific instruments and knowledge necessary to predict the timing of a solar eclipse and focus their coordination efforts accordingly. On the other hand, astronomers of the Qing court could predict the occurrence of solar eclipses. In fact, one of the most important tasks of the Bureau of Astronomy was to produce predictions of solar and lunar eclipses, exactly because of their special role in Chinese political astrology and their deep-rooted interpretation as a negative omen for the regime (Lingfeng, 2007). However, their predictions were often

inaccurate by modern standards (Lu and Shi, 2003a,b). Based on our reading of the literature, we think it is plausible to assume that the Bureau of Astronomy was not able to predict which specific areas within a given province of China would have been under the totality zone during any given solar eclipse. Any aggregate response to a predicted eclipse put in place by the Qing court at the national or provincial level would be absorbed by province fixed effects interacted with year fixed effects.

A standard econometric challenge when exploiting variation across geographical units is the degree of spatial correlation, which might lead to inflated t-statistics. To account for spatial correlation in residuals across Chinese counties, we cluster standard errors at the prefecture level in all our specifications. Prefectures are intermediate administrative units between counties and provinces. In our sample, we have 296 prefectures, with each prefecture encompassing on average 6.3 geographically contiguous counties. Our empirical analysis focuses on the eighteen provinces of what is usually referred to as "core China" or "China proper" under the Qing dynasty. This implies that it excludes the inner domains of Qing China, namely Manchuria, Inner and Outer Mongolia, Xinjiang and Tibet.

IV.B Cross-sectional approach to study long-run effects

To study the long-run effects of past rebellions on the incidence of the protests that led to the 1911 Revolution and the fall of the Qing empire we use an instrumental variable approach that relies on cross-sectional variation in the incidence of past rebellions generated by eclipses during the Qing dynasty period.

To this end, we start by estimating the predicted incidence of past protests per capita during the Qing period with the following first stage specification:

$$rebellion_{ip,1647-1899} = \alpha_p + \gamma eclipse_{ip,1647-1899} + \theta X_{ip} + u_{ip}, \tag{2}$$

where $rebellion_{ip,1647-1899}$ is the total number of peasant uprisings per capita observed in county i between 1647 and 1899, and $eclipse_{ip,1647-1899}$ is the total number of solar eclipses observed in county i during the same period.[15] Next, we estimate the following second stage specification:

$$rebellion_{ip,1902-1911} = \alpha_p + \beta \widehat{rebellion_{ip,1647-1899}} + \theta X_{ip} + \eta_{ip}, \tag{3}$$

where $rebellion_{ip,1902-1911}$ is the total number of protests per capita observed in county i between 1902 and 1911. Variables in per capita terms in the first and second stage regressions are computed using estimates of county-level population from Skinner et al.

[15] The Qing dynasty period lasted from 1644 to 1912. We exclude the years 1644 to 1646 in which the Qing consolidate their power. We exclude the years 1900 to 1912 as they are characterized by the wave of protests that led to the fall of the Qing which we use as our main outcome variable.

(2008), which refer to population in the capital city of each county estimated as of 1893.[16] All specifications include province fixed effects (α_p) and a set of county controls described below. Standard errors are clustered at prefecture-level.

The key identification assumption is that variation in the incidence of solar eclipses across Chinese counties during the Qing dynasty period is plausibly exogenous. Differently from the panel approach described above, this cross-sectional approach does not allow to control for county fixed effects. The main concern is that, although yearly variation in intensity and location of solar eclipses is plausibly exogenous, the intensity of their occurrence across counties over a long period of time might be spuriously correlated with other time invariant characteristics that are not observable by the econometrician. Although we cannot fully rule out this possibility, in what follows we present evidence consistent with the identification assumption.

First, we compare time-invariant characteristics of counties that were inside the totality zone of a solar eclipse at least once during the Qing dynasty period, with counties that were never within the totality zone. County-level observable characteristics include both socio-economic characteristics and geographical variables. Panel B of Table I reports estimated coefficients and p-values obtained by regressing each characteristic on a dummy capturing eclipse counties with standard errors clustered at the prefecture level as in the rest of the empirical analysis. As shown, we find no significant differences across socio-economic variables, including measures of county size as captured by log population, and measures of local economic development as captured by the log of the amount of the local agricultural tax – the main tax levied on local population – in silver units per capita. We also find no significant differences in the number of local clans (Dincecco and Wang, 2021; Bai et al., 2021), or in the suitability of land to the main crops farmed in China at the time: rice, millet and sweet potato.[17]

Next, we investigate differences in time-invariant geographical characteristics. Counties that experienced total eclipses during the Qing dynasty period are similar in terms of degrees longitude, distance to Beijing, distance to the provincial capitals, and distance to the Yangtze river. The main geographical differences are that eclipse counties tend to have higher average degrees north of latitude, higher terrain ruggedness and lower distance to the coast.[18] While these differences are not a concern when estimating the effect of eclipses on the probability of peasant uprisings using yearly variation in a panel specification with county fixed effects, this type of spurious correlation is a common con-

[16] This dataset classifies each county's capital city into one of 11 population size categories, ranging from up to 500 individuals to above 500,000. We assign to each county the midpoint of the population size category of its capital city.

[17] The data on number of clans is sourced from the Chinese Genealogy Knowledge Service Platform organized by Shanghai Library. Recent research has shown an important role of clans in the provision of local public goods and social connections, which could help in mobilizing the local people in rebellions.

[18] Terrain ruggedness is the geographical unevenness of the earth surface of the county, constructed following Nunn and Puga (2012).

cern in studies that investigate the persistent effects of past phenomena, and which rely on geographical variation to identify such effects in long-run cross-sectional specifications (Voth, 2021). When estimating equations (2) and (3), we include controls for all time invariant geographical characteristics with significant differences in Table I (G_{ip}). These characteristics are also included in panel regressions described in section IV.A interacted with year fixed effects. We show that the magnitude of coefficient estimates is stable when adding such geographical controls, which lends support to the identification assumption.

V Empirical Results

V.A The Effect of Solar Eclipses on Rebellions in Qing China

We start by studying the effect of solar eclipses on local rebellions during the Qing dynasty period. We estimate equation (1), where the outcome variable is a dummy equal to one if a peasant uprising was recorded in a given county and year. The results are reported in Table II. The estimated coefficient in column (1) indicates that counties that experience a total solar eclipse have a 17.5 percentage points higher probability of also experiencing a peasant uprising in the same year. In column (2) we include province times year fixed effects, while in column (3) we include the set of county controls described in section IV. As shown, the magnitude of the point estimate on the total eclipse dummy remains stable with the inclusion of these controls.

The premise behind the link between solar eclipses and rebellions is a shared interpretation that solar eclipses are a divine signal of undermined legitimacy. The eclipse-illegitimacy interpretation is mainly held by the Confucian school. Thus, we test whether the effects of eclipses on the propensity to rebel change depending on the local diffusion of Confucianism. To proxy for it, we use the geographical distribution of Confucian temples, under the assumption that regions with Confucian temples had a larger diffusion of Confucian ideology among the local population (Kung and Ma, 2014). In columns (4) and (5) of Table II we estimate equation (1) separately in counties with vs without Confucian temples. The effects are present in both sub-samples, with larger coefficient estimates in the sample of counties with Confucian temples. In the last column we formally test for the magnitude and statistical significance of the difference in the effect of eclipses across the two samples. As shown by the interaction term, this difference is statistically significant and its magnitude indicates that the effect of eclipses on the probability of rebellion is about 50% larger in counties with Confucian temples.

We explore the timing of the relationship between eclipses and rebellions with the following dynamic specification:

$$1(rebellion)_{ipt} = \alpha_i + \alpha_{pt} + \sum_{k=-3}^{k=+3} \gamma_k 1(year = k)_{ipt} + \Lambda_t G_{ip} + \theta X_{ipt} + \varepsilon_{ipt} \qquad (4)$$

where $1(year = k)$ is a dummy equal to 1 if year $t = k$ for county i, and captures the time relative to a total eclipse year in county i, which we set at $k = 0$. We include the 3 years prior and the 3 years after the total eclipse. The specification includes county and province times year fixed effects, as in equation (1). The results are reported in Figure VII. The effect of solar eclipses on unrest materializes in the same year in which the eclipse occurs, while the estimated coefficients on leads and lags are small and not statistically different from zero. It is important to emphasize here that unrest events are assigned to the year in which they started according to local chronicles. This might help explain why the documented effect of eclipses on rebellion is mostly contemporaneous.

We also present a set of robustness and additional results in Table A.1. To account for over dispersion in the eclipse variable due to the high number of zeros, we re-estimate our main specification using a negative binomial regression. The results are reported in column (2) and show a positive and significant effect of the total eclipse variable on the rebellion outcome. The magnitude of the estimate implies that total eclipses increase the probability of peasant uprisings by about 15 percentage points, which is smaller but comparable in magnitude to the baseline result (18 percentage points).[19] In column (3) we re-estimate equation (1) excluding from our sample the years of the Taiping rebellion. Figure IV shows a high concentration of unrest events reported around the years of the Taiping rebellion. The rebellion originated in the Southern city of Tianjing, where a group of Han ethnicity commanded by Hong Xiuquan declared independence from the Qing central government, which was of Manchu ethnicity. The rebellion escalated into a civil war, which lasted from 1850 to 1864, provoking millions of casualties on both sides, and ending with the victory of the Qing government. As shown, the point estimate on total eclipses is unchanged, indicating that the results are not driven by this particular historical episode.

Next in columns (4) and (5) of Table A.1 we split our sample in two sub-periods: before vs after 1800. We find positive and significant effects in both periods. In terms of magnitude, the estimates indicate that the solar eclipses have higher predictive power on peasant uprisings in the early period of the Qing rule than in the period between 1800 and 1911. Column (6) indicates that the impact of eclipses on rebellions is stronger in counties that already experienced a solar eclipse in the past, potentially because its interpretation is already diffused among the local population. Finally, in column (7) we interact solar eclipses with the occurrence of other natural disasters – including floods, famines and droughts – to study whether their impact is stronger in periods during which a county is already experiencing a negative economic shock. As shown, the coefficient on the interaction term is positive but not precisely estimated, which is likely driven by the limited number of counties experiencing both shocks in the same year.

[19] This number is obtained by multiplying the incidence rate ratio implied by the negative binomial estimate by the average probability of observing a rebellion in non-total eclipse years ($34.2 \times .0045 = 0.15$).

V.B Legacy of Rebellions and the 1911 Revolution

In this section, we test the long run effects of a history of peasant uprisings on the incidence of the protests that led to the 1911 Revolution and the fall of the Qing empire. For this analysis, we exploit plausibly exogenous variation in the incidence of past rebellions generated by eclipses during the centuries of Qing rule. This approach and its key identification assumptions are discussed in section IV.B.

We start by estimating the first stage equation (2). The results are reported in Table III. The estimated coefficient in column (1) indicates that counties with 1 standard deviation larger number of solar eclipses during the Qing dynasty period (0.72) experienced about 0.15 more rebellions per capita during the same period. Rebellions are reported per 1,000 inhabitants. The magnitude of the first stage coefficient increases when controlling for province fixed effects – column (2) – and when including the time invariant county controls described in section IV.B – column (3) – with point estimates increasing from 0.2 to between 0.24 and 0.26. The first-stage F statistic is 44.8.

Next, in Table IV, we study the effect of past protests on the incidence of protests during the 1902-1911 period, which hereafter we refer to as 1911 Revolution protests. We measure protests in number of events per capita, and present results for three specifications: the correlation between past protests and 1911 Revolution protests, a reduced form estimate of the effect of total eclipses on 1911 Revolution protests, and the 2SLS estimate obtained estimating equation (3). All specifications include the same set of county controls and fixed effects used in the first stage, and report standard errors clustered at the prefecture level – the intermediate administrative unit between counties and provinces – to account for spatial correlation in the error term.

Column (1) shows that Chinese counties with higher protest per capita during the Qing period also experienced more protest per capita during the 1911 Revolution period. The magnitude of this correlation declines but remains precisely estimated when controlling for county characteristics in column (2). We visualize the correlation in Figure VIII. The plotted points are residuals from regressing protests per capita in the two time periods on province fixed effects and county-level controls. The slope of the least squares regression line plotted through the points is 0.8 with a standard error of 0.18. As shown, this relationship is not driven by extreme observations, with most county-level points being close to the regression line.

In columns (5) and (6) we report the 2SLS coefficients. The magnitude of the coefficient implies that counties with a standard deviation larger number of past rebellions per capita – or about 1.1 additional peasant uprising per 1000 people recorded during the 1647-1899 period – had about 1.5 more social protests per 1000 people recorded between 1902 and 1911. The OLS estimate in column (2) is about 30% smaller of the 2SLS estimate in column (6). This downward bias in the OLS estimation could be driven by several

potential sources of endogeneity in the OLS regression. For example, regions in which the Qing court traditionally expects protests to erupt might be treated differently by the central government so to avoid such rebellions to resurface. Indeed, local officials during the Qing period (magistrates) were judged and promoted by the central government based also on their ability to deal with local crime and violence (Chu, 1962). If the measures taken by the central government and local officials in areas considered more at risk were effective, this would make such regions less likely to display rebellions in the future.

The existing literature in history, sociology and economics has proposed several potential drivers of the social protests that led to the 1911 Revolution and the fall of the Qing dynasty. One of such drivers is the series of reforms ("New Policies") introduced by the Qing court in the early 1900s, which included the elimination of the imperial examination to recruit civil servants, the traditional mean of social mobility during over a millennium of imperial rule (Franke, 1960, 1970). In particular, Bai and Jia (2016) exploit variation in local quotas for the Keju exam across Chinese prefectures to study how the abolition of the exam in 1905 contributed to participation in the anti-Qing protests that emerged in the early 20th century. The working assumption is that counties with higher number of quotas before the reform are more likely to participate in protest actions after the reform.

In column (1) of Table A.2 we replicate the results from Bai and Jia (2016) using as an outcome variable the number of protests per capita from Ding and Zhang (1982). As shown, local Keju quotas per capita are a strong predictor of protests leading up to the 1911 Revolution. In column (2) we replicate our main results for the sample of counties for which data on local Keju quotas is available, finding estimates that are similar in magnitude to those presented in Table IV. In column (3), we include both potential drivers of protests in the same regression. We find that coefficient estimates for both channels remain relatively stable in magnitude and statistically significant at standard levels, indicating that they capture independent variation.

V.B.1 Legacy of Rebellions and early Communist Party diffusion

In this section, we test whether the impact of a historical legacy of rebellions lasted after the 1911 Revolution. We focus, in particular, on whether a local tradition of uprisings explain geographical variation in the early diffusion of the Chinese Communist Party (CCP). Several historians and political scientists have argued that a correlation exists between membership in the Communist Party and a local history of peasant rebellions. Perry notices that "[s]cholars in the China field have also suggested that the legacy of the peasant rebellion was an important ingredient in the communists' rural success serving both as a source of inspiration to the early revolutionaries and as a familiar frame of reference for peasants who joined the movement" (Perry, 1980, p. 7).[20] Hofheinz Jr (1969)

[20]See, in particular, Jerome (1965) and Friedman (1974).

notes that many of the locations where the Communist Party formed were believed to have background societal elements conductive to violent revolt. In his seminal work "Crimson Rain", historian William Rowe studies one of such hotbed counties, Macheng, which had a tradition of violent uprisings and experienced a rapid growth of communism among the local population (Rowe, 2007).

We test whether counties with a historical tradition of peasant uprisings during the Qing period also experienced higher diffusion of communism in the late 1920s using the identification strategy described in section IV.B. Measuring early diffusion of communism is particularly challenging. To the best of our knowledge, there are no individual-level records of early CCP membership. As a result, we measure local participation using the place of birth of CCP members that died during the early years of the civil war, between 1927 and 1931. We obtained this data from the official website of the Chinese Civil Affairs Bureau, which includes information on the name, birthplace and place of death for all CCP party members who died in wars between 1927 and 1949.[21]

The results are reported in Table A.3, which reports the results of estimating equation (3) when the outcome variables are two measures of CCP diffusion: the number of CCP members that died during the civil war divided by county population, and a dummy equal to 1 if any CCP member recorded in our data was born in a given county. The magnitude of the 2SLS coefficients reported in column (2) implies that counties with a standard deviation larger number of past rebellions per capita were the birthplace of about 2 more CCP party members (per 1000 people) that died during the early years of the civil war, between 1927 and 1931. All variables in per capita terms are computed using estimates of county-level population from Skinner et al. (2008). Columns (3) and (4) show that counties with a standard deviation larger number of past rebellions per capita are about 24% more likely to be the birthplace of CCP party members. Overall, the results reported in Table A.3 are consistent with long run effects of a legacy of peasant rebellions on local participation in the CCP.

V.C Legacy of Rebellions and Protests in Present Day China

We investigate whether the long run effects of a historical tradition of social unrest extend to present day China. Between the end of the Qing dynasty and the first decade of the 21st century, China has experienced major economic transformations, including fast paced economic growth and structural transformation which has been accompanied by significant migration from rural to urban areas, and from the interior to the coast. Internal migration is likely to attenuate the role of a historical tradition of anti-government protests on current behavior. On the other side, the long persistence of such historical tradition is consistent with certain traits of Chinese society – such as the strong social

[21] Data is available at `https://www.chinamartyrs.gov.cn`.

and cultural linkages that migrants keep with their place of origin, and the justified right to protest against local authorities perceived as exploitative, which is deeply rooted in the Confucian tradition.

To measure the propensity to protest in present day China we use data on location of social protests with at least 100 participants that occurred in the period 2001 to 2013 from the China Academy of Social Sciences, as described in section III. We focus on two outcome variables: the number of protests per capita and a dummy capturing the occurrence of any social protest in a given location. We normalize the number of protests in the 2001-2013 period by county-level population recorded in 2000, and report this outcome in the number of events per million people.

The results are reported in columns (1) and (4) of Table V. We find evidence consistent with small but significant long run effects of a historical tradition of uprisings on current propensity to protests. The coefficient in column (1) implies that counties with a standard deviation larger number of past rebellions per capita had 0.9 additional protest events per million people between 1902 and 1913 – or 30% of a standard deviation in the outcome variable, roughly half of the explanatory power of past protests on 1911 Revolution protests.

In column (4) we estimate equation (3) using as an outcome variable a dummy which takes value 1 if any protest was observed in the 2001-2013 period. We find that the estimated effect of past rebellions instrumented with the incidence of total eclipses is about 0.18 with a standard error of 0.071. This indicates that counties with a standard deviation larger number of past rebellions per capita are about 20 percentage points more likely to also have experienced some form of social unrest in the 2001-2013 period.

The data on social protests recorded by the China Academy of Social Sciences includes information on the main target of each protest. We exploit this information to separate protests aimed at the local government authority (e.g. local party secretary and local government agencies) vs other targets, which mostly include protests by workers against local firms. The results are reported in columns (2)-(3) and (5)-(6). As shown, solar-eclipse driven variation in past protests explains variation in the incidence of current protests targeting local governments, while it does not explain variation in protests with other targets.

VI Mechanisms

Why should the incidence of past rebellions have long run effects on the inclination of a certain community to protest? In this section, we discuss and test in the data two potential mechanisms behind the documented persistence. We start in section VI.A by studying heterogeneous effects of persistence across regions with different levels of commemoration of rebel leaders from the past. As a test of reactivation of collective memory, we use data

from the first decade of the 2000s to study whether communities with different legacies of past protests tend to respond differently to similar grievances towards local governments, such as increases in local air pollution. Next, in section VI.B, we study whether a higher incidence of past protests has shaped the social structure or affected the long run level of economic development of Chinese counties.

VI.A Collective Memory via Celebration of early anti-Qing leaders

The commemoration of selected persons has been documented in many cultures as a way of shaping the collective memory and forging the cultural identity of a given community.[22] One anecdote that speaks to the potential role of commemorating individuals of the past in shaping the future actions of a community is the childhood story of Sun Yat-sen, one of the leaders of the 1911 Revolution. Sun Yat-sen was born in a village close to the hometown of Hong Xiuquan, the leader of the Taiping rebellion against the Qing rule that took place in the 1850s. When Sun was young, his favorite pass time was to listen to the story of Hong Xiuquan told by a Taiping veteran living in his village. In fact, he admired Hong so much that he named himself "Hong Xiuquan Jr".

We collect data on two potential measures of local transmission of the memory of past rebellions, which are described in detail in section III. First, we use physical structures – such as temples or memorials – celebrating anti-Qing martyrs. Second, we collect information on the presence of a positive recorded memory of anti-Qing martyrs in the local chronicles. by positive recorded memory we intend the existence of a description of the actions of the individuals that fought against the Qing invaders, in which the account has an anti-Qing tone. We think of the existence of such accounts – which we refer to as "legends" – and of the temples celebrating early anti-Qing martyrs as capturing the ability of a community to codify and transmit a culture of anti-government sentiment over time.

We test empirically whether the long-run effects of past rebellions is different across areas with vs without these signs of transmission of the memory of past rebellions. We study heterogeneous effects of past rebellions on both the incidence of 1911 Revolution protests and present-day China protests. The results of this analysis are reported in Table VI. In particular, we estimate equation 3 separately in the sub-samples of counties with vs without temples or legends celebrating early anti-Qing martyrs. As shown, almost 70% of counties in our sample have some recorded legends, while around 16% have a physical structure.

The point estimates on the 2SLS coefficients tend to be larger in magnitude in the sub-samples of counties that celebrated the leaders of past protests via temples and memorials and where the memory of anti-Qing actions remained recorded in local chronicles. Still,

[22] See, for example, Marschall (2009) on the role of memorials in South Africa post-apartheid.

estimates within both sub-samples are positive and tend to be noisy, with only significant differences emerging between coefficients in columns (5) and (6). Overall, the results presented in Table VI are suggestive evidence that persistence tend to be stronger in regions that preserved the collective memory of historical anti-government rebellions.

VI.A.1 Does historical memory shape the response to current grievances? An application to air pollution

Why does the presence of a collective memory of past anti-government rebellions translate into a higher propensity to protest decades, or even centuries, later? We attempt to rationalize the role of memory in shaping individual response through the framework proposed by Bordalo et al. (2020). In this model, the memory of similar past experiences serves as an anchor for individual decisions and influences how they react to new information. An important prediction of this model is that individuals with different sets of past experiences – a different *database* of memories – might make different decisions when facing the same choice. In our setting, the memories used by individuals to guide their decisions are not based on direct experiences, but on past experiences celebrated and remembered at the community level. In communities that accumulate more experiences of anti-government protests in response to grievances against the government, the protest response becomes a *norm*. Norms are then used to evaluate future actions to be taken in response to local government failures.

To test this mechanism in our setting, we compare counties that are exposed to the same source of grievances towards local governments in present day China, and then analyze how differences in their historical experiences with anti-government protests shape their reaction. As a shock to anti-government sentiment, we exploit changes in local air pollution levels. This choice is based on recent survey evidence, which has shown that changes in air pollution levels affect public satisfaction with the local and central government in China (Alkon and Wang, 2018).

We measure air pollution as the concentration of fine particle matter in the air ($PM_{2.5}$) recorded in a given county. Data on air pollution is collected by NASA from satellite images, and made available at the annual level for a grid of cells with a resolution of 0.01 degrees.[23] We define the concentration of $PM_{2.5}$ at the county-year level as the median level of $PM_{2.5}$ across cells whose centroids lie within the boundaries of each county. We define a high pollution year as a year in which the level of $PM_{2.5}$ is above the median in our sample. Notice that the median $PM_{2.5}$ in our dataset is 35.7 μ/m^3, which is very close to the threshold used by the US Environmental Protection Agency (EPA) to define a change in the air quality index (AQI) from "Moderate" to "Unhealthy for sensitive groups" (35.4).

[23]Data is publicly available at `https://sedac.ciesin.columbia.edu/`

Using a panel dataset at the county-year level, we estimate the following specification:

$$1(protest)_{ipt} = \alpha_i + \alpha_{pt} + \delta_1 1(HP)_{ipt} + \delta_2 \widehat{rebellion_{ip,1647-1899}} \times 1(HP)_{ipt} + \Lambda_t G_{ip} + u_{ipt} \quad (5)$$

where i indexes counties, and t indexes years between 2001 and 2013. The outcome variable is a dummy equal to 1 if a protest event is recorded in the CASS dataset for that county and year, and $1(HP)_{it}$ is a dummy equal to 1 if air pollution levels are above the median in our sample. We instrument the interaction $rebellion_{ip,1647-1899} \times 1(HP)$ with the number of total eclipses experienced by county i in the 1647-1899 period interacted with the high pollution dummy. The coefficient of interest is δ_2, which captures the heterogeneous response to an increase in air pollution between counties with different eclipse-driven historical incidence of anti-government protests. Notice that we do not claim that changes in pollution levels are randomly allocated across counties. Instead, we are interested in comparing to what extent the response to these endogenous shocks is different across counties that, for plausibly exogenous reasons, have a different historical memory of protest actions.

The results are reported in Table A.4. Column (1) reports the contemporaneous effect of higher than median air pollution levels on the probability of social protests at the local level. We find a positive, small and marginally insignificant correlation: counties in which yearly pollution levels are on average above 35.7 μ/m^3 are about 1 percentage point more likely to experience at least one episode of social unrest. In column (2) we estimate a version of equation (5) based on the "endogeneous" level of historical anti-government protests, as captured by the total number of rebellions recorded during the Qing period. As shown, communities with a higher incidence of past rebellions during the Qing dynasty period are more likely to react with social protests to an increase in the air pollution index above the median.

In columns (3) and (4) we present the reduced form and 2SLS coefficients. The magnitude of the 2SLS coefficient indicates that counties with a standard deviation larger number of rebellions per capita during the Qing dynasty period are 2.5 percentage points more likely to experience social protests in response to an increase in the air pollution index. Columns (5) and (6) show that the protest response is solely explained by protests targeting local governments. Finally, in column (7) and (8) we split the sample into counties with vs without a temple or legend celebrating anti-Qing martyrs. The evidence presented in section VI.A suggests that the long-term memory of past protests at the community level is stronger in such counties. Consistently, we find that, within this sample, the difference in the propensity to protest in response to increases in air pollution is almost twice as large as in the overall sample.

Overall, the evidence presented in this section is consistent with the idea that differ-

ences in the historical incidence of past protests affect communities' propensity to react to current grievances against local governments. This is a potential channel linking the incidence of past protests with current protests at the community level, even over long periods of time.

VI.B Effect of past rebellions on economic development

A second potential mechanism behind the observed persistence is that higher intensity of social protests in the past affects local economic development in the long run. For example, this might happen because higher social instability discourages private or government investments and hinders economic growth. In turn, lower economic development can make certain locations more prone to anti-government protests in the long run, independently from the collective memory of past rebellions described above. This is because, as documented by a large literature, the private opportunity cost of protest participation declines for individuals with less economic opportunities (Campante and Chor, 2012).

We test this channel by estimating equation (3) using proxies of economic development both in the early 1900s – before the beginning of the wave of protests leading to the Xinhai revolution – and in 2000. Measures of economic development in the early 1900s are scarce. We rely on three measures that are observable in our data at the county-level: the log of county population observed in 1900 from Hu (1935) – only available for 719 counties –, the cumulative investment by the central government in new infrastructure located in a given county during the Qing period up to 1900, and the cumulative number of years in which the taxes collected in a given county were lower than the fixed quota established by the Qing court.[24] The results are reported in columns (1) to (3) of Table VII. As shown, the 2SLS coefficients for the effect of past rebellions on these three measures of economic development at the beginning of the 20th century are noisy and not statistically different from zero.

Next, in columns (4) to (6), we focus on measures of economic development as observed at the beginning of the 21st century. For this analysis, we use data on population and GDP sourced from the China County Statistical Yearbooks for the year 2000. As shown, we find positive but non-significant 2SLS coefficients for the effect of past rebellions on population in 2000, and negative and noisy estimates when the outcomes are GDP and

[24]Data on infrastructure and tax collection is sourced from "Routine Memorials" – reports made by the six major departments of the central government in the Qing Dynasty to the emperor. The six departments included the Ministry of Personnel, the Ministry of Revenue, the Ministry of Rites, the Ministry of War, the Ministry of Justice, and the Ministry of Works. We focus on the Ministry of Works and the Ministry of Revenue. The Ministry of Works was in charge of infrastructure construction for the central government. In their reports, they detailed information on infrastructure construction financed and conducted by the central government, including date, location, and type of infrastructure constructed, such as a temple, a bridge or a road. The Ministry of Revenue was responsible for the central government's financial budget, including the collection of tax quota established by the Qing court for each county. In their reports, they provided detailed information on whether each county in China met its tax quota in a given year.

GDP per capita in 2000. Overall, the results presented in Table VII indicate that an economic channel is unlikely to be a primary driver of long run persistence in social protests in the setting studied in this paper.

VII Concluding Remarks

This paper documents that plausibly exogenous differences in the incidence of past protests can have a persistent effect on the tendency to protest of a given community in the long-run. In particular, we document that Chinese counties with a higher incidence of peasant uprisings against local government officials during the Qing dynasty period (1644-1912) had a higher participation in the protests that led to the 1911 Revolution and the fall of the imperial rule. We provide evidence indicating that the cultural transmission of the past protest experience via the celebration of anti-government leaders is a potential mechanism behind the documented persistence, and that differences in the incidence of past protests can shape a community's response to current grievances against local governments. This suggests that even the memory of events not directly experienced by an individual – but that are transmitted across generations within a given community – can act as a reference point for future behavior by members of that community.

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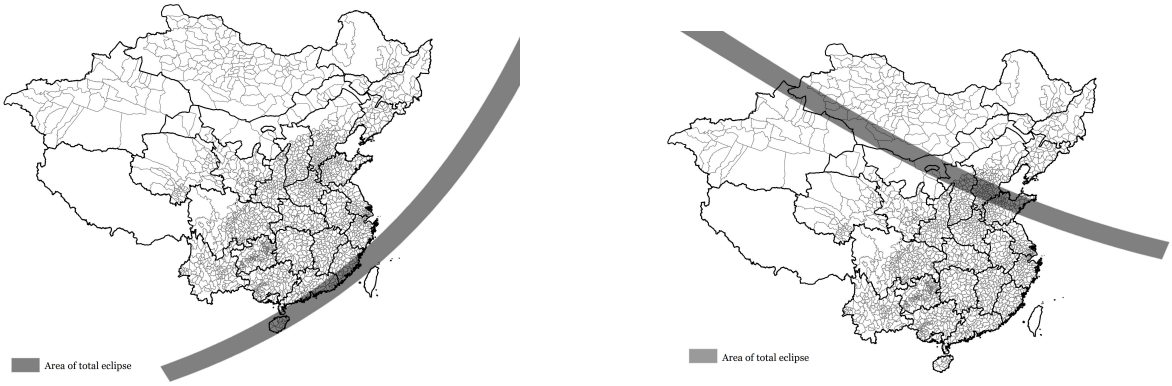
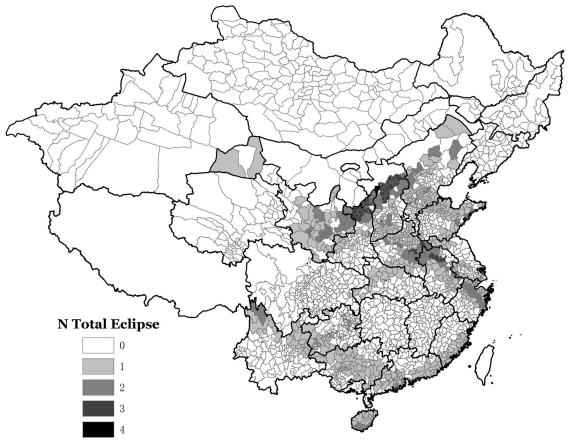
Figures and Tables

Figure I: Zone of totality of solar eclipses: Examples



Notes: This figure shows the zones of totality of two eclipses: 1742 (left) and 1760 (right). Source: authors' calculation using data from NASA.

Figure II: Number of Total Eclipses by County: 1647-1911

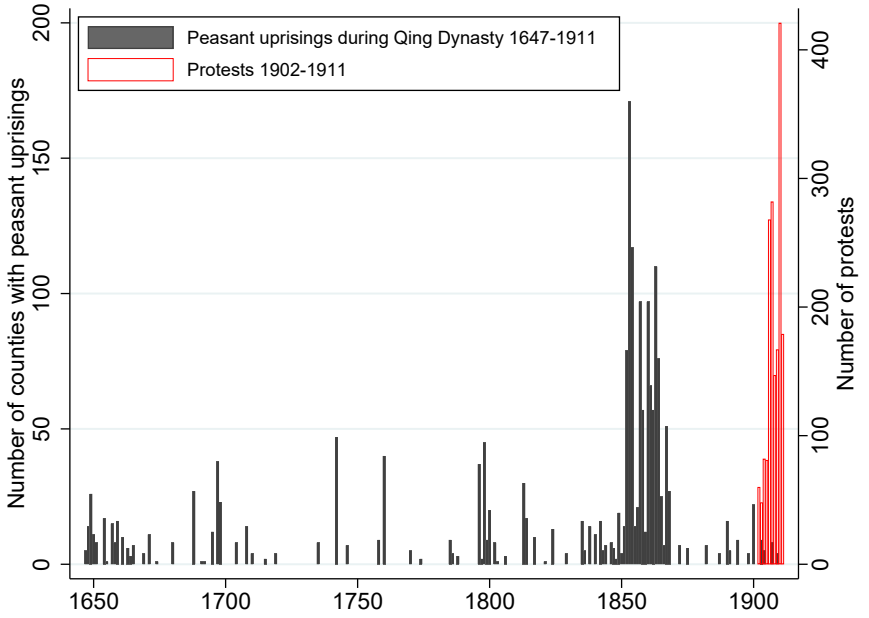


Notes: This figure shows the number of total eclipses that each county has observed during the Qing dynasty period. Source: authors' calculation using data from NASA.

Figure III: Number of counties experiencing total eclipses by year: 1647-1911

Notes: This figure shows the number of counties experiencing total eclipses in each year during the Qing dynasty period. Source: authors' calculation using data from NASA.

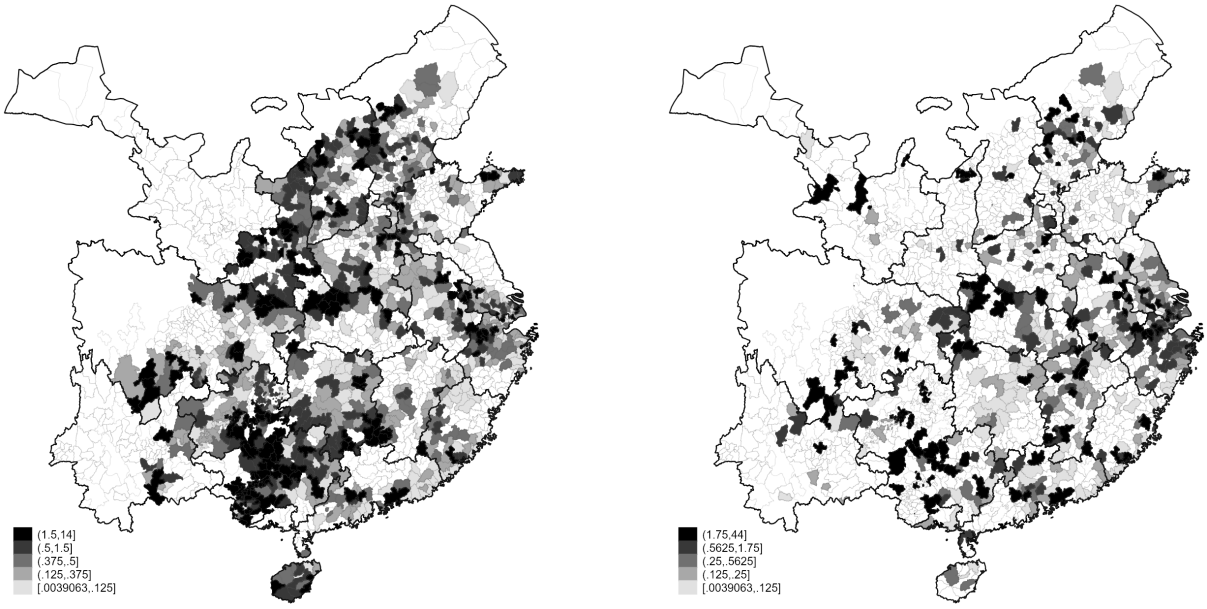
Figure IV: Rebellions in China: 1647-1911



Notes: Dark gray bars report the total number of counties reporting peasant uprisings between 1647 and 1911 sourced from China's Military History Editorial Committee (2003). Red hollow bars report the number of protests between 1902 and 1911 sourced from Ding and Zhang (1982).

Figure V: Geographical distribution of protests per capita

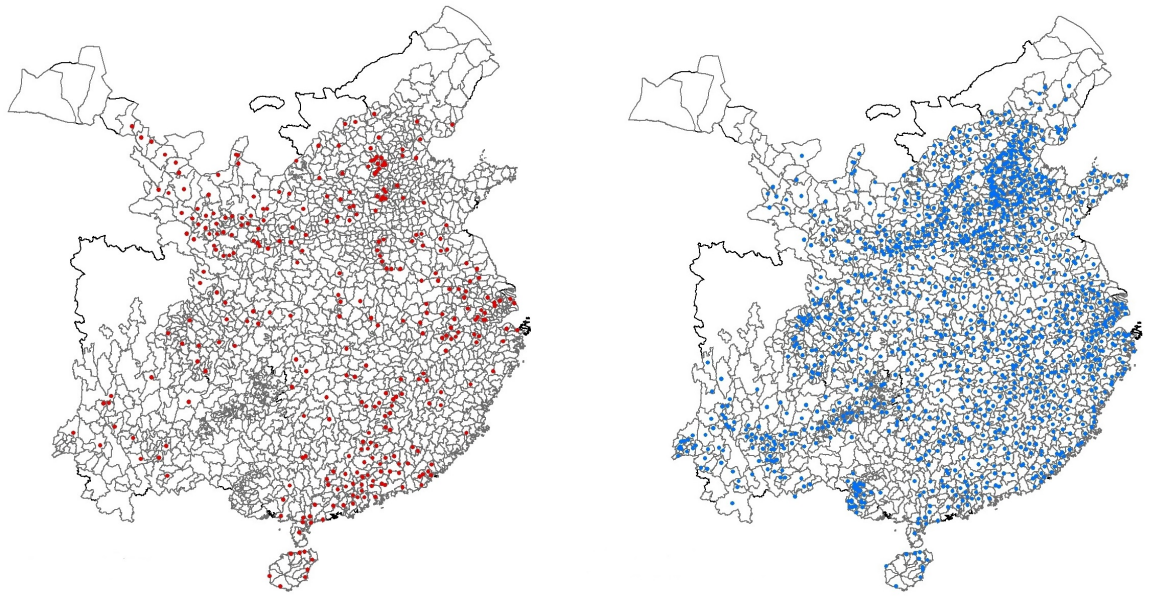
(a) 1644-1899 (b) 1902-1911



Notes: Panel (a) shows the total number of peasant uprisings per capita that each county has experienced between 1647 and 1899. Panel (b) shows the total number of protests per capita that each county has experienced between 1902 and 1911. The maps reports county borders (light gray) and province borders (dark gray).

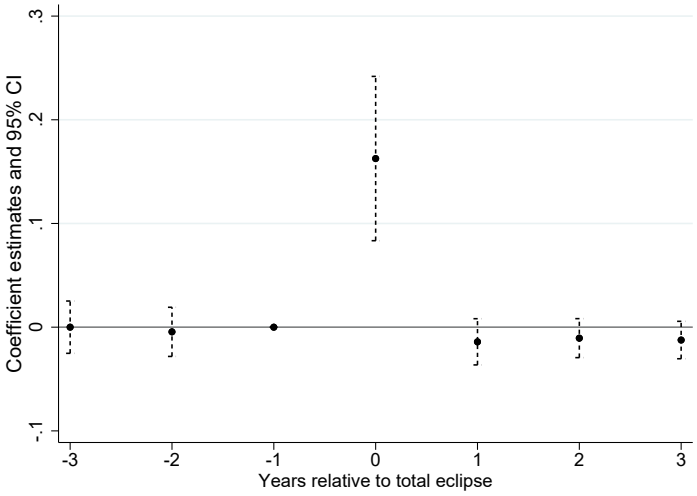
Figure VI: Geographical distribution of Anti-Qing Memory

(a) temples (b) legends



Notes: Panel (a) shows the geographical distribution of temples in memory of officials martyred during the anti-Qing war (1644-1664). Panel (b) shows the geographical distribution of county chronicles' mentioning of the heroic legends of officials martyred during the anti-Qing war (1644-1664).

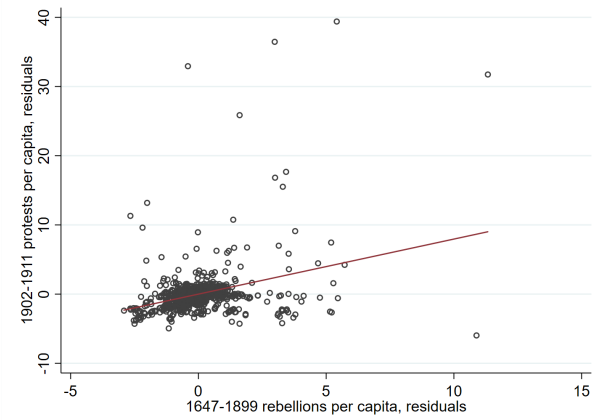
Figure VII: Timing of the effect of eclipses on probability of rebellion



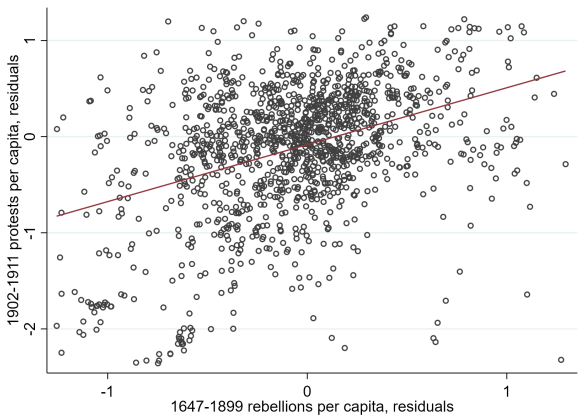
Notes: The figure reports the estimated coefficients and 95% confidence intervals on the up-to-3-period leads and lags of total eclipses described in equation (4). Standard errors used to construct confidence intervals are clustered at the prefecture level.

Figure VIII: Correlation between 1911 Revolution protests and Qing rebellions per capita

(a) all counties



(b) exclude top-bottom 5%



Notes: This figure reports the correlation between total number of peasant uprisings observed in each county between 1647 and 1899 and total number of rebellions observed in each county in the years 1902-1911. Both variables are in per capita terms using population estimates from Skinner et al. (2008). The plotted points are residuals from regressing each variable on province fixed effects and county-level controls. County controls include log distance to the coast, log distance to Beijing, degrees latitude and terrain ruggedness.

Table I: Balance test for counties inside vs outside totality zone of solar eclipses

Panel A: time varying characteristics	coefficient	p-value
Famine	0.101	0.395
Flood	-0.163	0.684
Drought	0.446	0.275
Insect infestation	0.125	0.672
Earthquake	0.189	0.330
N obs: 407,650, eclipse-year observations: 860		
Panel B: time invariant characteristics	**coefficient**	**p-value**
Log population (1893)	-0.092	0.303
Log Agricultural land tax in silver units per capita (1820)	-0.136	0.317
Number of clans	-1.531	0.231
Crop suitability: millet (foxtail)	0.069	0.501
Crop suitability: rice	-0.114	0.128
Crop suitability: sweet potato	0.115	0.232
Latitude degrees	0.384	0.028
Longitude degrees	0.220	0.272
Terrain ruggedness	0.048	0.056
Log distance to Beijing	0.062	0.694
Log distance to province capital	0.329	0.310
Log distance to coast	-0.278	0.008
Log distance Yangtze river	0.056	0.450
N obs: 1550, eclipse counties: 681		

Notes: The table reports the point estimates and p-values on a dummy capturing eclipse counties when the outcome variables are time-varying (Panel A) and time-invariant (Panel B) county characteristics. Eclipse counties are those inside the totality zone of at least one solar eclipse during the Qing dynasty period. See section IV for a description of each variable and data sources.

Table II: The Effect of Total Eclipses on The Probability of Rebellions Panel Specification

outcome:	1(rebellion)					
				confucian temple		
				yes	no	
	(1)	(2)	(3)	(4)	(5)	(6)
1(eclipse)	0.175***	0.181***	0.179***	0.242***	0.099***	0.141***
	(0.044)	(0.043)	(0.042)	(0.058)	(0.029)	(0.041)
1(eclipse) × confucian temple						0.078*
						(0.045)
Year FE	y	n	n	n	n	n
County FE	y	y	y	y	y	y
Province × year FE	n	y	y	y	y	y
County controls	n	n	y	y	y	y
R-squared	0.053	0.204	0.216	0.249	0.228	0.217
N clusters (prefectures)	249	249	249	185	195	249
Observations	407,650	407,650	407,650	212,241	195,409	407,650

Notes: The table shows coefficient estimates corresponding to equation (1). The dependent variable 1(rebellion) is a dummy equal to 1 for county-year observations with a recorded rebellion in local chronicles and 0 otherwise. 1(eclipse) is a dummy variable equal to 1 for county-year observations within the totality zone of an eclipse in a given year, and 0 otherwise. County controls include all time varying county characteristics reported in Panel A of Table I, quintiles of distance to the coast, quintiles of distance to the Beijing, degrees latitude and terrain ruggedness interacted with year fixed effects. Standard errors clustered at the prefecture-level reported in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table III: The Effect of Past Eclipses on Incidence of Rebellions during Qing period

outcome:	N Rebellions per capita (1647-1899)		
	(1)	(2)	(3)
$(\text{N Total Eclipses})_{1647-1899}$	0.193***	0.264***	0.239***
	(0.072)	(0.070)	(0.068)
Province FE	n	y	y
County controls	n	n	y
R-squared	0.012	0.144	0.390
N clusters (prefectures)	249	249	249
Observations	1,550	1,550	1,550

Notes: The table shows coefficient estimates corresponding to equation (2). The dependent variable is the total number of rebellions per capita recorded between 1647 and 1899 in each county. (N Total Eclipses) is the number of total eclipses observed in the county between 1647 and 1899. Variables in per capita terms are constructed using county population estimates from Skinner et al. (2008). County controls include log distance to the coast, log distance to Beijing, degrees latitude and terrain ruggedness. Standard errors clustered at the prefecture-level reported in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table IV: The Effect of Past Rebellions on 1902-1911 Protests

outcome:	N Protests per capita (1902-1911)					
	OLS		Reduced Form		2SLS	
	(1)	(2)	(3)	(4)	(5)	(6)
(N Rebellions per capita)$_{1647-1899}$	0.981***	0.796***			1.367***	1.194***
	(0.183)	(0.182)			(0.435)	(0.408)
(N Total Eclipses)$_{1647-1899}$			0.361**	0.308**		
			(0.140)	(0.123)		
Province FE	y	y	y	y	y	y
County controls	n	y	n	y	n	y
R-squared	0.215	0.247	0.040	0.167	0.159	0.097
N clusters (prefectures)	249	249	249	249	249	249
Observations	1,550	1,550	1,550	1,550	1,550	1,550

Notes: The table shows coefficient estimates of OLS, reduced form and 2SLS specifications described in section IV.B. Columns (5) and (6) correspond to equation (3). The dependent variable is the total number of protests per capita recorded between 1902 and 1911 in each county. (N Rebellions per capita) is the total number of rebellions per capita recorded between 1647 and 1899 in each county. (N Total Eclipses) is the number of total eclipses observed in the county between 1647 and 1899. Variables in per capita terms are constructed using county population estimates from Skinner et al. (2008). County controls include log distance to the coast, log distance to Beijing, degrees latitude and terrain ruggedness. Standard errors clustered at the prefecture-level reported in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table V: The Effect of Past Rebellions on Current Protests

outcome:	N protests per capita (2001-2013) target			$1(\text{protest})_{(2001-2013)}$ target		
	all	local gov	other	all	local gov	other
	(1)	(2)	(3)	(4)	(5)	(6)
$(\text{N Rebellions per capita})_{1647-1899}$	0.919**	0.925**	0.165	0.181**	0.148***	0.023
	(0.405)	(0.406)	(0.218)	(0.071)	(0.056)	(0.054)
Province FE	y	y	y	y	y	y
County controls	y	y	y	y	y	y
N clusters (prefectures)	249	249	249	249	249	249
Observations	1,550	1,550	1,550	1,550	1,550	1,550

Notes: In columns (1)-(3), the dependent variable is the total number of social unrest episodes per capita recorded in a given county by the CASS database. In columns (4)-(6), the dependent variable is a dummy equal to 1 if any social unrest episode is recorded in CASS in a county between 2001 and 2013. County controls include log distance to the coast, log distance to Beijing, degrees latitude and terrain ruggedness. Standard errors clustered at the prefecture-level reported in brackets. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table VI: Heterogeneous Effects by Memory of Past Rebellions

outcome:	N Protests per capita (1,000) 1902-1911				N Protests per capita (million) 2001-2013			
	legend		temple		legend		temple	
	yes	no	yes	no	yes	no	yes	no
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(N Rebellions per capita)$_{1647-1899}$	1.538***	0.951	2.081*	1.427**	1.219**	0.166	2.133*	0.492
	(0.556)	(0.963)	(1.228)	(0.578)	(0.597)	(0.580)	(1.166)	(0.607)
Province FE	y	y	y	y	y	y	y	y
County pop categories FE	y	y	y	y	y	y	y	y
County controls	y	y	y	y	y	y	y	y
N clusters (prefectures)	222	102	116	234	222	102	116	234
Observations	1,275	273	306	1,242	1,275	273	306	1,242

Notes: County controls include log distance to the coast, log distance to Beijing, degrees latitude and terrain ruggedness. Standard errors clustered at the prefecture-level reported in brackets. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

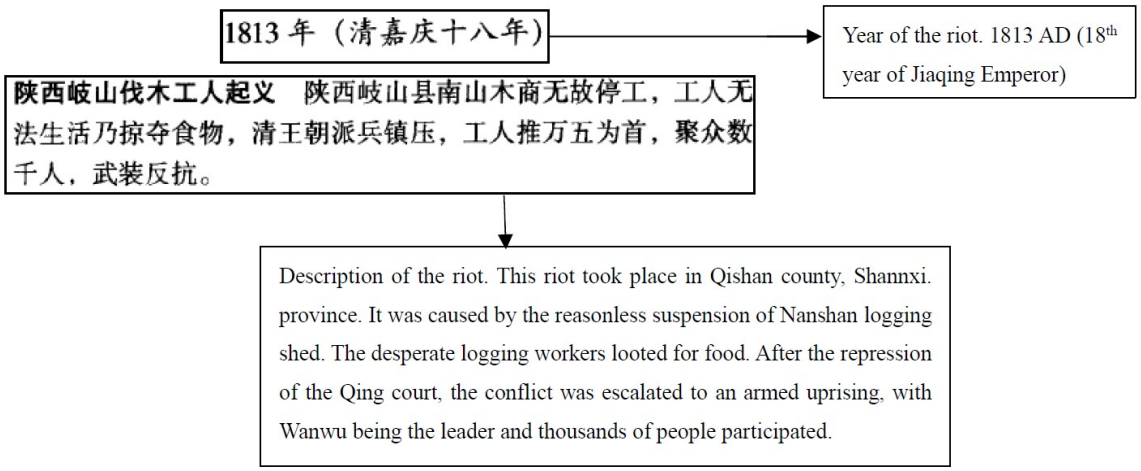
Table VII: Past Rebellions and Socio-Economic Development

outcomes:	log(pop)	government infrastructure	tax shortages	log(pop)	log(gdp)	log(gdp) per capita
	1900	1644-1912	1644-1912	2000	2000	2000
	(1)	(2)	(3)	(4)	(5)	(6)
(N Rebellions per capita)$_{1647-1899}$	0.092	0.002	0.080	0.188	-0.234	-0.174
	(0.225)	(0.020)	(0.114)	(0.133)	(0.196)	(0.179)
Province FE	y	y	y	y	y	y
County controls	y	y	y	y	y	y
N clusters (prefectures)	158	249	249	249	249	249
Observations	719	1,550	1,550	1,550	1,550	1,550

Notes: County controls include log distance to the coast, log distance to Beijing, degrees latitude and terrain ruggedness. Standard errors clustered at the prefecture-level reported in brackets. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

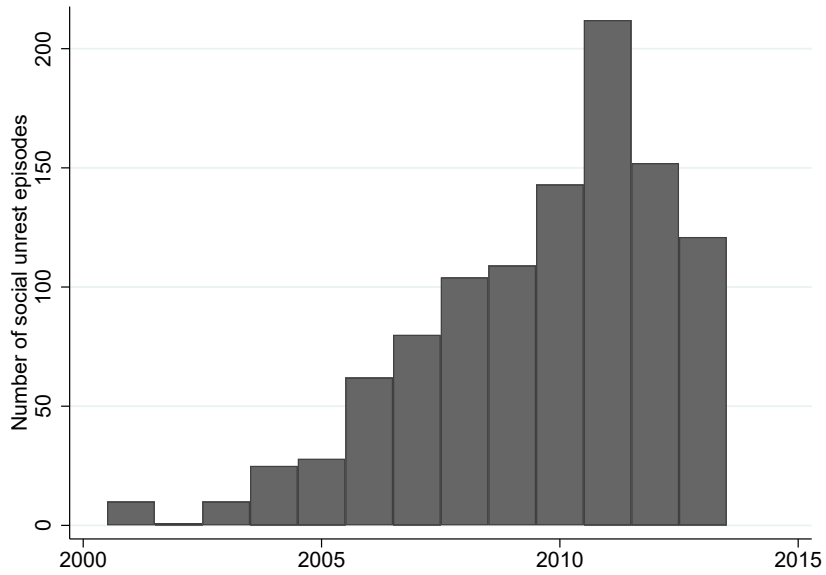
Appendix

Figure A.1: Example of Local Protest Record



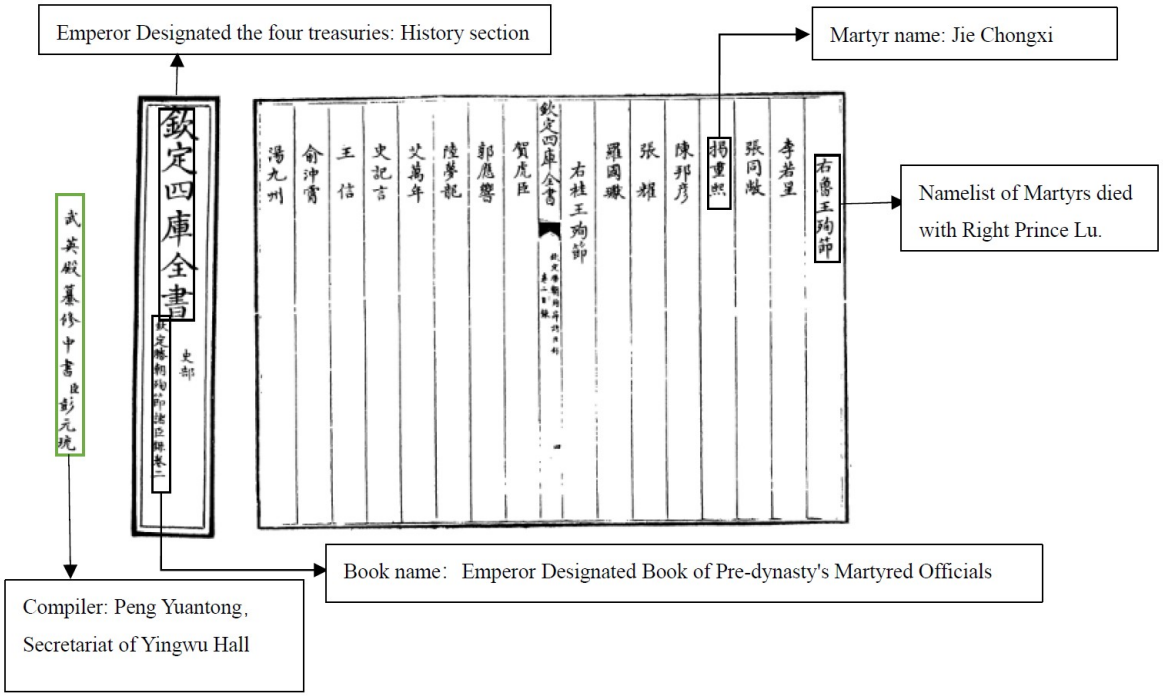
Notes: This figure shows the record of a local rebellion as it appears in the book "Chronology of Wars in Chinese History" (Zhongguo Lidai Zhanzheng Nianbiao). The year of the riot and a short description regarding the location, the reason, the leader and number of participants is provided. It also provides a short discussion of the rebellion and the government's reaction.

FIGURE A.2: NUMBER OF SOCIAL UNREST EPISODES: 2001-2013



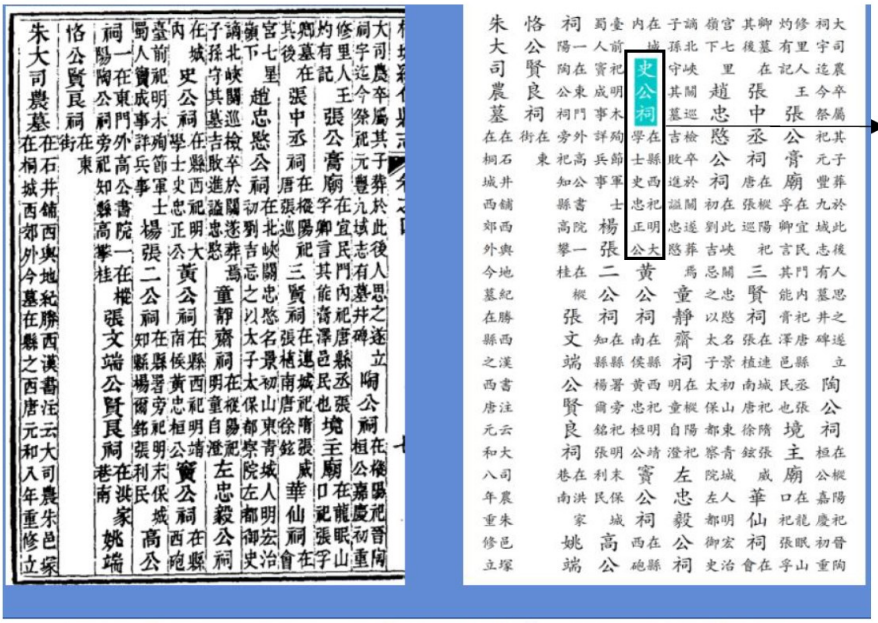
Notes: This figure shows the total number of social unrest episodes involving more than 100 participants recorded in the CASS dataset between 2001 and 2013.

Figure A.3: Example of anti-Qing Martyr Record



Notes: The figure shows an example of anti-Qing martyr extracted from the "Emperor Designated Book of Pre-dynasty's Martyred Officials". The book is part of the History Section of the Siku Quanshu (translated as the Complete Library in Four Sections, or the Emperor Designated of the four Treasuries), a massive collection of books compiled by the Qing court at the end of the 18th century. The names of the martyrs are ordered according to the princes they served and died with.

FIGURE A.4: EXAMPLE OF ANTI-QING MARTYR'S TEMPLE RECORD

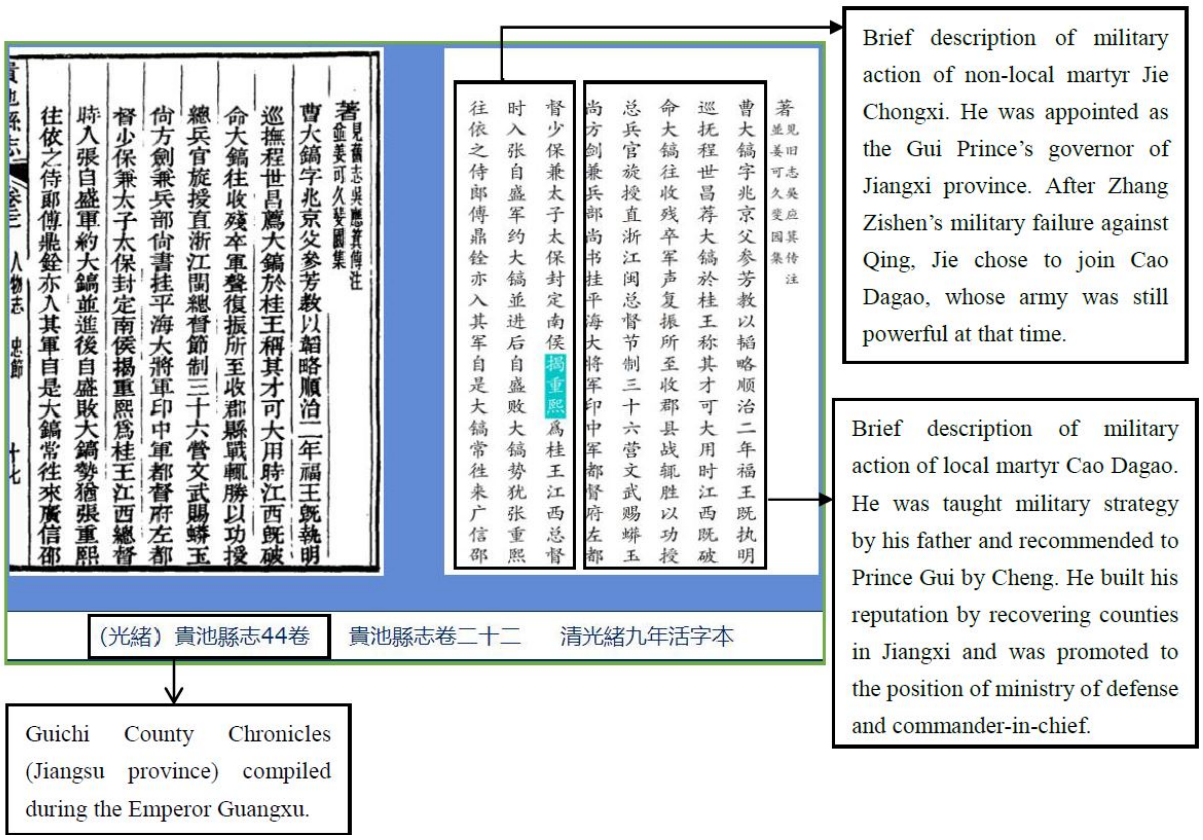


Name of the temple: Shi's Temple. It was located at the west of the county. It is in memory of Shi Kefa. Shi was the ministry of defense of Southern Ming dynasty. Shi's posthumous name is Zhongzheng, or "loyal and upright"

Tongcheng County Chronicle (Anhui province), Chapter 24, compiled during the Emperor Daoguan.

Notes: This figure shows an example of the location of the martyrs' temples. The temple location information comes from the local chronicles. It also provides the posthumous title of the martyr.

FIGURE A.5: EXAMPLE OF ANTI-QING MARTYR'S LEGEND RECORD



Notes: This figure shows an example of the martyrs' legends. On top of the martyr who was originated from the county, e.g., Cao Dagao, it also mentioned his non-local associated and also a martyr, Jie Chongxi.

Table A.1: The Effect of Total Eclipses on The Probability of Rebellions
Additional Results

outcome:	1(rebellion)						
	baseline	negative binomial	exclude Taiping 1850-1864	early period pre-1800	late period 1800-1911	subsequent shocks	eclipse during bad times
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1(eclipse)	0.179***	3.534***	0.181***	0.295***	0.054**	0.152***	0.177***
	(0.042)	(0.133)	(0.042)	(0.067)	(0.027)	(0.034)	(0.042)
1(eclipse) × 1(past eclipse)						0.131**	
						(0.057)	
1(past eclipse)						0.002*	
						(0.001)	
1(eclipse) × 1(natural disaster)							0.050
							(0.069)
1(natural disaster)							-0.000
							(0.001)
County FE	y	y	y	y	y	y	y
Province × year FE	y	y	y	y	y	y	y
County controls	y	y	y	y	y	y	y
N clusters (prefectures)	249	249	249	249	249	249	249
Observations	407,650	407,650	384,400	237,150	170,500	407,650	407,650

Notes: The dependent variable 1(rebellion) is a dummy equal to 1 for county-year observations with a recorded rebellion in local chronicles and 0 otherwise. 1(eclipse) is a dummy variable equal to 1 for county-year observations within the totality zone of an eclipse in a given year, and 0 otherwise. 1(past eclipse) is a dummy variable equal to 1 for counties that have already experienced a total eclipse in previous years, and 0 otherwise. County controls include all time varying county characteristics reported in Panel A of Table I, quintiles of log distance to the coast, log distance to Beijing, degrees latitude and terrain ruggedness interacted with year fixed effects. Standard errors clustered at the prefecture-level reported in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table A.2: The Effect of Past Rebellions on 1902-1911 Protests Comparison with Imperial Examination Channel

outcome:	N Protests per capita (1902-1911)		
	(1)	(2)	(3)
log Keju quotas per capita	0.589***		0.381**
	(0.169)		(0.160)
(N Rebellions per capita)$_{1647-1899}$		1.203**	1.172**
		(0.520)	(0.503)
N clusters (prefectures)	233	233	233
Observations	1,508	1,508	1,508

Notes: The dependent variable is the total number of protests per capita recorded between 1902 and 1911 in each county. (N Rebellions per capita) is the total number of rebellions per capita recorded between 1647 and 1899 in each county. Standard errors clustered at the prefecture-level reported in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table A.3: The Effect of Past Rebellions on early diffusion of Chinese Communist Party

outcome:	CCP members per capita		1(CCP diffusion)	
	(1)	(2)	(3)	(4)
(N Rebellions per capita)$_{1647-1899}$	1.826**	2.062*	0.203***	0.216***
	(0.874)	(1.094)	(0.070)	(0.077)
Province FE	y	y	y	y
County controls	n	y	n	y
N clusters (prefectures)	249	249	249	249
Observations	1,550	1,550	1,550	1,550

Notes: The dependent variable is the number of CCP party members deaths per capita. CCP party members are assigned to counties based on their place of birth, and can only be identified is they died during the civil war in the period 1927 to 1931. Data is from the Chinese Civil Affairs Bureau and described in section III. Variables in per capita terms are constructed using county population estimates from Skinner et al. (2008). County controls include log distance to the coast, log distance to Beijing, degrees latitude and terrain ruggedness. Standard errors clustered at the prefecture-level reported in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table A.4: Memory of Past Rebellions and Current Grievances

outcome:	1(protest)							
	OLS		Reduced Form	2SLS				
					target		temple or memorial	
					local gov	other	yes	no
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(N Rebellions per capita)$_{1647-1899}$ × 1(high air pollution)		0.009*		0.023**	0.022**	0.000	0.045**	-0.004
		(0.004)		(0.012)	(0.010)	(0.009)	(0.020)	(0.005)
(N Eclipses)$_{1647-1899}$× 1(high air pollution)			0.018**					
			(0.008)					
1(high air pollution)	0.009*	-0.001	0.001	-0.015	-0.017*	0.004	-0.030	0.004
	(0.005)	(0.007)	(0.006)	(0.012)	(0.010)	(0.010)	(0.021)	(0.012)
R-squared	0.249	0.262	0.262	0.010	0.005	0.006	0.014	0.002
N clusters (prefectures)	306	306	306	306	306	306	244	136
Observations	24,115	24,115	24,115	24,115	24,115	24,115	17,277	6,825

Notes: The outcome variable in all columns is a dummy equal to 1 if a protest event is recorded in a given county and year in the CASS dataset. 1(high air pollution)$_{it}$ is a dummy equal to 1 if the level of $PM_{2.5}$ in a given county and year is above the median in our sample (35.7 μ/m^3). County controls include quintiles of distance to the coast, degrees latitude and terrain ruggedness interacted with year fixed effects. Standard errors clustered at the prefecture-level reported in brackets. Significance level: *** p<0.01, ** p<0.05, * p<0.1.