

DISCUSSION PAPER SERIES

DP16921

Eclipses and the Memory of Revolutions: Evidence from China

Jacopo Ponticelli and Meng Miao

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Discussion Paper DP16921
Published 17 January 2022
Submitted 12 January 2022

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JEL Classification: D74, O53, N3

Keywords: Social Protests, Persistence, Qing dynasty, Confucianism

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Acknowledgements

We received valuable comments from Daniel Mattingly (discussant), Hanming Fang, Nicola Gennaioli, Zhiguo He, David Yang, Shang-Jin Wei, Nancy Qian, Michael Song, Mounu Prem, Joachim Voth and seminar participants at NBER Chinese Economy Working Group Meeting, CUF-Beijing, QCSS-NYU conference and Economic History Society annual conference. Jiacheng Yan provided excellent research assistance.

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Meng Miao Jacopo Ponticelli*

January 13, 2022

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I INTRODUCTION

Throughout history, social protests have shaped societies, influenced policy-makers' agendas, and, in some instances, forced regime changes. From the Arab Spring uprisings of 2010-12 to the Hong Kong protests of 2019-20, the last decade has witnessed a large number of such episodes. 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 how an individual decision to participate in protest actions interacts with others', and pointed to coordination and information frictions as potential drivers of the incidence of social protests.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. Recent experimental evidence has shown that past participation in protests has persistent effects on an individual's probability to participate in future protests (Bursztyn et al. 2019). However, there is no direct empirical evidence on whether persistence in protest participation exists at the community-level, and whether it can be transmitted across generations over long periods of time, affecting a community's propensity to react to current grievances.

To study this question, we present empirical evidence from China. In particular, we investigate whether the incidence of social unrest against local government officials under the Qing dynasty period (1644-1912) has a persistent effect on the incidence of anti-government protests in present-day China. The main identification challenge is that unobservable characteristics that make certain communities more rebellious in the past, might also make them more rebellious centuries later. We overcome this challenge by exploiting exogenous variation in the incidence of past protests generated by the visibility and magnitude of solar eclipses across Chinese counties. In the Confucianism tradition, a solar eclipse is considered a negative divine signal on the legitimacy of a ruler. 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.

To test this hypothesis we construct a new dataset containing the date and location of anti-government rebellions that occurred during the Qing dynasty period starting from county chronicles. These local chronicles record all major events that took place in a given region – including insurgency actions – and were compiled by independent, reputable local intellectuals (Almond et al., 2019). Our dataset includes 1,806 rebellions that occurred during the 268 years of the Qing dynasty. Rebellions mostly took the form of peasant

¹See Gehlbach et al. (2016) for a recent review and Cantoni et al. (2019) for experimental evidence on strategic substitutability in protest participation. See Manacorda and Tesei (2020) and Enikolopov et al. (2019) for recent evidence on the role of social media and availability of telecommunication technologies such as mobile phones as information and coordination mechanisms facilitating protest participation.

uprisings, which were frequent in rural China and played an important role in several major political changes in Chinese history. Poverty and hunger were primary causes of peasant uprisings (Long, 2016; Wang, 1884), which targeted local elites and government officials for their unrestrained exploitation of local farmers. We merge data on the year and location (county) of protests 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).

Our empirical strategy proceeds in two steps. In the first step, we test the hypothesis that solar eclipses positively affect the incidence of protests against local authorities during the Qing dynasty period. Solar eclipses are a plausibly exogenous source of variation because their areas of visibility, as well as their timing, are solely determined by the relative position of the sun, the earth, and the moon. Consistently, we show that the exposure of Chinese counties to solar eclipses is orthogonal to a large set of observable geographical and socio-economic characteristics. We find that counties in the totality zone of a solar eclipse are about 18 percent more likely to experience a rebellion in the eclipse year relative to counties that are outside of the totality zone. This effect is stronger in counties with a larger diffusion of Confucianism.

In the second step of our empirical analysis, we study the persistent effects of past rebellions. Using variation in the incidence of past rebellions generated by solar eclipses, we test their long run effects on the incidence of social protests in present day China. We use detailed data on current protests that has been recently made available by the China Academy of Social Sciences (CASS), and which covers events with more than 100 participants that occurred between 2001 and 2013. Our 2SLS estimates indicate that one additional rebellion during the 1644-1912 period predicts 0.2 more episodes of social unrest during the 2001-2013 period. We find similar elasticities for different measures of incidence of social unrest, such as number of protests per capita, and number of protest participants per capita in a given county.

Exploiting information on the target of each protest event, we document that the solar-eclipse driven variation in past protests explains the incidence of current protests targeting local governments (such as local party secretary or local government agencies), but not protests targeting other entities, such as local firms. We also investigate heterogeneity by type of protesters. We document that the effect is mostly driven by protests carried out by workers in relatively lower-education groups, such as farmers or taxi drivers, while the effect is muted when we focus on protests carried out by higher-education groups, such as college students or teachers.

We also introduce a set of robustness tests to show that our results are not driven by a spurious correlation between exposure to solar eclipses in the past and other geographical characteristics of Chinese counties. This is a common concern in studies that investigate the persistent effects of past phenomena on current outcomes, and which rely on geo-

graphical variation to identify such effects (Voth, 2020). In particular, we show that the documented effects are robust to controlling for a large set of geographical variables that are traditionally correlated with the intensity of economic activity in the long run, such as distance to the coast or distance to the capital city. Additionally, when estimating long run effects of past rebellions, we always control for province fixed effects, effectively relying on variation across counties located within the same geographical area of China. Regions affected by total eclipses tend to be relatively thin strips of land cutting across the Chinese territories, which insures we can exploit fine variation in exposure across counties within the same province. To account for spatial correlation, we cluster standard errors at the prefecture level – intermediate administrative units containing about 6 geographically contiguous counties – in all our specifications.

Why should the incidence of past anti-government rebellions have long run effects on the inclination of a certain community to protest? A large empirical literature has documented that cultural norms and beliefs can persist within certain communities over long periods of time.² However, the mechanisms behind this persistence are often hard to pin down.³ Our setting offers measurable signs of inter-generational transmission of the memory of past protest experiences against the central authority. First, we collect data on the date of construction and the geographical location of physical structures – such as temples and memorials – celebrating prominent individuals that fought the initial Qing invasion of China. Second, we collect information on the presence of a positive recorded memory of these early anti-Qing leaders, as captured by the description of their actions in the local chronicles, in which the account has an anti-Qing tone.⁴ Commemoration of selected individuals and historical episodes is a mechanism documented in many cultures as a way of shaping the collective memory and forge the cultural identity of a given community (Marschall, 2009; Nora, 1989). Consistent with this hypothesis, we find that the long-run effect of past rebellions is concentrated in areas that celebrated such events 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 centuries 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. For example, Ochsner and Roesel (2017) document that Austrian municipalities that were pillaged by Turkish troops between the 16th and the 17th century were more responsive to a 2005 right-wing populist campaign against

²See Voth (2020) for a recent review.

³For example, Voigtländer and Voth (2012) document that German towns with a higher incidence of pogroms against Jews in the Middle Ages displayed significantly more anti-Semitic attitudes in the interwar period of the 20th century. They argue that persistence might be partly explained by local anti-Semitic traditions and symbols that remained in the local culture for centuries.

⁴See on this the related work 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.

Turks and Muslims. This mechanism is also consistent with the model of choice proposed in Bordalo, Gennaioli, and Shleifer (2020), where the memory of 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 take different decisions when presented with the same choice. To test this mechanism, we compare counties that are exposed to the same source of grievances in nowadays China, and then analyze how their protest reaction depends on their historical 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 and central government in China (Alkon and Wang, 2018). Our findings indicate that, for the same increase in air pollution as measured by $PM_{2.5}$, counties that – for plausibly exogenous historical reasons – have a larger historical experience of anti-government rebellions, are more likely to respond to this source of grievances with protest actions.

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 certain "pilot" revolutionary are treated as a signal for other people to join. For example, 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 into a demonstration as they observe fellow citizens rebelling in increasing numbers. Cantoni et al. (2019) use a field experiment in Hong Kong to study how the information of others' plans to protest affect an individual's decision to participate in protests. Our paper exploits the insight of this literature to rationalize the empirical link between solar eclipses and rebellions during the Qing dynasty period.⁵

More recently, Bursztyn et al. (2019) 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 to its ability to sustain political engagement over time.

⁵A 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).

Bursztyn et al. (2019) 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 protests. Our paper contributes to this recent literature by providing causal evidence on the long-run persistence in inclination to protest at the community level.

Our paper is also related to the stream of literature focusing on the consequences of protest actions. This literature has documented that protests can have an independent impact on voting behavior (Madestam et al. 2013 and Aidt and Franck 2015), and on economic outcomes (Collins and Margo, 2007). For example, Madestam et al. (2013) use weather shocks to instrument for attendance at tea party protests in 2009 and find that protest participation in 2009 affected votes for the republican party in the 2010 US presidential elections.

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, that 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 (2021) 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, 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. Section III describes in detail our data collection process. Section IV describes our identification strategy and the main empirical results of the paper. Section V concludes.

II HISTORICAL BACKGROUND

II.A SOLAR ECLIPSES AS A COORDINATION DEVICE IN THE CONFUCIANISM TRADITION

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 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 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. A total eclipse presents itself as nothing less than spectacular: the sun is blocked, day becomes night, and stars become visible for as long as one hour.

According to Confucianism, the dominant ideology in ancient China which continues to play a major role in shaping the minds and actions of Chinese society today, an eclipse is a signal regarding the legitimacy of a 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.⁶ Those rulers who failed to do so would be abandoned by heaven, leaving the people with the right to overthrow them.

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

⁶Mencius 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).

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 eclipse 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 (Bai and Jia, 2016). The interpretation of solar eclipses appears in all the 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 Keju, would spend 60% of their adult lives memorizing and understanding the Confucian canon and was therefore familiar with this interpretation of solar eclipses. Moreover, Keju candidates, successful or not, usually enjoyed a higher social status and had a stronger voice in local affairs due to their ability of reading and writing. 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 Keju quotas (Zang, 2015).

Because of 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.⁷

⁷It is interesting to note that the Qing emperors did not try to dispel the superstitious interpretation

II.B SOCIAL PROTESTS DURING THE QING DYNASTY PERIOD

Peasant uprisings 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 a peasant uprising in either a direct or indirect way.

Poverty and hunger were the primary causes of peasant uprisings (Long, 2016; Wang, 1884). Perry (1980) suggests that violence and banditry were simply a survival strategy for desperate farmers, especially in regions hit by bad harvests. However, uprisings were often due 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 the private lands of peasants and profited from the manipulation of local silver-money exchange rate to exploit them. Local officials, who were usually in debt due to the large investment they had to made to prepare for the Keju exam, did not hesitate to levy additional taxes over 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. Similarly, Wang (2008) and Yang (2010) suggest that exploitation of local elites and corrupt officials over peasants were the main driver of the relatively high frequency of revolutions over the last 10 years of the Qing dynasty.

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 ruler if they treat people with mercy. (“Everyone can be a saint”, Mengzi, 5A6, 6B2). This idea justified Chinese people’s enthusiasm for uprising. 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.

III DATA

In this section we describe our main data sources, and we provide details on the data collection process to construct the new data sets on the incidence of protests during the

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).

Qing dynasty period, and on the presence of signs of the anti-Qing sentiment in a given community such as temples and legends. 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.

III.A DATA ON 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.⁸

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 DATA ON 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). On top of the peasants revolts against Qing, the book also includes accounts of wars and battles between Qing and foreign powers as well as battles of the Xinhai Revolution, which brought to the end of the Qing dynasty and the establishment of the Republic of China. 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 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.

⁸Data 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

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. 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 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 unrest episodes in the 1850s and 1860s is due to the Taiping rebellion (1851-1864) and the Nian rebellion (1853-1868). The Taiping's 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 VI (a) reports the geographical distribution of peasant uprisings recorded during the Qing dynasty period according to the Chronology of Warfare in Dynastic China.

Data on social protests in modern 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 V 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.⁹ Figure VI (b) reports the geographical distribution of social protest in the 2001-2013 period according to the

⁹According 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.

CASS database. The provinces with the highest number of social protests recorded are Shaanxi, Hubei, Hunan and Guangdong.¹⁰

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’s 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.¹¹ The book contains a comprehensive list of 1,600 civilians and military officials who died in the war against Qing’s invasion. The officials’ names are ordered according to the princes they served and died with. Figure A.2 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 spread their legends. On the other hand, worshipping 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.¹²

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.3 provides an

¹⁰In the case of Hubei and Hunan, the timing and motive of many of the recorded protests can be attributed to the Three-Gorges dam project, which caused the relocation of about 1.2 million people whose towns and villages were flooded by the water reservoir created by the new dam. Migrants were often relocated in areas that were less economically developed than their hometowns, received lower salaries and perceived to have been unfairly treated by the local government, feelings that generated discontent and often social protests (Liu and Feng, 2007).

¹¹Interestingly, 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.

¹²In 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.

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.¹³ We then use both electronic and manual searches to locate the martyrs' temples in the local chronicles. Our dataset includes 308 anti-Qing martyrs' temples. Figure VII, panel (a), shows the geographical distribution of such temples.

The accounts of martyrs' actions against the Qing's invasion were also recorded in the "memorabilia" section of local chronicles. Such section recorded the important events that took place within the county, including the fight of 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.4 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 VII, panel (b) shows the geographical distribution of counties with recorded anti-Qing legends in local chronicles.

IV IDENTIFICATION STRATEGY AND RESULTS

Our empirical strategy proceeds in two steps. First, we document the effect of solar eclipses on the probability of rebellions during the Qing dynasty period, from 1644 to 1912. Our objective is to test the hypothesis that solar eclipses positively affect the incidence of protests against local authorities. We start by discussing why we consider solar eclipses a valid instrument for social unrest during the Qing dynasty period in section IV.A. All the results of the first step of our empirical analysis are then presented in section IV.B.

In the second step of our empirical analysis we study the degree of persistence of past rebellions. Using variation in the incidence of past rebellions generated by eclipses, in section IV.C we test their long run effects on the incidence of social protests in modern-day China. In sections IV.D and IV.E, we discuss and provide evidence on potential mechanisms behind this persistence effect. In particular, we argue that the memory of

¹³Often 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.

rebellions occurred during the Qing dynasty was transmitted within a given community via temples and legends celebrating the leaders of such rebellions. We test this argument using data on the dates and geographical location of the temples constructed to celebrate rebel leaders of the past across China, as well as the codification of anti-Qing fighters' stories in local chronicles. Finally, we study whether the presence of such historical memory shapes the protest response of local communities to current grievances, using changes in air pollution levels as a source of variation in grievances.

IV.A SOLAR ECLIPSES AS AN INSTRUMENT FOR REBELLIONS

Our main identification assumption is that both the timing and the geographical exposure of different counties to a solar eclipse are exogenous. This assumption is based on the fact that areas where a solar eclipse is visible, as well as its date, are solely determined by the relative position of the sun, the earth, and the moon. Thus, the degree of exposure of a given area to an eclipse should be orthogonal to geographic, demographic, economic and cultural characteristics of that area.

To validate this assumption in our data, we compare Chinese counties that are inside vs outside the totality zone of solar eclipses on a large set of observable characteristics. The results of this balance test are reported in Table I. We start in Panel A by comparing time-invariant characteristics of counties that were inside the totality zone of a solar eclipse at least once during the period under study with counties that were never within such totality zone. Time invariant characteristics include a large set of geographical variables, including latitude, longitude, average terrain ruggedness, distance to the imperial capital Beijing, distance to the coast, distance to the Yangtze river, and distance to the provincial capital.¹⁴ We also compare counties based on a set of time-invariant socio-economic characteristics available in our data for the Qing period, including the size of the county as captured by its population, the amount (in silver units) of the local agricultural tax (only available for 1820), the presence of at least one Confucian temple recorded in local chronicles, the local Keju quota (in number of positions), and the number of local clans.¹⁵ Among the geographical variables, we find that counties inside the totality zone of solar eclipses tend to be closer to the coast, closer to Beijing and tend to have higher average degrees east of longitude. Indeed, these three variables capture the same variation, as

¹⁴Terrain ruggedness is the geographical unevenness of the earth surface of the county, constructed following Nunn and Puga (2012).

¹⁵Population data are from Skinner (1964), which categorizes each county into one of 11 population size categories, ranging from counties with up to 1000 individuals to counties with population above 500,000 individuals. Log population is the log of the midpoint of each population size category. The local Keju quota is the total number of local candidates allowed to join higher-level Keju examinations, constructed following Bai and Jia (2016). 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 (Dincecco and Wang, 2021; Bai et al., 2021).

higher degrees east of longitude correspond to a movement from the interior to the coast of China, and Beijing is located close the west coast of China. In our empirical analysis we control for these three geographical characteristics whose differences between eclipse and non eclipse counties is statistically significant, and show that our results are stable when adding these controls. We find no significant differences across all other geographical characteristics, nor among the socio-economic variables described above, which lends support to the identification assumption that the geographical distribution of total solar eclipses is as good as random.

Even if the timing and location of eclipses is itself random, eclipses may bring about other incidences – such as natural disasters — which themselves might increase the probability of social unrest.¹⁶ In Panel B of Table I, we compare eclipse and non-eclipse county-years in terms of the incidence of four (time-varying) measures 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 during the Qing dynasty kept a detailed record of such events, from which we extracted our data. We also check for any correlation between the incidence of total solar eclipses and dummies capturing the construction of new infrastructures in a given county-year, or whether a tax relief was granted to the local population.¹⁷ As shown, we find no systemic differences in the incidence of natural disasters, new infrastructure or tax relief across counties that experienced eclipses in a given year versus those that did not during the period under study.

Another potential concern is whether the timing of eclipses could have been predicted by Chinese astronomers and thus anticipated by either the rebels or the central government. As discussed in section II, during the Qing dynasty, the study of astronomy was monopolized by the Qing court via the Bureau of Astronomy. In this sense, it is plausible that local organizers 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, though often inaccurately by modern standards (Lu and Shi, 2003a,b). 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, they were hardly able to predict which specific ar-

¹⁶For instance, some researchers have argued that solar eclipses can increase the probability and intensity of the El Niño and La Niña effects, a weather phenomenon that can increase the risk of extreme weather events (Lin et al., 1999).

¹⁷These last two variables are extracted from county chronicles. We think of them as potential alternative determinants of social unrest. Using data on European countries during the XXth century, previous research has shown that austerity measures can be a powerful determinant of social unrest (Ponticelli and Voth, 2020).

areas within a given province of China – would have been under the area of totality during any given solar eclipse. From an identification standpoint, any aggregate response to a predicted eclipse put in place by the Qing court would affect in a similar way all counties in our sample, and thus be absorbed by time fixed effects in our specifications.

IV.B 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. Our baseline specification is as follows:

$$1(\textit{rebellion})_{it} = \alpha_i + \alpha_t + \beta 1(\textit{eclipse})_{it} + \varepsilon_{it} \quad (1)$$

The outcome variable $1(\textit{rebellion})_{it}$ is a dummy equal to one if a peasant uprising was recorded in county i and year t . The source of this data are local chronicles, as described in section III. The independent variable $1(\textit{eclipse})_{it}$ 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, and thus should be thought of as an intention-to-treat effect of eclipses. The specification reported in equation (1) includes county and year fixed effects.

In addition to equation (1), we also estimate the following augmented specification:

$$1(\textit{rebellion})_{ipt} = \alpha_i + \alpha_t + \alpha_{pt} + \beta 1(\textit{eclipse})_{it} + \theta X_{it} + \varepsilon_{ipt} \quad (2)$$

which includes time varying county-level controls as well as province p fixed effects interacted with year fixed effects. Time varying controls at county-level are meant to capture alternative determinants of protests that we can observe in our data. They include all time varying controls reported in Panel B of Table I: dummies for natural disasters (floods, droughts, earthquakes, insect infestation), famines, and two variables capturing government policies – a dummy capturing new infrastructure expenditures in the county, and a dummy capturing any form of local taxation relief.

A standard econometric challenge when exploiting cross-sectional 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.

The results of estimating equation (1) are reported in Table II. The estimated coefficient in column (1) indicates that counties that experience a total solar eclipse have a

17.5 percent higher probability of also experiencing a peasant uprising in the same year. In column (2) we control for province times year fixed effects, to absorb province specific trends, while in column (3) we additionally control for the set of time varying county-level characteristics described in Panel B of Table I. As shown, the magnitude of the point estimate on the total eclipse dummy remains stable with the inclusion of these controls. In fact, we only find a positive and significant effect of contemporaneous tax reliefs on local rebellions, which might have been introduced as a response to peasant uprisings against taxes levied by local officials. Table I showed that eclipse counties tend to be closer to the coast. Thus, in column (4) we additionally control for quintiles of distance to the coast interacted with year fixed effects to account for potentially heterogeneous incidence of protests across counties at different distance from the coast. As shown, the magnitude of the estimated coefficient on eclipses is not affected by this control.

Next, we explore the timing of the relationship between eclipses and rebellions with the following dynamic specification:

$$1(\text{rebellion})_{it} = \alpha_i + \alpha_t + \sum_{k=-3}^{k=+3} \gamma_k 1(\text{year} = k) + \varepsilon_{it} \quad (3)$$

where $1(\text{year} = k)$ 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 calendar year and county fixed effects, as in equation (1). Notice that this specification focuses on counties that experienced an eclipse at some point during the period under study. The results of estimating equation (3) are reported in Figure VIII. As shown, the effect of total 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, indicating that the effect of eclipses on rebellion is mostly contemporaneous. Figure VIII also shows the absence of pre-existing trends in rebellions in counties that experienced an eclipse at $k = 0$.

IV.C THE PERSISTENCE OF PROTESTS

In this section we test whether the incidence of social protests within a given community persists over the long-run. In particular, we exploit plausibly exogenous variation in the incidence of past rebellions generated by eclipses during the Qing dynasty to test their long run effects on the incidence of protests in present-day China. For this analysis, we rely on a set of cross-sectional regressions of current incidence of protests across Chinese counties on the incidence of protests in those same counties during the Qing dynasty period. We instrument the latter with the overall incidence of solar eclipses in a given county during the Qing dynasty period.

We start by discussing the cross-sectional version of our first stage specification, which is as follows:

$$\sum_{t=1644}^{1912} rebellion_{ipt} = \alpha_p + \gamma \sum_{t=1644}^{1912} eclipse_{it} + \eta_{ip} \quad (4)$$

Equation (4) links the overall number of protests observed in a county during the 1644-1912 period with the overall number of total eclipses visible from that same county during the same period. We include in this specification province-level fixed effects (α_p), county population size categories fixed effects, and the county-level controls for which significant differences arise in Panel A of Table I, which include: distance to the coast, distance to the imperial capital Beijing, and degrees east of longitude. The results are reported in Table III. The estimated coefficient in column (1) indicates that Chinese counties experiencing 1 additional total eclipse during the 1644-1912 period experienced about 0.45 more rebellions against local authorities during the same period. This point estimate is stable when adding controls in column (2). The first-stage F statistics is 59.7.¹⁸

We also show results using two alternative measures of a county exposure to solar eclipses: the number of all types of eclipses weighted by their magnitude (i.e. the percentage of the sun disk covered) in columns (3) and (4), and the total number of eclipses, independently from their magnitude, in columns (5) and (6). As shown, the first stage coefficient is positive and highly significant irrespective of the measure used. However, total eclipses have a significantly larger impact on the incidence of rebellions than eclipses that do not fully cover the sun disk, potentially because total eclipses are a more salient signal than partial ones. Thus, we focus our attention on variation generated by total eclipses in the remaining of the empirical analysis.

In Table IV we report our main results on persistence: we study the effect of past protests on the incidence of current protests. To measure the incidence of current protests we create four main outcome variables: number of social protests, a dummy capturing the occurrence of any protest, the number of social protests per capita, and number of participants in social protests per capita in a given county during the period 2001-2013. The data on social protests is sourced from the China Academy of Social Sciences Dataset described in section III. For each of these outcomes, we present a simple correlation of past protests on current protests, a reduced form specification of current protests on the number of total eclipses experienced by a county during the Qing dynasty period, and an instrumental variable estimate which uses equation (4) as the first stage. All specifications in Table IV include the same set of county controls and fixed effects used in the first stage results reported in Table III, 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.

¹⁸This number refers to the Kleibergen-Paap Wald F-statistic.

Let us start by discussing the magnitude of the 2SLS coefficients, which capture the effect of past protests on the incidence of current protests. The magnitude of the coefficient in column (3) indicates that counties that experienced 1 additional rebellion against the local government during the 1644-1912 period experienced 0.18 more episodes of social unrest during the 2001-2013 period. This magnitude corresponds to about 14 percent of a standard deviation in the level of protest activity registered in the 2001-2013 period across Chinese counties. About 20 percent of the 1855 counties in our sample have experienced some protest events during the 2001-2013 period.

In column (6) we report the 2SLS coefficient when the outcome variable is 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 0.1 with a t-stat of 2.8. This indicates that counties that had 1 additional anti-Qing rebellion in the past – due to their exposure to total eclipses – are about 10 percent more likely to also have experienced some form of social unrest in the 2001-2013 period. Since the existing literature has not explored whether persistence in protest participation exists at the community-level, and whether it can be transmitted across generations over long periods of time, there is no obvious benchmark with which to compare the magnitude of the estimates reported in this paper. To the best of our knowledge, the only available evidence on persistence in protest participation is at the individual level and over the short-run. In an experimental setting, Bursztyn et al. (2019) find that participation in the July 1, 2017 Hong Kong protests makes individuals around 47 percent more likely to participate in the same type of protest the following year.¹⁹

We find consistent effects when using alternative outcomes such as the number of protest events per capita or protest participation per capita as outcome variables, as shown in columns (7) to (12) of Table IV. Notice also that the 2SLS estimates for all outcomes are between 3 and 5 times larger than the OLS estimates. This downward bias in the OLS estimation could be driven by several potential sources of endogeneity in the OLS regression. For example, traditionally more rebellious regions might be treated differently by the central government over time so to avoid such rebellions to resurface. If the central government measures are effective, this would make such regions less likely to display rebellions in the future. This is also consistent with the positive correlation between tax relief policies and rebellions in the panel regression presented in Table II.

Although counties exposed and counties non-exposed to total eclipses during the Qing dynasty period were similarly likely to have a Confucian temple at baseline, a potential concern with the estimates reported in Table IV is that the driver of the long-run effects of past protests on current protests is the local diffusion of Confucianism, as the compliers of our experiment are more likely to be Confucian areas. To explore this issue, we replicate our key results of Table IV restricting our sample to traditionally Confucian counties,

¹⁹The source is Table C.9, Panel B in Bursztyn et al. (2019).

defined as those with the presence of a Confucian temple. The results are reported in Table A.1 and show that all our main results are robust to exploiting variation in the incidence of solar eclipses *within* the sample of Confucian counties. As shown, the magnitude of the point estimates is larger when focusing on the sample of Confucian counties.

IV.C.1 Heterogeneous Effects by Target and Type of Protesters

Before discussing and empirically investigating potential mechanisms, we present a set of heterogeneous effects. The data on social protests recorded by the China Academy of Social Sciences includes not just the location of each protest event and the number of participants, but also information on the main target of the protest and the type of protesters involved. We exploit this information to study whether variation in the historical diffusion of protests affects the incidence of current protests about specific topics or carried out by specific groups. All the results reported in this section use the instrumental variable specification described in the previous section.

We start by investigating heterogeneity in the target of the protest. The CASS dataset includes a large set of potential targets. We are particularly interested in separating 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 (1) and (2) of Table V. We find that the 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. This result suggests that the persistent effects of historical protests are stronger when protesters have grievances against the same target. In our setting, this target is local government officials.

Next, we investigate heterogeneity by type of protesters. Also in this case the CASS dataset includes detailed categories of protesters, which are usually identified by their main occupation. We use this information to split the data on protest events into two types based on the plausible level of education of the protesters. In particular, we define protest events from higher-education groups as those carried out by college students, teachers, foreign employees and business owners. We defined the residual category as protests carried out by farmers, taxi drivers, and all other categories of workers, which we consider as lower-education groups. The results are reported in columns (3) and (4) of Table V. As shown, we find that the effect is muted for protests carried out by higher-education groups, and mostly present for protests carried out by the residual category. Although not statistically significant at standard levels, the magnitude of the point estimates suggest that low skilled individuals might be more responsive to community-level traditions of expressing discontent against the government via public protests.

IV.D THE MEMORY OF PAST PROTESTS

Why does the incidence of past rebellions have long run effects on the inclination of a certain community to organize anti-government protests centuries later? In this section, we discuss and test a potential mechanism behind this persistence: the inter-generational transmission of the memory of past rebel leaders. The commemoration of selected persons and historical episodes are used in many cultures as a way of shaping the collective memory and forge the cultural identity of a given community.²⁰ In our setting, one anecdote that speaks to the role of commemorating rebels of the past is about the childhood of Sun Yat-sen, one of the leaders of the Xinhai revolution, which overthrew the Qing court in 1911. Sun Yat-sen was born in a village close to the hometown of Hong Qiuquan, the leader of the Taiping revolution against the Qing rule that took place in the 1850s. When Sun was young, his favorite past 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 so that he called himself the “Hong Xiuquan Jr”.

To provide evidence on this channel, we collected data on two potential signals of the existence of local transmission of the memory of past rebellions. First, we collected information on the date of construction and the geographical location of physical structures – such as temples or memorials – celebrating anti-Qing martyrs. Second, we collected information on the presence of a positive recorded memory of anti-Qing martyrs in the local chronicles. As described in section III, 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 (or 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 then test empirically whether the effect of past rebellions on current protests is different across areas with vs without these signs of transmission of the memory of past rebellions. To this end, we estimate the following specification:

$$\begin{aligned} \sum_{t=2001}^{2013} protest_{ipt} &= \alpha_p + \gamma_1 \sum_{t=1644}^{1912} rebellion_{it} + \gamma_2 1(temple) \\ &+ \gamma_3 \sum_{t=1644}^{1912} rebellion_{it} \times 1(temple) + \eta_{ip} \end{aligned} \quad (5)$$

where $1(temple)$ is a dummy equal to one if county i has a temple or memorial celebrating an anti-Qing leader that fought the Qing invasion. The incidence of protests during the Qing period is instrumented with the incidence of total eclipses as per our first stage equation (4). We estimate a similar specification for the presence of positive recorded

²⁰See, for example, (Marschall, 2009) on the role of memorials in South Africa post-apartheid.

memory of early anti-Qing rebels in the local chronicles, which we refer to as *legends*.

The results of this analysis are reported in Table VI. In column (1) we report the correlation between past protests and current protests as already documented in Table IV. In columns (2) and (3) we estimate an OLS version of equation (5), which shows that the correlation in column (1) is concentrated in 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. In columns (4) to (6) we then present the second stage coefficients of these heterogeneous effects. The results of column (5) show that the long-run effect of past rebellions is stronger in counties that celebrated anti-Qing leaders either via temples, thus preserving their memory for future generations. Similarly, in column (6), we document that such persistence is driven by counties where the memory of anti-Qing actions remained recorded in the local chronicles.

IV.E DOES HISTORICAL MEMORY SHAPE THE RESPONSE TO CURRENT GRIEVANCES? AN APPLICATION TO AIR POLLUTION

The results presented in Table VI are consistent with persistence being concentrated in regions that preserved the collective memory of historical anti-government rebellions. However, these results do not explain why the presence of such a collective memory translate into higher propensity to protest centuries later. A potential mechanism that rationalize these findings is described in the model of choice proposed by Bordalo, Gennaioli, and Shleifer (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 is that individuals with different sets of past experiences – a different *database* of memories – might take 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, that 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 protest 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 local and central government in China (Alkon and Wang, 2018). We measure air pollution as the concentration of fine particule matter in the air ($PM_{2.5}$) recorded in a given county. This data on air pollution is collected by NASA from satellite images, and made available at the annual level for a

grid of cells with resolution of 0.01 degrees.²¹ 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 $35.7 \mu/m^3$, 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). Using a panel dataset at the county-year level, we estimate the following specification:

$$1(\text{protest})_{ipt} = \alpha_i + \alpha_t + \delta_1 1(HP)_{it} + \delta_2 \sum_{t=1644}^{1912} \text{rebellion}_{it} \times 1(HP) + u_{ipt} \quad (6)$$

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. 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 VII. 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 $35.7 \mu/m^3$ are about 1 percent more likely to experience at least one episode of social unrest. In column (2) we estimate a version of equation (6) 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 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. On the other hand, we see no effect of pollution on protests in areas with no past rebellions, which are about half of our sample of counties.

In columns (3) and (4) we present the reduced form and 2SLS coefficients. The magnitude of the 2SLS coefficient indicates that counties with 1 additional eclipse-driven rebellion during the Qing dynasty period are 2.5 percent more likely to experience social protests in response to an increase in the air pollution index. Finally, in column (5) we restrict our attention to the sample of counties with a temple or legend celebrating anti-Qing martyrs. The evidence presented in section IV.D indicates that the long-term

²¹Data is publicly available at <https://sedac.ciesin.columbia.edu/>

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 (4.6 percentage points) than in the overall sample.

Overall, the evidence presented in this section is consistent with the idea that differences in the historical incidence of past protests affect communities' propensity to react to current grievances against local governments. This is a potential channel linking incidence of past protests with current protests at community level, even over long periods of time.

V CONCLUDING REMARKS

This article shows 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. Our evidence also indicates 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.

Our evidence 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. China is a particularly interesting setting to study the persistence of local collective memory. In the last two decades, the Chinese society has experienced large migrations, mostly from rural to urban and coastal areas. A potential consequence of a substantial internal migration process is to attenuate the influence of symbols and stories of the past on current behavior, especially given these stories are celebrating the fight against a foreign ruler that has not been in power for more than a century. On the other side, certain traits of the Chinese society – such as the importance of family and local community ties, as well as the justified right to upraise against local authorities perceived as exploitative rooted in the Confucian tradition – are consistent with the existence of these long run effects.

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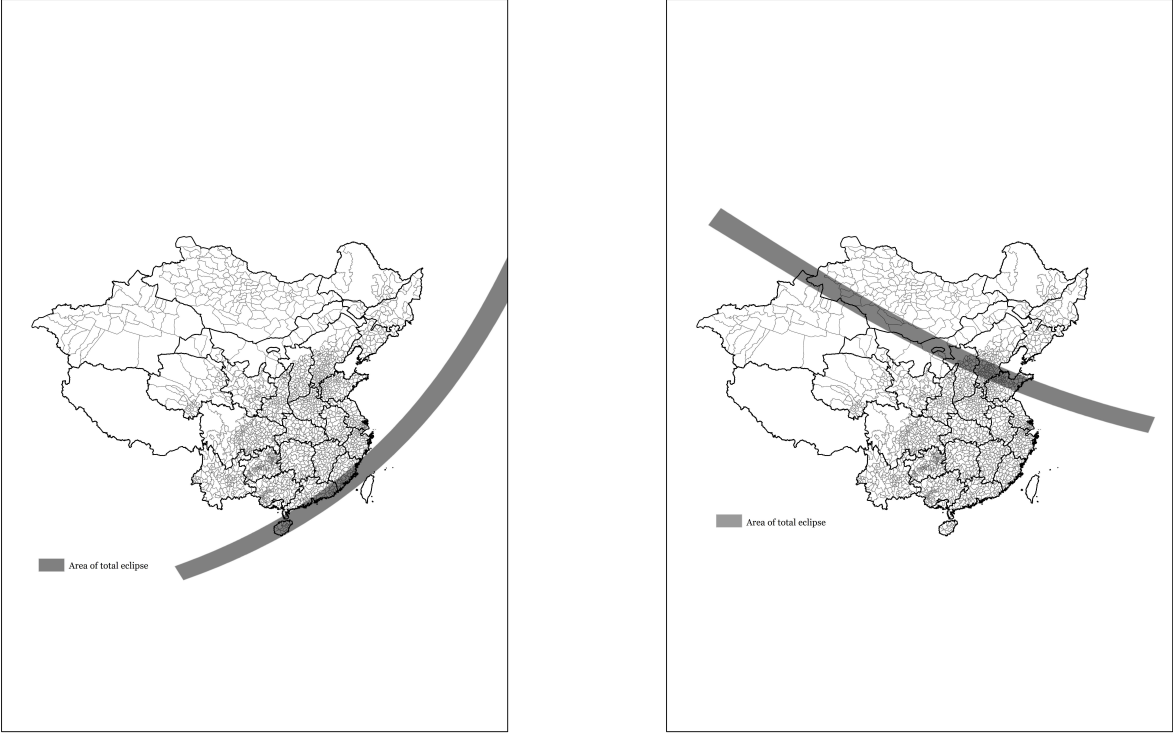
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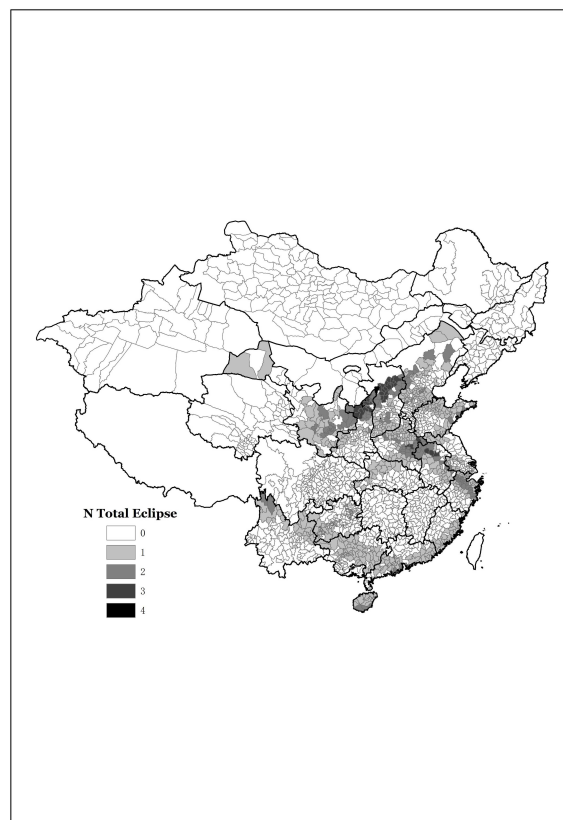
FIGURES AND TABLES

FIGURE I: ZONES OF TOTALITY: ILLUSTRATIVE EXAMPLES



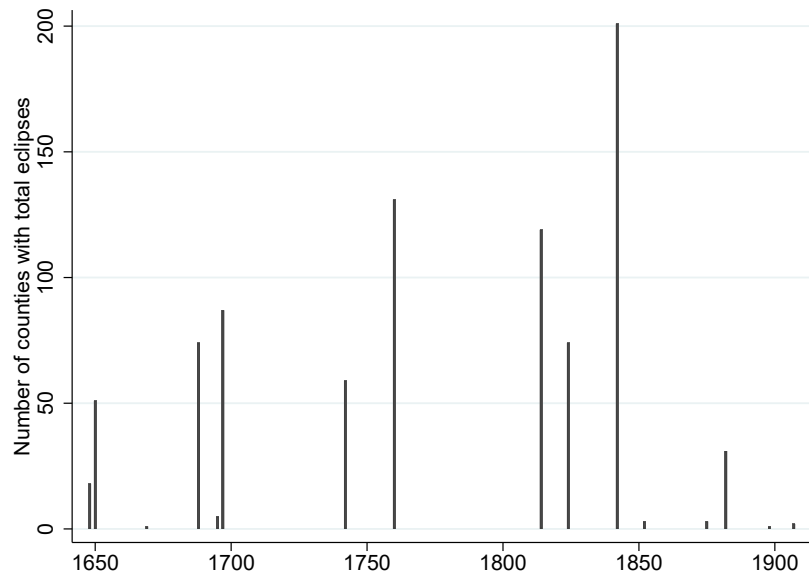
Notes: This figure shows the zones of totality of two eclipses: 1742 (left) and 1760 (right). The zone of totality was calculated using data from NASA.

FIGURE II: NUMBER OF TOTAL ECLIPSES BY COUNTY: 1644-1912



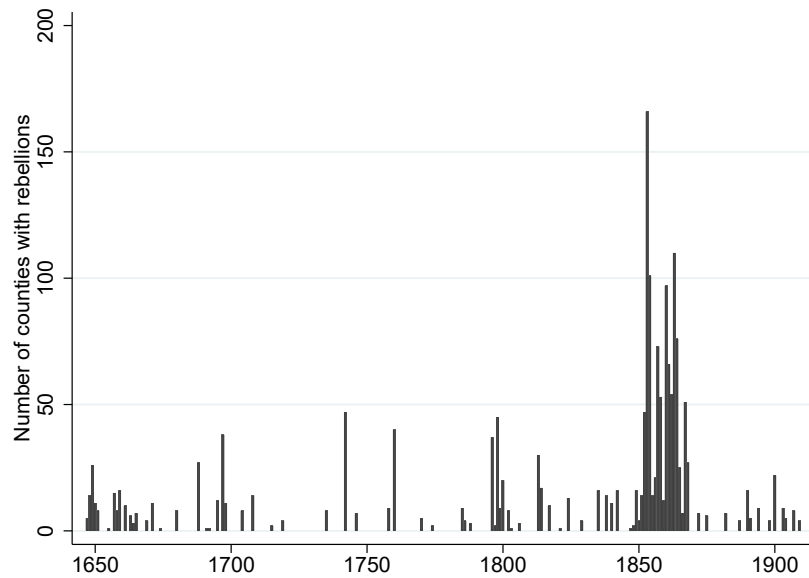
Notes: This figure shows the total number of eclipses that each county has observed during the Qing dynasty period (1644-1912).

FIGURE III: NUMBER OF COUNTIES EXPERIENCING TOTAL ECLIPSES BY YEAR:
1644-1912



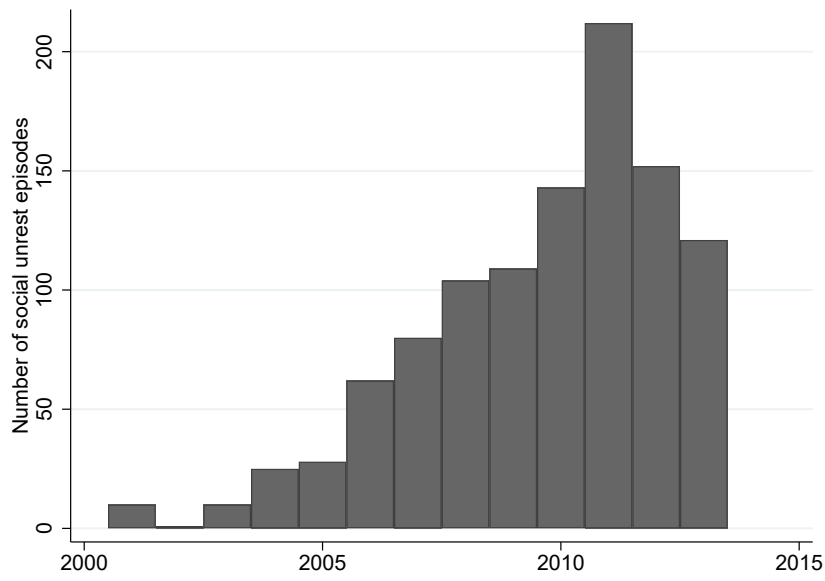
Notes: This figure shows the total number of counties experiencing total eclipses in each year during the Qing dynasty period (1644-1912).

FIGURE IV: NUMBER OF COUNTIES WITH PEASANT UPRISINGS BY YEAR: 1644-1912



Notes: This figure shows the total number of counties reporting peasant uprisings in each year during the Qing dynasty period (1644-1912).

FIGURE V: NUMBER OF SOCIAL UNREST EPISODES: 2001-2013

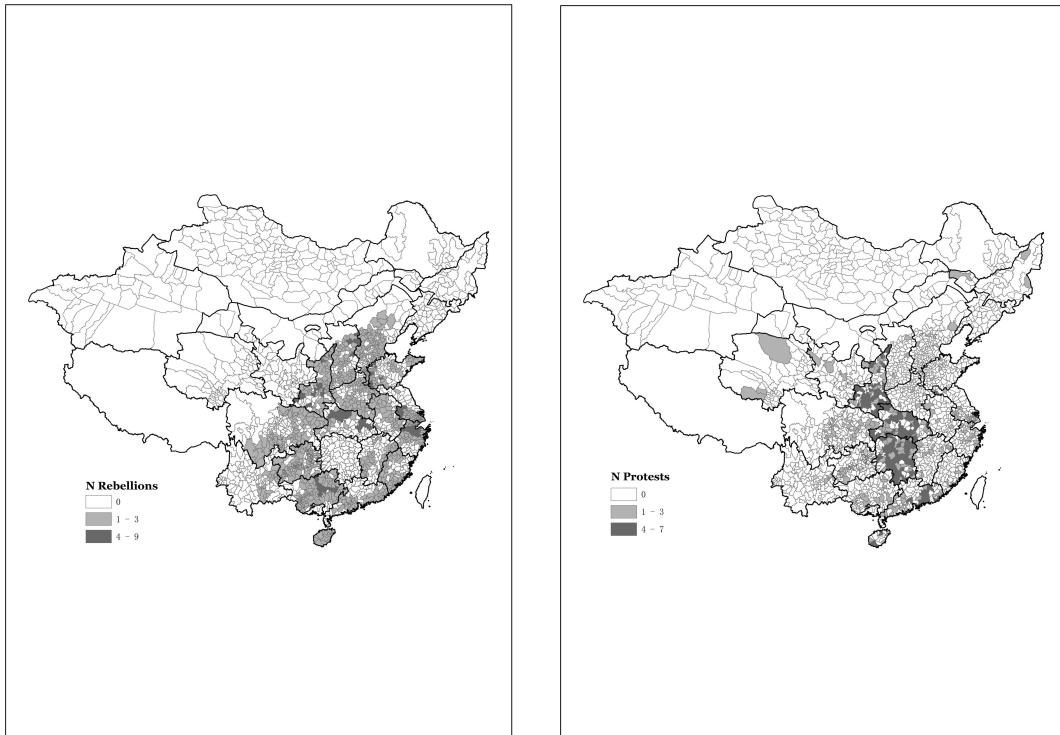


Notes: This figure shows the total number of social unrest episodes involving more than 100 participants recorded in the CASS dataset between 2001 and 2013.

FIGURE VI: GEOGRAPHICAL DISTRIBUTION OF SOCIAL UNREST

(a) 1644-1912

(b) 2001-2013

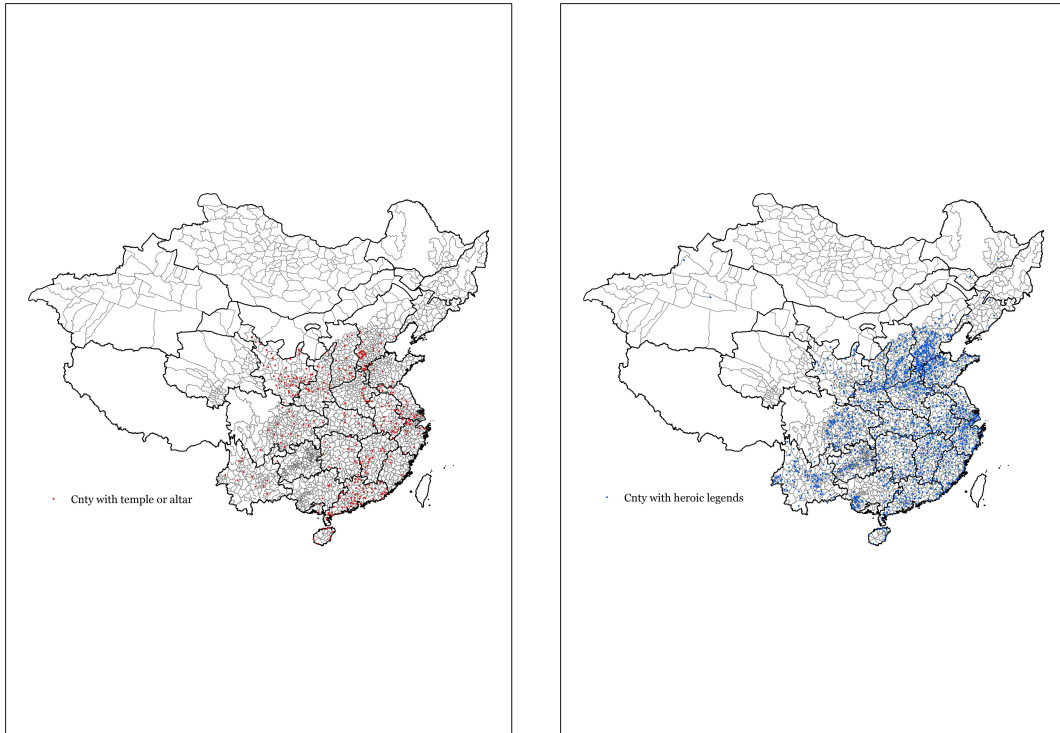


Notes: Panel (a) shows the total number of rebellions that each county has experienced throughout Qing China (1644-1912). Panel (b) shows the total number of protests that each county has experienced between 2001 and 2013.

FIGURE VII: GEOGRAPHICAL DISTRIBUTION OF ANTI-QING MEMORY

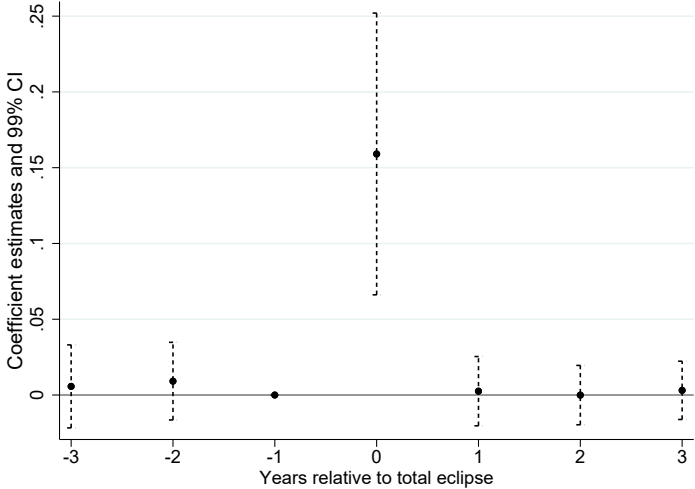
(a) Temples

(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 VIII: TIMING OF THE EFFECT OF ECLIPSES ON PROBABILITY OF REBELLION



Notes: This table reports the coefficient and 99% confidential intervals of the incidents of rebellions on the up-to-3-period leads and lags of incidents of eclipse. All regressions include baseline county level controls as well as county and year fixed effect. Standard errors used to construct confidence intervals are clustered at county level.

TABLE I: BALANCE TEST FOR COUNTIES INSIDE VS OUTSIDE TOTALITY ZONE OF SOLAR ECLIPSES

County characteristics	Totality zone		Difference	P-value
	Outside	Inside		
Panel A: Time invariant characteristics				
Latitude	33.32	32.39	-0.93	0.330
Longitude	109.73	113.30	3.58	0.000
Terrain ruggedness	0.48	0.46	-0.03	0.391
Log distance to Beijing	13.94	13.55	-0.39	0.001
Log distance to the coast	13.05	12.18	-0.86	0.000
Log distance to the province capital	11.68	11.58	-0.10	0.722
Log distance to the Yangtze river	12.71	12.88	0.17	0.263
Log population	8.05	8.09	0.04	0.626
Agricultural land tax (silver units)	181,092	180,895	-197	0.989
Presence of a Confucian temple	0.44	0.47	0.02	0.634
Local Keju quota (number of positions)	9.88	10.00	0.11	0.957
Number of clans	6.31	5.86	-0.45	0.782
N observations	1,174	681		
Panel B: Time varying characteristics				
Earthquake	0.0011	0.0023	0.0012	0.446
Famine	0.0007	0.0012	0.0004	0.704
Flood	0.0108	0.0070	-0.0038	0.192
Drought	0.0057	0.0081	0.0025	0.550
Insect infestation	0.0025	0.0047	0.0021	0.438
New infrastructure	0.0004	0.0012	0.0007	0.528
Tax relief	0.0033	0.0058	0.0025	0.314
N observations	487,005	860		

Notes: The table reports average values of time-invariant (Panel A) and time-varying (Panel B) county characteristics for counties inside vs outside the totality zone of solar eclipses in the period 1644-1912. See section IV.A for a description of each variable and data sources.

TABLE II: THE EFFECT OF TOTAL ECLIPSES ON THE PROBABILITY OF REBELLIONS

outcome:	1(rebellion)			
	(1)	(2)	(3)	(4)
1(eclipse)	0.175*** (0.044)	0.181*** (0.043)	0.181*** (0.043)	0.179*** (0.042)
Famine			0.004 (0.004)	0.004 (0.004)
Earthquake			-0.002 (0.002)	-0.002 (0.002)
Flood			0.000 (0.001)	0.000 (0.001)
Drought			0.002 (0.001)	0.002 (0.001)
Insect infestation			0.001 (0.002)	0.001 (0.002)
New infrastructure			-0.000 (0.004)	-0.001 (0.004)
Tax relief			0.020*** (0.005)	0.020*** (0.005)
Observations	487,865	487,865	487,865	487,865
R-squared	0.048	0.204	0.205	0.215
Year FE	y	y	y	y
County FE	y	y	y	y
Province \times year FE	n	y	y	y
Distance Coast \times year FE	n	n	n	y
N clusters (prefectures)	296	296	296	296

Notes: The table shows coefficient estimates corresponding to equations (1) and (2) . 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. Standard errors clustered at the prefecture-level reported in brackets. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

TABLE III: FIRST STAGE: THE EFFECT OF INCIDENCE OF ECLIPSES ON INCIDENCE OF REBELLIONS IN THE 1644-1912 PERIOD

outcome:	N Rebellions (1644-1912)					
	(1)	(2)	(3)	(4)	(5)	(6)
(N Total Eclipses) ₁₆₄₄₋₁₉₁₂	0.447*** (0.121)	0.459*** (0.122)				
(N Eclipses - weighted) ₁₆₄₄₋₁₉₁₂			0.053*** (0.018)	0.047** (0.018)		
(N Eclipses) ₁₆₄₄₋₁₉₁₂					0.031*** (0.012)	0.028** (0.012)
Observations	1,855	1,855	1,855	1,855	1,855	1,855
R-squared	0.332	0.340	0.299	0.306	0.300	0.306
Province FE	y	y	y	y	y	y
County pop categories FE	n	y	n	y	n	y
County-level controls	n	y	n	y	n	y
N clusters (prefectures)	296	296	296	296	296	296

Notes: The table shows coefficient estimates corresponding to equation (4). The dependent variable is the total number of rebellions throughout the Qing dynasty period (1647-1909) in each county. (N Total Eclipses)₁₆₄₄₋₁₉₁₂ is the number of total eclipses observed in the county throughout Qing dynasty. (N Eclipses - weighted)₁₆₄₄₋₁₉₁₂ is total number of all types of eclipses weighted by their magnitude (expressed in percentage of the sun disk covered by the moon). (N Eclipses)₁₆₄₄₋₁₉₁₂ is the unweighted sum of solar eclipses, independently of their magnitude. County population categories fixed effects are the 11 categories of county population size during the Qing dynasty period as reported in Skinner (1964). County-level controls include: distance to the coast, distance to Beijing and degrees of longitude east. Standard errors clustered at the prefecture-level reported in brackets. Significance level: *** p<0.01, ** p<0.05, * p<0.1..

TABLE IV: THE EFFECT OF PAST REBELLIONS ON CURRENT PROTESTS

outcome:	N Protests			1(Protest)			N Protests per capita			Protest size per capita		
	OLS (1)	RF (2)	2SLS (3)	OLS (4)	RF (5)	2SLS (6)	OLS (7)	RF (8)	2SLS (9)	OLS (10)	RF (11)	2SLS (12)
(N Rebellions) _{1644–1912}	0.065*** (0.024)		0.185* (0.102)	0.034*** (0.009)		0.104*** (0.037)	0.009* (0.005)		0.047* (0.024)	0.021*** (0.007)		0.073** (0.030)
(N Total Eclipses) _{1644–1912}		0.085* (0.049)			0.048*** (0.015)			0.021** (0.010)			0.033*** (0.012)	
Observations	1,855	1,855	1,855	1,855	1,855	1,855	1,855	1,855	1,855	1,855	1,855	1,855
Province FE	y	y	y	y	y	y	y	y	y	y	y	y
County pop categories FE	y	y	y	y	y	y	y	y	y	y	y	y
County-level controls	y	y	y	y	y	y	y	y	y	y	y	y
N clusters (prefectures)	296	296	296	296	296	296	296	296	296	296	296	296

Notes: In columns (1)-(3), the dependent variable is the total number of social unrest episodes recorded in a given county by the CASS database. In columns (4)-(6), the dependent variable is a dummy equal to 1 if the county experienced some protest events in the 2001-2013 period according to the CASS data set. In columns (7)-(9), the dependent variable is the total number of social unrest episodes recorded in a given county by the CASS database divided by the county's population. In columns (10)-(12), the dependent variable is the sum of all participants in social unrest episodes reported in CASS normalized by the county's population. $(N\ rebellion)_{1644-1912}$ is the total number of rebellions during the Qing dynasty period. $(N\ Total\ Eclipses)_{1644-1912}$ is the number of total eclipses observed in the county during the Qing dynasty period. County population categories fixed effects are the 11 categories of county population size during the Qing dynasty period as reported in Skinner (1964). County-level controls include: distance to the coast, distance to Beijing and degrees of longitude East. Standard errors clustered at the prefecture-level reported in brackets. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

TABLE V: THE EFFECT OF PAST REBELLIONS ON CURRENT PROTESTS
BY TARGET AND TYPE OF PROTESTERS

	N Protests			
	target		protester	
	anti local gov	other	high education	other
	2SLS	2SLS	2SLS	2SLS
	(1)	(2)	(3)	(4)
(N Rebellions) _{1644–1912}	0.204** (0.081)	0.020 (0.071)	0.006 (0.042)	0.149 (0.105)
Observations	1,855	1,855	1,855	1,855
Province FE	y	y	y	y
County pop categories FE	y	y	y	y
County-level controls	y	y	y	y
N clusters (prefectures)	296	296	296	296

Notes: The dependent variable is the total number of social unrest episodes recorded in a given county by the CASS database. County population categories fixed effects are the 11 categories of county population size during the Qing dynasty period as reported in Skinner (1964). County-level controls include: distance to the coast, distance to Beijing and degrees of longitude East. Standard errors clustered at the prefecture-level reported in brackets. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

TABLE VI: THE EFFECT OF PAST REBELLIONS ON CURRENT PROTESTS
HETEROGENEOUS EFFECTS BY MEMORY OF PAST PROTESTS

	N Protests					
	OLS (1)	OLS (2)	OLS (3)	2SLS (4)	2SLS (5)	2SLS (6)
(N Rebellions) _{1644–1912}	0.065*** (0.024)	0.009 (0.024)	-0.044 (0.037)	0.185* (0.102)	0.041 (0.100)	-0.056 (0.135)
1(Temple)		0.017 (0.126)			-0.239 (0.423)	
(N Rebellions) _{1644–1912} × 1(Temple)		0.347*** (0.079)			0.544 (0.337)	
1(Anti-Qing Memory)			0.051 (0.061)			-0.148 (0.214)
(N Rebellions) _{1644–1912} × 1(Anti-Qing Legends)			0.153*** (0.051)			0.338* (0.193)
Observations	1,855	1,855	1,855	1,855	1,855	1,855
Province FE	y	y	y	y	y	y
County pop categories FE	y	y	y	y	y	y
County-level controls	y	y	y	y	y	y
N clusters (prefectures)	296	296	296	296	296	296

Notes: The table shows coefficient estimates corresponding to equation (5). The dependent variable in all columns is the total number of social unrest episodes recorded in a given county by the CASS database. We report the OLS results in columns (1)-(3) and the 2SLS results in columns (4)-(6). $1(Temple)$ is a dummy variable that equals 1 if the county has any temple or memorial celebrating anti-Qing martyrs, and 0 if otherwise. $1(Anti-Qing\ Legends)$ is a dummy variable that equals 1 if there is any description of heroic legends of anti-Qing martyrs in the county chronicles, and 0 if otherwise. County population categories fixed effects are the 11 categories of county population size during the Qing dynasty period as reported in Skinner (1964). County-level controls include: distance to the coast, distance to Beijing and degrees of longitude East. Standard errors clustered at the prefecture-level reported in brackets. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

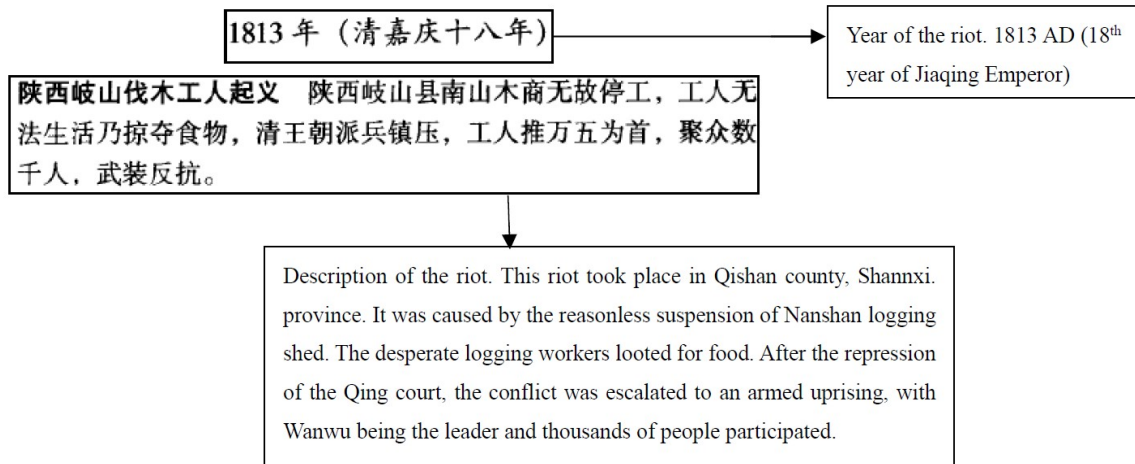
TABLE VII: MEMORY OF PAST REBELLIONS AND CURRENT GRIEVANCES

outcome: sample:	1(Protest)				
	all counties				temple/legends counties
	OLS (1)	OLS (2)	RF (3)	2SLS (4)	2SLS (5)
1(High pollution)	0.008 (0.005)	-0.002 (0.007)	0.001 (0.006)	-0.016 (0.012)	-0.033 (0.021)
(N rebellions) _{1644–1912} × 1(High pollution)		0.011** (0.005)		0.025** (0.012)	0.046** (0.021)
(N eclipses) _{1644–1912} × 1(High pollution)			0.019** (0.009)		
County FE	y	y	y	y	y
Year FE	y	y	y	y	y
Observations	24,115	24,115	24,115	24,115	17,277
N clusters (prefectures)	306	306	306	306	244

Notes: Standard errors clustered at the prefecture-level reported in brackets. Significance level: *** p<0.01, ** p<0.05, * p<0.1..

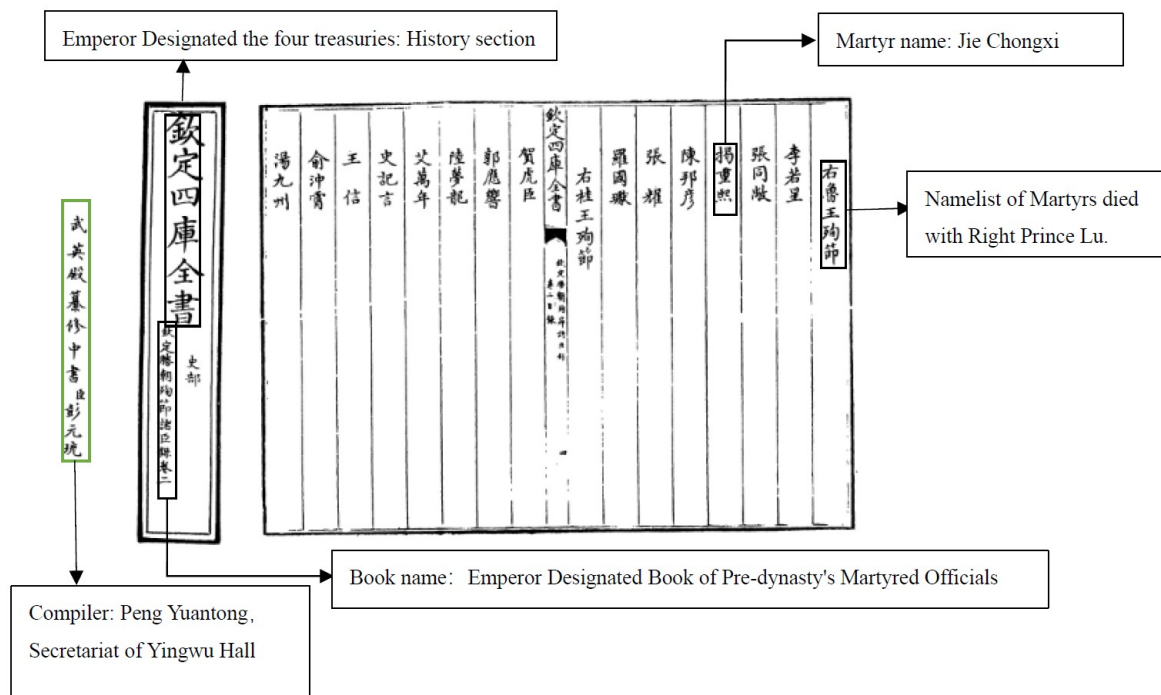
Appendix

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: 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 LEGEND RECORD

貴池縣志卷三十三 人物志 忠節 十七

著見舊志吳應其傳注
盛美可久斐圖集

曹大鎬字北京父參芳教以韜略順治二年福王既執明
巡撫程世昌薦大鎬於桂王稱其才可大用時江西既破
命大鎬往收殘卒軍聲復振所至收郡縣輒勝以功授
總兵官旋授直浙江閩總督節制三十六營文武賜蟒玉
尙方劍兼兵部尙書桂平海大將軍印中軍都督府左都
督少保兼太子太保封定南侯獨重熙為桂王江西總督
時入張自盛軍約大鎬並進後自盛敗大鎬勢猶張重熙
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貴池縣志卷三十三 人物志 忠節 十七

(光緒) 貴池縣志44卷 貴池縣志卷二十二 清光緒九年活字本

Guichi County Chronicles (Jiangsu province) compiled during the Emperor Guangxu.

Brief description of military action of non-local martyr Jie Chongxi. He was appointed as the Gui Prince's governor of Jiangxi province. After Zhang Zishen's military failure against Qing, Jie chose to join Cao Dagao, whose army was still powerful at that time.

Brief description of military action of local martyr Cao Dagao. He was taught military strategy by his father and recommended to Prince Gui by Cheng. He built his reputation by recovering counties in Jiangxi and was promoted to the position of ministry of defense and commander-in-chief.

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 PAST REBELLIONS ON CURRENT PROTESTS
CONFUCIAN COUNTIES SAMPLE

outcome:	N Protests	1(Protest)	N Protests per capita	Protest size per capita
	2SLS (1)	2SLS (2)	2SLS (3)	2SLS (4)
(N Rebellions) _{1644–1912}	0.326* (0.168)	0.163*** (0.052)	0.084** (0.041)	0.127*** (0.038)
Observations	840	840	840	840
Province FE	y	y	y	y
County pop categories FE	y	y	y	y
County-level controls	y	y	y	y
N clusters (prefectures)	204	204	204	204

Notes: All columns report the 2SLS regression results of Table IV conditioning on the sample of counties that report having a Confucian temple during the Qing dynasty period. County population categories fixed effects are the 11 categories of county population size during the Qing dynasty period as reported in Skinner (1964). County-level controls include: distance to the coast, distance to Beijing and degrees of longitude East. Standard errors clustered at the prefecture-level reported in brackets. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.