

Warlords, State Failures, and the Rise of Communism in China

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Abstract

This paper documents that the spread of communism in China was partly caused by state failures in the early 20th century. It finds that famines became more frequent after China fell into warlord fragmentation, especially for prefectures with less rugged borders and those facing stronger military threat. The relation between topography and famines holds when using historical border changes

to instrument border ruggedness. More people from famine-inflicted prefectures died in the subsequent decades for the communist movement, but not for the Nationalist Army. There is evidence that famines exacerbated rural inequality, which pushed more peasants to the side of the communists.

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1. Introduction

When the Chinese Communist Party (CCP) was founded a century ago, few would have expected it to take over China and turn the world's most populous nation to communism: the communist military force started as a tiny guerrilla militia, yet it was able to overcome long odds to triumph with a giant peasant army. But many historians find it not surprising because "The Chinese peasant family had built into it a highly explosive potential to which the Communists in due course were to set the spark" (Moore 1966, page 213). Indeed, in a famous essay on the analysis of social classes in China written in 1925,² Mao Zedong, the future ruler in China between 1949 to 1976, declared that the famine-trodden tenant-peasants were the most sympathetic group to the communists because "In hard times they piteously beg help from relatives and friends, borrowing a few *tou* or *sheng* of grain to last them a few days, and their debts pile up like loads on the backs of oxen. They are the worst off among all peasants and are highly receptive to revolutionary propaganda" (Mao 1961, page 17).

In this paper, we analyze the historical and institutional causes of the plight of the Chinese peasantry in the early years of the Republic, and examine how the experience of rural poverty fostered the rise of communism in China. General Yuan Shikai, the first President and the general in charge of the major army then, died unexpectedly in 1916, leaving behind him a fragmented China without a strong central state. His proteges, who turned warlords, had full control within their domains and fought each other for territory and resources from 1917 to 1926. Since the warlords faced territory insecurity and the risk that his place would be taken by other warlords, they were reluctant to spend resources to prevent famines or provide famine relief when they occurred, the beneficiary of which might soon be the subjects of the next ruler. From the outset, a warlord's incentive for famine-control was at odds with that of his subject population, as illustrated by the sharp increases in the incidence of famine after 1916.

We hypothesize that the ruler's incentive to contain famines was shaped by his capacity to defend his territory. A key factor to consider in that era was topography: whether the domain was protected by rugged terrain, which deterred military invasion from other warlords. We find that prefectures with higher border ruggedness suffered fewer famines during the warlord period: based on our preferred specification, increasing border ruggedness by one standard deviation (0.27) is associated with a reduction in the probability of famine by 15 percentage

² *Analysis of the Classes in Chinese Society*, written on the eve of the nationwide communist uprising, is one of the most important pieces by Mao, and appears as the first article in the official Selected Works of Mao Zedong (1961).

points, or about three quarters of the standard deviation. This is consistent with the notion that, with rugged terrain on the border, warlords would find it easier to defend their territory and therefore behave more like stationary rulers, as in Olson (1993), and would adopt benevolent policies. As a comparison, the ruggedness of terrain away from the border does not explain famines in the warlord era.

Since borders might have been drawn for reasons that also affected the famine outcome, topographical conditions at the border could be endogenous. To cope with this, we refer to a predetermined historical event that shaped border conditions in China, which should not correlate with the warlord-era famines. During the Mongol occupation of China (1271-1368), prefecture borders were massively redrawn, intentionally away from natural barriers. The purpose of this was to suppress rebellions, as rebels' ability to hold against Mongol reprisals using natural barriers would have been weakened. We trace the history of prefecture borders and show that the border sections that were reset during the Mongol occupation were less likely to be rugged: a higher percentage of such prefectural border is correlated with less border ruggedness in the warlord era. We use this percentage as the instrumental variable (IV) for topographical conditions at the border during the warlord period. To guard against the possibility that our IV affects the warlord-era famines through channels other than the current border ruggedness, we correlate the Mongol-era border IV with a number of pre-warlord-era historical conditions of a prefecture such as the population, road access in Qing dynasty, Qing designation of basic prefecture characteristics (i.e., being a transport hub, a business center, a high crime area, and an area tough to collect taxes), and historical tradition of rioting. Reassuringly, we do not find significant correlations. We then proceed to the IV estimation, and obtain the same qualitative results, i.e., a prefecture was more likely to have famines when its territory was more difficult to defend due to border topography.

We consider and rule out several scenarios of potential omitted variables for explaining famines. The relation between border ruggedness and famines could not be explained by harsh natural conditions: we do not find correlations between border ruggedness and the frequency of natural disasters. Nor could the incidence of famine be explained by constraints on the ruler's

resources: we find that the occurrence of famines has nothing to do with fiscal revenue, or the tradition of violence in the region, either. There is, however, evidence that famines reflect a warlord's incentives, in that famines could rise with potential military threat: the likelihood of famine was higher if an adjacent warlord belonged to another military bloc, if the adjacent warlord had better military training, or if the adjacent warlord had powerful allies. We conclude that a ruler's willingness to contain famines remains a function of his calculation of the likelihood of holding his territory.

Throughout Chinese history, famines frequently ended dynasties through peasant rebellions (Chapter 7, Acemoglu and Johnson 2019). But state failures happening at critical historical junctures, e.g., the infusion of communist ideologies in the 1920s, had more significant impacts in the long run. We show that it was in the prefectures with the highest warlord-era famines that the most local residents died in uniform serving the Communist party. This is possible by tracing the birthplaces of the 1.24 million members of various Communist organizations (largely the army) killed in the Communist rise to power. We use the number of war casualties relative to the local population as a measure of Communist penetration. We find that prefectures hit hardest by famines in the decade before 1927 were also home to the most Communist war casualties after 1927. This holds when using a three-stage least square approach: relying on the 13th-century re-demarcation by Mongolian rulers to predict warlord-era border ruggedness, which is used to predict the warlord-era famines, which in turn predicts the number of communist war casualties. Our findings are suggestive that warlord-era famines deeply affected many peasants who later swelled the communist military force. In a placebo test, we also investigate casualty rates for the non-communist Kuomintang (Nationalist Party, or KMT), ruling party of China after 1927. There we do not find a relationship between warlord-era famines and subsequent KMT casualties.

Exactly why did famines push peasants into the arms of the Communists? Using land ownership surveys between 1918 and 1921, we find that famines raised landless tenancy: famine occurrence raised the fraction of tenant households by 1.7 percentage points in the following year. We also show that as tenant households rose, there was an increase with the

number of local communist casualties in the following decades. Land inequality, exacerbated by famine, may have pushed more peasants to the side of the communists.

Our paper contributes to a nascent economics literature on the origin and spread of ideologies.³ Moore (1966) shows how historical factors shaped various ideologies. More recent inquiries on the topic focus on the underlying mechanisms of such transformation. Contributing factors have been found to include historical anti-Semitism tradition (i.e., plague-era pogroms, see Voigtländer and Voth, 2012), the propaganda machine (i.e., radio propaganda, Adena et al. 2015), the achievement in upgrading infrastructure in initial years of a leader (Voigtländer and Voth 2019), high social organization density (Satyanath, Voigtländer and Voth, 2017), the fiscal austerity and the 1931 banking crisis (Galofré-Vilà et al. 2020, and Doerr et al. 2020), risks of unemployment (King et al. 2008). Similarly, severe drought and economic hardship also facilitated the rise of Socialist peasant organizations as well as the rise of the Sicilian Mafia in the last decade of the 19th century in Italy (Acemoglu, De Feo, and De Luca 2020). The subsequent increase in Socialist support after the first World War in Italy caused the “red scare” and facilitated the Fascist rise (Acemoglu et al. 2020). Finally, U.S. bombing near population centers generated grievances and led more Vietnamese to participate in Communist (i.e., Viet Cong) insurgencies (Dell and Querubin 2018). We contribute by showing that state failure after warlord fragmentation led to rising famines and rural inequality in some areas, which facilitated the spread of Communism in China.

Relatedly, we also contribute to the literature on the adverse effects of inequality.⁴ Income inequality has long been conjectured to be negatively correlated with economic growth (Alesina and Rodrik, 1994; Aghion, Caroli and García-Peñalosa, 1999; Persson and Tabellini, 1994). There is evidence that inequality has adverse consequences as well, such as the impact of colonial period land inequality on investment in agriculture, health and education in India (Banerjee and Iyer, 2005), the impact of land inequality on human capital accumulation and economic growth (Galor, Moav and Vollrath, 2009). The more destructive impact of inequality,

³ An important non-economics reference that studies the political and economic causes of totalitarianism is Arendt (1951).

⁴ For a comprehensive review of inequality, see Atkinson, Piketty and Saez (2011), and Piketty and Saez (2014).

however, results in conflicts and violence, as demonstrated theoretically by Esteban and Ray (2011), and empirically by evidence of a positive relationship between land inequality and political violence in South America (Midlarsky, 1988; Muller and Selligson, 1987), and survey evidence on the positive relationship between income inequality and revolutionary support (MacCulloch, 2005). We contribute by providing evidence that land inequality likely contributed to support of the CCP and subsequent coming to power by Communists in China, an event that has shaped the world of today.

Finally, our paper adds to the literature on the incentives of the state in providing basic state functions. Olson (1993) postulates that “A secure autocrat has an encompassing interest in his domain that leads him to provide a peaceful order and other public goods that increase productivity,” and that the ruler will go rogue if he expects a brief tenure. Similarly, Acemoglu (2005) shows that the ruler underinvests in public goods when he is unable to extract rents in a weak state. Several pieces of evidence are consistent with this logic of the ruler’s ability to benefit from good institutional arrangements in determining the provision of public goods. First, the willingness to adopt inclusive institutions in the American colonies is shown to depend on the differences in disease environments that affected the colonizers’ expected survival rate (Acemoglu, Johnson and Robinson 2001). Second, armed groups in Congo perform different state functions in regions depending on their ability to tax the local main product (Sanchez de la Sierra 2020). Third, long ruling durations of leaders of the Christian West relative to the Muslim world from the 8th to the 16th century are found to facilitate the development of executive constraints in the Christian West (Blaydes and Chaney, 2013). It is to contribute to these strands of research as well that we empirically examine the conditions that incentivized rulers in such a way as to bring about complete state failure, and greatly facilitated the spread of Chinese Communism.

2. Historical Background and Hypotheses

In this section we describe the historical background of the warlord era, the incidence of famines around that era, and the rise of Communism in China.

2.1 Fragmentation of China in the Early 20th Century

In the late 19th century, the ruling Manchurian Qing Dynasty, after being repeatedly defeated by Western powers, keenly felt the need to have a modern army.⁵ The government then established the New Army,⁶ named so to distinguish it from the old, corrupt and incompetent military establishment. The New Army was led by General Yuan Shikai, who adopted Western-style military institutions, training methods, and modern weaponry. He made the New Army the dominant military force in imperial China, and served as the Qing government's designated army leader. Through his leadership and networks—fostered partly through his own military institute to train military officials—General Yuan built strong authority within the New Army. With his dominant political influence, the officials he trained were sent to key positions across the country, e.g., as commanders of divisional armies. By 1901, five of China's seven divisional commanders and many more senior officials in the New Army were followers of Yuan.

On October 10 of 1911, a nationalist uprising occurred in Wuchang, central China, and it was quickly followed up with widespread insurrections in other major cities. The Manchurian Qing Court soon found the situation out of control, with 14 of the then 18 provinces declaring independence within 41 days. The only capable military force that might have been able to squash the rebellion, the New Army, also turned against the Qing Court. General Yuan Shikai, with his dominant military power, negotiated a deal with the revolutionaries, and forced the Emperor to abdicate. Backed by his military force, Yuan got himself elected as the first president of the Republic of China in February 1912.

The newly founded Republic under Yuan inherited all the territories from the previous Qing dynasty. Yuan's paramount power led to his overconfidence: on December 12, 1915, he abolished the Republic and declared himself the new Emperor, a move fiercely opposed by various parties including many regional leaders throughout China. Failing to suppress these oppositions, Yuan had to cancel his coronation 83 days later. Following this public humiliation,

⁵ For more detailed narrative of this period of China, see Chi (1976) and Spence (2012).

⁶ Also called the Beiyang New Army, following its heritage of the previous Beiyang (North Sea) Navy.

Yuan was diagnosed with serious uremia in March 1916, and died 3 months later that year. Yuan's sudden and unexpected death left behind a vacuum of power that led to the fragmentation of China. No other politician could have matched his power to unite the various regional military forces. His former followers formed their own factions, and became rivals for power. Other local leaders who had obeyed Yuan's orders out of fear of his military power no longer hid their separatist intentions. In 1917, after failing to form a federation government among these antagonist factions, the country became fragmented and fell into the control of numerous warlords.

Now political and military power was largely in the hands of the warlords, and the nominal central government had little control. The warlords made independent decisions over their internal and external affairs. They nominated and appointed local officials and no longer contributed their shares of taxes to the central government. Enjoying the benefits of local control, all warlords wanted more territory, and had to prepare for likely military conflicts on their borders. Consequently, they levied high requisitions on peasants, who lost protection from the central government, and induced "appalling man-made suffering" (Moore 1966, p. 187).

2.2 Famines in China

Over the centuries, Chinese residents had frequently faced the threat of famines. Moreover, after decades of Malthusian growth and dramatic population expansion in the middle of the Qing China, the average land-mass per capita was too small to support a family even during the harvest year (Will, 1990). It left a typical rural household with little private savings and great odds of famine in the event of crop failure. During the 20th century, China, with a total population equaling twice that of Europe, had 46 times higher casualties as a result of famine.⁷

Famine prevention and relief has been a key function of the Chinese bureaucratic system (Will, 1990). Mandated by the imperial court, local officials had to provide monthly reports on local weather and precipitation. The central government then issued forecasts on harvests and food shortage in all regions of China. Local officials were also required to keep necessary

⁷ From http://www.emdat.be/advanced_search/index.html, Centre for Research on the Epidemiology of Disasters (CRED).

reserves of rice and wheat in the state-run granaries, so that they could sell the crops to smooth local price hikes during food shortages. In addition, the central government could intervene and coordinate crop transportation across provinces.

When the warlords took over in 1917, however, famine prevention and relief became their responsibility. The central government could no longer coordinate with local governments for cross-regional support. Moreover, ruling warlords were no longer accountable to the central government if they failed to provide effective humanitarian relief. As warlords had complete control of local affairs, they made decisions based on their own political and economic calculus.

2.3 The Rise of Communism in China

The CCP was founded a century ago, in 1921. In 1924, the CCP and the Nationalist Party, also known as the Kuomintang (KMT), formed a political coalition in South China's Guangzhou, aiming at defeating the warlords and unifying China. In July 1926, the coalition launched a series of military assaults on warlords and successfully advanced northward. A year later in 1927, the coalition broke down. The KMT, after having heavily suppressed the communists, continued its military campaign and unified China in 1928, ending a decade of warlord control. The CCP formed its own army in August 1927, recruiting mostly from the peasantry, and fought a guerilla war against the KMT until end of 1936, when China faced imminent invasion threat from Japan. The two parties reached a truce to coordinate defense against Japanese invasion, but military skirmishes continued to break out between the two sides. The truce broke shortly after the end of the second world war in 1945. The communist army and the government army waged a bloody civil war until 1949, when the CCP took control of China and the KMT retreated to Taiwan, China. We summarize the timeline of major political events in Figure 1.

The rise of Communism in China has attracted strong academic interest, and various explanations have been offered.⁸ In addition to Moore's classic work which addresses the key role played by the peasantry, some attribute the communist success over the Nationalists to the more equitable tax rates and land policy for peasants in the areas under their control during the late 1930s and the 1940s (Seldon 1971). Others attribute the communist success to the Party

⁸ See Xu, Png, Chu and Chen (2019) for a thorough review of this literature.

apparatus' capacity for mobilization and organization (Chen 1986; Walder 2017). Still others attribute it to policy failures of the Nationalists (Chi 1982), or their centralization efforts in the countryside that destabilized the local governance norms and turned state agents into unbridled predators on peasants, which created favorable conditions for the Communists (Xu et al. 2019). The Japanese invasion, which aroused Chinese nationalism, also helps to explain the success of the Communists (Johnson 1962). Another contributing factor could be the Silver Purchase policy of Franklin Roosevelt, which drove China off silver and onto a fiat paper standard. This ultimately facilitated hyperinflation and the Nationalist downfall in China (Friedman 1992). In this paper, we add to this literature by showing how state failures associated with warlord fragmentation made local poor peasants more susceptible to communism.

2.4 Hypotheses

We now propose hypotheses on how the warlord era might have affected subsequent provision of public goods and have exerted long-term impact. The shift from centralized control to fragmented warlord control would adversely affect the ruler's incentives to provide public goods. Since a place could be taken over by another warlord, and the warlord faced territory insecurity and shorter reign, he would have favored more short-term policies. We hypothesize that a warlord, facing a higher probability of losing control over his territory than that under centralized rule was *less* likely to choose policies with immediate costs and long-term benefits, e.g., famine prevention and humanitarian relief. We thus expect:

The warlord fragmentation hypothesis: the shift from centralized rule to decentralized warlord control would increase the incidence of famines due to a lower probability of retaining his territory in the future.

The warlord's incentive to contain famines was shaped by his capacity to defend his territory. A key factor to consider in that era was topography. In particular, with rugged terrains on the border, warlords would find it easier to defend their territory, and they therefore would behave more like stationary rulers, as in Olson (1993), and would have adopted benevolent policies, including both prevention of famines and famine relief.

The effects of border ruggedness on famine incidence would furthermore depend on perceived military threat. The relative military advantage of the warlord's neighboring rivals, by making it harder to hold on to the warlord's own territory, should have an adverse impact on his willingness to provide sound governance and famine relief. However, when his prefecture was more rugged on the border, the relative military strength of the neighboring warlords would imply less threat than when his prefecture border was not rugged, especially in the early 20th century with poorly-equipped armies. As a result, the warlord's relative incentive in containing famines in areas with rugged borders (than with non-rugged borders) would be more pronounced in the face of stronger military threat from neighboring warlords. We thus expect:

The border ruggedness hypothesis: Due to expectations of a longer ruling horizon, prefectures with rugged borders would have less pronounced increase in famines during warlord fragmentation. Moreover, this famine-containing effect would be stronger when military threat from neighboring warlords was stronger.

What would be the likely consequences of more famines in the first half of the 20th century in China? The literature suggests that an increasing level of absolute poverty is likely to fan the flame of revolutions and rebellions. Rising absolute poverty in general causes resentment over the prevailing world order, and leads to desires among the deprived to use whatever means at their disposal to change the existing institutional arrangements. Indeed, survey evidence find that income inequality is associated with higher support for revolutions (MacCulloch, 2005), and there is empirical evidence of a positive relationship between land inequality and political violence in South America (Midlarsky, 1988; Muller and Selligson, 1987), and evidence of support of Communism by German citizen with high risks of unemployment risks in the elections in early 1930s (King et al., 2008).⁹

The potential for exploiting rural poverty for revolution was keenly recognized by some key Chinese Communist leaders in the 1920s. The future CCP leader Mao Zedong advocated

⁹ Historically, Chinese dynasties often ended with famine-induced peasant rebellions (chapter 7, Acemoglu and Johnson, 2019).

in the mid-1920s focusing on mobilizing peasants as the key political support base (Ch'en, 1983). When famines forced peasants to sell their meager land, this would only make them more prone to revolution propaganda. Mao's assessment of the impact of economic hardship on support of Communism echoed the views of Lenin, who viewed the 1891-1892 Volga famine in Russia as fuel for revolutionary fervor. Lenin, as quoted by Vodovozov in Ellman (2005), hailed the Russian famine as able to "force the peasant to reflect on the bases of the capitalist system, demolish faith in the tsar and tsarism, and consequently in due course make the victory of the revolution easier." (Ellman, 2005, page 823). We thus expect:

The famines-and-communism hypothesis: The regions experiencing warlord-era famines would be more likely to witness the spread of communism due to the appeal of Communist ideology as well as its policy of land redistribution and reduction in land inequality.

3. Data and Measurements

In this section we discuss our data and our key measurements.

3.1 Warlords and Border Ruggedness

Information about warlords is from The Chronicles of Beiyang Government Officials, which contains details on the appointment and ranks of all government officials between 1912 and 1927. In the post-1916 warlord era, there were 78 warlords that controlled the 289 prefectures in 18 provinces. A warlord's rule was fragile and often short-lived. They were frequently replaced by other warlords, or could lose control of some of their territories due to military conflicts, or even assassination. In our sample, the average ruling period of the warlord in a prefecture was only four years. However, the overall scale and casualty-count of the wars during this period were relatively small (Chi, 1976). Most of the time, soldiers in the battlefield had little fighting spirit or loyalty to their generals, and wars usually served as a negotiation tool for a calculating warlord. The low casualty rate could also be the result of poor weaponry.

Topography has always played an important role in wars, especially in low-intensity warfare, where natural barriers could deter military actions. This could have profound impact on the incentives and behavior of warlords. According to Olson (1993), warlords in China in

the 1920s “were men who led some armed band with which they conquered some territory and who then appointed themselves lords of that territory. They taxed the population heavily and pocketed much of the proceeds. The warlord Feng Yu-hsiang was noted for the exceptional extent to which he used his army for suppressing bandits and for his defeat of the relatively substantial army of the roving bandit, White Wolf.” The specific case of roving bandits cited by Olson occurred in central China’s Henan province features a vast plain. The lack of ruggedness on the border made the area difficult to defend. In fact, in the post-1916 period, warlords in Henan had an average length of control of just one year and 8 months. Olson explained the malign policies in Henan by the short-term nature of their reign. Such short-termism might have stemmed from geographical factors.

We calculate terrain ruggedness along the border using the method in Nunn and Pugua (2012). For each prefecture, we calculate the ruggedness of the area within 10 kilometers of the border (See Appendix Figure A1 for details). As an illustration, ruggedness with value over two indicates that the benefits of cultivation fall below necessary costs (Food and Agriculture Organization 1993). In the Henan province, only 8.3% of borderlines fall into this category. For agriculture production, lack of ruggedness makes disaster relief easier.

3.2. Famines

Data on famines come from *The Chronicles of Famines in China’s Modern History* (“The Chronicles” hereafter), the most comprehensive and reliable source about modern China’s famines. It covers all famines that had occurred in modern China before the collapse of the Republic of China in 1949.

Our main sample covers the period between 1912, the beginning of modern China, and 1926, when the coalition between the Nationalist Party and the Communists Party started to unify China by conquering most warlords through military campaigns. The Chronicles record 167 famines in 126 prefectures during this period. The vast majority of famines, or 162 out of the 167, took place after 1916.

3.3. Communist War Casualties

The decades-long military operations of the CCP resulted in heavy casualties. We collect data on all recorded communist war casualties (recorded as “martyrs”) from China’s Ministry of Civil Affairs, which uses this data set to pay pension and death benefits to family members of CCP war deaths.¹⁰ The data set covers 1.24 million people who died in in the communist military insurrections between 1927 and 1949. It records their names, place of birth, and place and date of death. Our data set records 188 prefectures which are home to CCP war casualties. The mean number of CCP war casualties in a prefecture is 6,597; the median, 1,183.

4. Border Ruggedness and Famines

In this section we test the warlord fragmentation hypothesis and the terrain ruggedness hypothesis. We first conduct the ordinary least square estimation, and then offer extensive sensitivity checks, as well as the instrumental variable estimation.

4.1. Baseline Results

We first examine how the incidence of famines changed from unified central rule to the warlord era by the following specification:

$$Famine_{i,t} = \beta Post_t + V_i + \varepsilon_{i,t} \quad (1)$$

The dependent variable $Famine_{i,t}$ is a dummy variable indicating the existence of recorded famines in prefecture i in year t . $Post_t$ is a dummy variable indicating the warlord-years between 1917 and 1926. We control for prefecture fixed effects V_i to hold all time-invariant factors constant. We cluster standard errors at the prefecture level to allow the unobservables correlated over time within the prefecture. Our sample here covers the prefectures from 1912 to 1926. The results are in Column 1 of Table 2.

Consistent with the warlord fragmentation hypothesis, the incidence of famines clearly rose drastically after the warlords took over. The coefficient indicates that after the arrival of the warlord period, the incidence of famines increased by 5.3 percentage points, or roughly $\frac{1}{4}$ of one standard deviation (SD) of the famine indicator in our sample period.

¹⁰ The original wording is martyrs, and they were officially-designated CCP war casualties. For simplicity we refer to these as war casualties.

Since a key interest is how border ruggedness shaped the warlord's incentives, we further estimate the following baseline specification:

$$Famine_{i,t} = \beta Post_t \times Ruggedness_i + \gamma Post_t \times X_i + \mu_i + \theta_t + \varepsilon_{i,t} \quad (2)$$

$Ruggedness_i$ measures the geographical ruggedness in border areas of a prefecture.¹¹ The coefficient of its interaction with the warlord-era dummy, γ , is the parameter of interest, and captures the effect of border ruggedness on the famine incidence of a prefecture in the warlord era. We control for prefecture and year fixed effects. Because prefectures differ in their capacity to contain famines, we add a series of variables, X_i , to be interacted with $Post_t$ so that pre-determined local features are allowed to have distinct effects on famines after the warlord period. Among X_i , the size of a prefecture is captured by the logarithm of the population of the prefecture in 1911 and the logarithm of the area of the prefecture. The condition on precipitation and climate is captured by the latitude of the prefecture. Logistical and transportation costs are captured by the log distance from the capital city of the prefecture to the nearest point of the Yangtze River, of the log distance from the capital city of the prefecture to the nearest point of coastline, and of the log of the total length of rivers within the prefecture. Furthermore, we also control for the Qing classifications of key features of the prefecture, namely Chong (i.e., important in transportation/communication), Fan (i.e., important in business), Pi (i.e., difficult to gather taxes), and Nan (i.e., high in crimes).¹² We interact these variables with $Post_t$ to capture the effect of these key geographical and other pre-existing features in the warlord era. We cluster standard errors at the prefecture level. Our hypothesis is that terrain ruggedness in border areas is associated with lower incidence of famines: with the protection of precipitous terrains from the enemies, the warlord could act like a stationary bandit and make benevolent policies.

Column 2 of Table 2 reports the results of this specification. Here the measure of border ruggedness is our default, that is, the ruggedness within the 10-kilometer strip within the

¹¹ Overall, the vast majority of prefectures of a warlord neighbored with prefectures ruled by other warlords. Later, we shall conduct a sensitivity check that allows the effects of $Post \times$ ruggedness only for those prefectures that neighbored with territories of other warlords.

¹² This informative Qing classification of the prefecture was used to measure political importance and difficulties in governance in Imperial China.

prefectural border. The coefficient of our main explanatory variable $Post_t \times Ruggedness_i$ is negative and significant at -0.095. This result is consistent with the border ruggedness hypothesis, that rugged terrain on the border might encourage the warlord to have long-term perspectives by protecting him from imminent military threats, and the warlord would then seek to provide sound governance to reap the benefits from ruling for a long duration.

The lack of terrain ruggedness made a prefecture vulnerable to a rival warlord, and this effect should have been most acute in border areas. Away from the border, the lack of terrain ruggedness posed less of a threat. We thus expect that geographical features in interior non-border areas had less impact. In column 3, we measure ruggedness within the strip of 10-15 kilometers away from the border. The coefficient on $Post_t \times Ruggedness_i$ sharply falls to -0.033. If we move further inward to the strip of 15-20 kilometers away from the border, as in column 4, the coefficient on $Post_t \times Ruggedness_i$ further reduces to nearly zero and loses statistical significance. Similarly, column 5 shows that terrain ruggedness in central areas, i.e., the areas that are 20+ kilometers away from the border, also did not affect famine occurrence. Consistent with our hypothesis, terrain ruggedness in areas away from the border strip did not affect governance outcome since this did not facilitate defense and therefore does not affect the calculation of a warlord.

4.2. Robustness

We have found that border ruggedness of a prefecture significantly reduced the incidence of famines when China was ruled by competing warlords. An alternative explanation could be that natural conditions turned harsher in the post-1916 warlord period, and those prefectures with rugged borders might be associated with more favorable natural conditions by sheer chance. If so, our interpretation based on warlord incentives for a long-run horizon, when omitting time-varying shocks in natural conditions, might be spurious. To ensure that the famine-ruggedness link was not driven by omitting natural shocks, we examine whether natural conditions became worse, especially for the rugged areas, after the warlord fragmentation. We run the following regression:

$$Disaster_{i,t} = \beta Post_t + \gamma Post_t \times Ruggedness_i + \delta Post_t \times X_i + \mu_i + \theta_t + \varepsilon_{i,t} \quad (3)$$

$Disaster_{i,t}$ is a dummy variable indicating recorded natural disasters in The Chronicles in prefecture i in year t , which includes droughts, flooding, locusts, and earthquakes. $Post_t$ and X_i are defined as before. μ_i represents the prefecture fixed effects; θ_t , year fixed effects. In columns 1 and 2 of Panel A in Table 3, neither $Post_t$ nor $Post_t \times Ruggedness_i$ is significant, suggesting that natural conditions did not deteriorate in the warlord period, and that prefectural border ruggedness was not associated with obvious changes in local natural conditions.

We also conduct three other robustness checks in Table 3. First, a small number of prefectures (i.e., six) did not directly neighbor with prefectures controlled by other warlords—then their border ruggedness could have little military implication for them. In general, given the frequent changes of territories during that era, our prior is that even inner prefectures' border ruggedness matters since they could become outer prefectures some months or years later. This is why in the base scenario we include the border ruggedness of all prefectures. After excluding all six of such prefectures in column 3, we obtain similar results as in our baseline regression.

Second, wars could interrupt agricultural and business activities and lead to famines. To exclude the impact of wars, we delete the observations with wars happening in the observation prefecture-year. The coefficient of $Post_t \times Ruggedness_i$ is -0.096, similar as before. When the prefectures were surrounded by less rugged borders, warlords, war or not, still did less to prevent famines or provide famine relief for their subjects.

Third, we consider the sensitivity of our results when taking into account famine severity. In our baseline regressions we consider famine incidence. But famines differ in severity, and more severe famines might reflect more serious governance failure. Do our key results still hold if famine severity is considered? Because the data set does not provide a precise scale of famines, we construct our new famine measure relying on qualitative descriptions, as described in Su, Fang and Yin (2014). We create an ordinal variable that is 2 if the record mentions human casualties, 1 if the record mentions hunger or malnutrition, and 0 otherwise. Among the 167 famines, 78 are classified as severe (i.e., with a scale of 2), and 89 as mild (i.e., with a scale

of 1). Column 5 reports the OLS results using the ordinal indicator as the dependent variable, and column 6 reports the results using an ordered logistic regression. $Post_t \times Ruggedness_i$ has a negative and significant coefficient in both columns. Border ruggedness thus has significant associations with the post-warlord famine severity as well.

4.4. The Instrumental Variable Estimation

Although ruggedness in a specific location is determined by orogeneses and is likely exogenous, *border ruggedness* need not be, because border decisions could be affected by factors such as politics (Alesina 2003) and the uses and types of irrigation projects for agricultural production (Wittfogel, 1957; Kitamura and Lagerlof, 2020). The border, for instance, could be set along a rugged mountain to protect a rich prefecture from being looted. The observed correlation between border ruggedness and fewer famines may reflect the fact that more prosperous areas could provide more disaster relief. To deal with this type of endogeneity, we employ the instrumental variable approach. In particular, we make use of a historical boundary rule called the jigsaw rule, which was adopted by the Mongolian occupiers in the Yuan Dynasty centuries ago for military reasons. This rule drastically reshaped border conditions in China.

4.4.1. The jigsaw rule and our instrumental variable

Throughout history, the regional boundaries in China had been largely demarcated by geographical patterns, following the contours of mountains, rivers, and other natural geographical boundaries. This reduced the costs of intra-prefecture transportation and communication, and facilitated localized administration. Such geography-based rules were overhauled by the Mongols during their occupation during the short-lived Yuan Dynasty from 1271 to 1368. As an external conqueror whose ethnic population made up less than 1% of the Chinese population, the Mongols faced constant threat of rebellions. Rebels could conveniently use major mountains and rivers along prefectural borders and other interlocked geographical condition as defensive positions, from which they could fight back against the army of the ruling Yuan Dynasty. Realizing this, the Mongols radically changed border demarcation.

Their demarcation rule was called the jigsaw rule. Under this rule, the natural boundaries of major mountains and rivers were often ignored, and new jigsaw borders not based on natural

geographical boundaries were drawn up, resulting in a border's deviation from natural barriers. In practice, the jigsaw rule required some areas inside the geographical defense line being carved out and merged with that of the nearby prefecture—the purpose was to prevent rebels from taking advantage of natural barriers along the border. It was not unusual, then, for one prefecture in the Yuan Dynasty to cover territories crossing several major rivers and mountains. Although some of the boundary changes made during Mongolian rule were abolished in subsequent dynasties, the influence of the jigsaw rule in border demarcating remained, and there remain many jigsaw areas in many prefectures today.

An example of such border changes is the Sichuan Basin. Being surrounded by high mountains, the Sichuan Basin represents natural boundary for defense, and had long been regarded as an ideal place for rebellion throughout Chinese history. Indeed, the Sichuan regions were among the hardest place to conquer for the Mongols, and the conquering process cost the life of the Mangu Khan, then the top military leader of the Mongolian Empire. To reduce geographical advantages of local military forces over the Yuan army, the Mongols imposed the jigsaw rule. A large chunk of the Sichuan Basin was carved out to Shaanxi province, and its borders were pushed away from mountains to prevent possible rebellions based in Sichuan. Now if people in Sichuan rebelled, the ruler could use the territory of Shaanxi province with no natural barriers to Sichuan to attack the rebels easily. As a result, the border between what is now Sichuan Province and the neighboring Shanxi Province features no high elevations (see Figure 2).

Because some parts of the warlord-era prefectures' border conditions were determined some 700 years ago due to military considerations of the Mongols, we can rely on the Mongol demarcation as a source for the instrument variable for the warlord-era border ruggedness. We calculate the percentage of the warlord-era prefectural borders drawn during the Yuan Dynasty (*Mongol Border*), and find that it is negatively correlated with our measure of border ruggedness (see Figure 3). This shows that the Mongol demarcation significantly shifted prefectural borders away from rugged terrains.

4.4.2. The plausibility of exclusion restrictions

Even though *Mongol Border* was determined centuries ago, it could still affect famine outcomes in the warlord era via some intermediate channels. To shed light on the possibility that our instrumental variable might be correlated with our outcome variable (i.e., famines) through other channels, we conduct a test on the exclusion restrictions in Table 4. We run regressions to relate *Mongol Border* to prefectural features which might have affected famines. These features include the total population, the historical mileage of roads in Qing Dynasty, the distance to Beijing (i.e., the capital city), the area size, and the Qing classification of key features of the prefecture, namely Chong (i.e., important in transportation/communication), Fan (i.e., important in business), Pi (i.e., difficult to gather taxes), and Nan (i.e., high in crimes). Our instrumental variable, *Mongol Border*, does not significantly correlate with these geographical features at conventional levels, which is suggestive that our IV likely meets the exclusion restrictions.

4.4.3. The instrumental variable estimation results

The first- and the second-stage estimations are as follows:

$$Post_t * Ruggedness_{i,t} = \beta Post_t \times Mongols\ Border_i + \delta Post_t \times X_i + \mu_i + \theta_t + \varepsilon_{i,t} \quad (4)$$

$$Famine_{i,t} = \theta Post_t \times Ruggedness_i + \delta Post_t \times X_i + \mu_i + \theta_t + \varepsilon_{i,t} \quad (5)$$

We report estimates from the IV regression in Table 5. In column (1), our instrument is significantly related to border ruggedness. The first-stage F-statistics for our IV is 67.7, indicating a non-weak IV. According to the second-stage results in column 2, the key term $Post_t \times Ruggedness_i$ is significant and negative. Once corrected for endogeneity, the coefficient on $Post_t \times Ruggedness_i$ changes from -0.096 to -0.556, indicating a downward bias of the OLS estimate. Based on this specification, increasing border ruggedness by one standard deviation (0.27) is associated with a reduction in the probability of famine by 15 percentage points, or about three quarters of the standard deviation.

5. Mechanisms and Alternative Explanations

Border ruggedness may affect the incidence of famine through various channels, or merely reflect omitted variables. In this section, we consider potential alternative explanations.

5.1. Military Threat as a Mechanism

We now test the second part of the border ruggedness hypothesis: that border ruggedness was more important when neighboring rival warlords had greater military strength, and its effect on famines would be stronger.

We identify several factors during the post-warlord period that could have amplified the importance of border ruggedness in military defense. The first is whether the adjacent prefecture was under the control of an enemy. According to Chi (1976), Chinese warlords fell into 16 military blocs. We define the neighboring warlord as an enemy if he belonged to a different bloc. The second factor is whether the neighboring warlord had better military training, as proxied by whether they had gone to military academies. We assume those with professional military education had advantage over others in the case of military confrontations. The third factor is whether the adjacent enemy had strong allies. Chinese warlords were dominated by three major military blocs. Warlords in these major blocs are considered as having strong allies. These three factors affected the military strength of the warlord relative to his neighbors and his chances of survival, and therefore may have altered his perceived ruling horizon.

Panel A of Table 6 includes these variables and their interactions with border ruggedness to our baseline regression. We find that the incidence of famines rose significantly when a prefecture neighbored with an enemy warlord (Column 1), or when a warlord had better military training (Column 2), or when the adjacent enemy warlord belonged to one of the three major military blocs (Column 3). It suggests that, under powerful military threat from his rivals, the warlord had weak incentives to prevent famines. However, we find that this threat-induced effect was partly mitigated by a rugged border, as illustrated by the negative sign of the interactive terms between border ruggedness and these key variables. These results offer consistent evidence that a key channel for border ruggedness to affect famine was its role in providing defense against threats from neighboring warlords and especially those militarily strong ones.

If border ruggedness indeed altered a warlord's incentives and prompted him to be more likely a stationary bandit, as we have argued, we should see evidence of a longer ruling horizon.

To this end, we create a dummy variable $Turnover_{i,t}$, which is 1 if the prefecture's ruling warlord was replaced by another in year t in the post-1916 period, and 0 otherwise. We hypothesize that border ruggedness should have negative impact on $Turnover_{i,t}$. Similarly, we sum up the frequency of warlord turnover in a given prefecture after 1916, and hypothesize that this aggregate, $Turnover\ Frequency_i$, should also be negatively related to border ruggedness. In the warlord years between 1917 and 1926, Chinese prefectures experienced frequent change of rulers, with 270 prefectures having at least one turnover. The average prefecture experienced four changes of controlling warlords in a short span of a decade, totaling 913 such events.

We run the following regressions using the warlord period (1917-1926):

$$Turnover_{i,t} = \beta_1 Ruggedness_i + \gamma_1 X_i + \varepsilon_{i,t} \quad (6)$$

$$Turnover\ Frequency_i = \beta_2 Ruggedness_i + \gamma_2 X_i + \varepsilon_i \quad (7)$$

Panel B of Table 6 reports the results. Border ruggedness indeed reduced warlord turnover. In column 1, border ruggedness has a negative and significant coefficient of -0.108, suggesting that a one-SD increase in border ruggedness (i.e., 0.272) is associated with a three percentage points drop in the probability of turnover. In column 2, border ruggedness also has a negative and significant impact on the total number of turnovers in the prefecture, with a coefficient of -0.693, indicating that a one-SD increase in border ruggedness would reduce total number of turnovers in a decade by roughly 0.2 times. These results suggest that warlords' topography-driven decisions were indeed shaped by ruling horizon.

5.2. Resident Composition Is Unlikely to Be a Mechanism

Border areas with rugged terrains could attract people who want to escape from the state (Scott 2009). Thus, housing potentially difficult people to govern, rugged borderlines might incubate unrest and rebellion if the ruler did not provide necessary disaster relief. Taking this into account, the warlord might be forced to behave in a more responsible way.

To check this mechanism, we identify prefectures classified by the Qing government as being rife with violent crimes, and prefectures with a historical record of riots. In the post-1916 sample of prefectures, we further include in the regression these two dummy variables and their

interactions with border ruggedness to see if they affected famines either independently or through border ruggedness. Because our key prefecture-level indicators are not time-varying, we cannot include in these regressions the prefecture fixed effects. We thus include year and warlord fixed effects to control for the time trend and warlord-specific factors.¹³ The warlord-fixed effect reflects a fixed region with a unique warlord-ruling history: In the case of rule by one warlord, it captures his ability and policy benevolence; in the case of rule by multiple warlords, their ability and policy benevolence.

We cluster standard errors by warlord to allow for correlations among the error terms from prefectures controlled by the same warlord. In columns 1 and 2 of Table 7, both variables and their interactions with border ruggedness are insignificant, indicating that differential population composition is unlikely to be a channel for the link between famine and border ruggedness.

5.3. Fiscal Capacity Is Not a Mechanism

Apart from affecting the ruler's incentives, border ruggedness could increase the warlord's resources and thus the incidence of famines. For instance, a warlord surrounded by rugged terrain might need to spend less resources in military affairs, and would therefore have more resources at his disposal, and he would be less constrained in his ability to provide for his people. We should point out that, in the long run, differences in fiscal resources could be part of the stationary bandit effects, so our concern here is that the difference in fiscal resources merely reflects pre-existing endowment before the warlord fragmentation period. If so, our previous findings on the negative relation between border ruggedness and famine incidence may reflect not his calculation on his ruling horizon but his endowment.

To address this possibility, we consider two proxies for local resource constraints. The first is the amount of local taxes. We have data on prefectural business taxes (*Likin*) and land taxes, the two major sources of local fiscal income, in the year 1925. The second proxy for resource constraints is total warlord resources, measured as the sum of fiscal revenue of all the

¹³ An illustration might be useful here. Suppose a province had 5 prefectures, A, B, C, D, and E. Initially A, B, and C were under Warlord 1, D and E were under Warlord 2. Then in the middle of the warlord period, C changed hands to Warlord-2. Then the set of unique warlord history regions are: A and B; C; D and E.

prefectures ruled by the same warlord. We test the resource channel by interacting these variables with border ruggedness. In columns 3 and 4 of Table 7, none of the fiscal variables are significant, suggesting that they did not affect famine prevention and relief. Moreover, the interactive terms between these resource variables and border ruggedness are also insignificant, suggesting that fiscal resources did not intensify the role of border ruggedness in affecting famines. After controlling for these additional variables, coefficients on border ruggedness remain negative and significant. These results suggest that border ruggedness did not affect famine outcomes via fiscal resources.

5.4. Territory Size Could Be a Mechanism

Finally, we consider whether the territory size of the warlord could explain famine. The size of a country has far-reaching implications in political economy (Alesina 2003). For instance, a larger territory enables the warlord to mobilize more resources to defend himself, and helps to facilitate the movement and deployment of his troops. Moreover, warlords with a larger territory could be more capable, either in military might or in general governance capacity. These considerations imply that warlord states with larger territories should have lower incidence of famines.

In column 5 of Table 7, the size of warlord territory and border ruggedness both have a negative and significant coefficient, suggesting that when a warlord controlled a large territory, or when he was surrounded by a rugged terrain, he would be more willing to prevent famine or provide famine relief. The interaction term between the area size and border ruggedness is positive and significant, suggesting that border ruggedness was less important when the warlord controlled a larger territory. Overall, these results indicate that a larger territory size did contribute to fewer famines, and that the impact of ruggedness on famines remains robust, and is more pronounced in smaller warlord states. Note that this interpretation is not inconsistent with our hypothesis. For instance, if larger territory means stronger military might, this should make border ruggedness less essential for military defense, and make the local warlord more like a stationary bandit, reducing famine incidence.

6. The Rise of Communism

We now test the famines-and-communism hypothesis by examining whether the economic hardship faced by peasants, as measured by the warlord-era famines, facilitated the rise of Communism in China.

6.1. Warlord-Era Famines and the Rise of Communism

In China before the 20th century, typical famines would have at most caused local rebellions that could have been quickly put down by the government. But the CCP's emergence—along with the spread of the Communism ideology—quickly changed this scenario. With its strong emphasis on discipline and punishment, the CCP had been among the most powerful mobilizers of the masses (Moore 1966, Chen 1986, Walder 2017). Moreover, while traditional peasants had strong sense of local connections and cared only about clan-based or very local interests (such as fellow villagers), the CCP emphasized the sense of class belonging, the mentality of class struggle between the haves and the have-nots, sometimes exaggerating their wealth and their rent requirements (Bianco, 1983). As the literature underscores the importance of belief in determining individual behaviors (North 1991), this combination of disciplines and class consciousness made the peasants a powerful force to overcome collective action problems, and made peasants in famine-stricken regions more susceptible to the Communist ideology and to joining its army to change the prevailing social order.

To assess whether the famines during the warlord era helped the rise of Communism, we begin by measuring the spread of communists in a location by the mobilization of local peasants, as captured by the number of CCP casualties (“CCP war casualties”) born in a prefecture up to 1949, the year of Communist takeover in China. The more local residents, largely peasants, died for the Communist cause, the more clearly successful the CCP was in mobilizing peasants in that area (Kelliher, 1994). During the CCP's three decades of struggle for power, the number of its casualties largely rose after 1927, a year after the end of our sample period, when the Communist Party started to resort to armed force to overthrow the Nationalist government. To see if our measure of CCP mobilization is related to the famine experience during the warlord period, we run the following regression:

$$CCP_i = \beta \#Famine_i + \gamma X_i + v_k + \varepsilon_i \quad (8)$$

Here CCP_i is the logarithm of the number of Communist soldiers (and a much smaller number of Communist cadres not in the military) killed between 1927 and 1949 who were born in a prefecture. $\#Famine_i$ is the number of famines in the prefecture during the warlord period prior to 1927. X_i is a vector of control variables as in our baseline regression. We control for province fixed effects (v_k). On average, a province has 16 prefectures.

The results are in Table 8. Column 1 shows that the number of famines during the warlord period is positively and significantly associated with the spread of the communists after 1927, as proxied by the number of war deaths on the communist side. Specifically, a one-standard-deviation increase in famines prior to 1927 (i.e., 0.192) is associated with 27% rise in the number of communist war casualties in the subsequent two decades. This finding is suggestive that extreme economic hardship due to early experience of famines helped the CCP to mobilize local people—almost all were peasants—and pushed more of them to the side of communists.

6.2. The Three-Stage-Least-Square (3SLS) Approach

We now consider the possibility that the warlord-era famines could be correlated with other determinants of CCP war casualties, making the famines endogenous. Given our earlier tests that border ruggedness likely did not affect famines through other channels, we can estimate the following system of three-stage-least-square (3SLS) model (Becker and Woessmann, 2009; D’Acunto, Prokopczuk and Weber, 2019):

$$Ruggedness_{ik} = \pi_1 \text{Share of Yuan Border}_i + \gamma_1 X_i + v_k + \varepsilon_{1i} \quad (9)$$

$$\#(Famine)_{ik} = \pi_2 \widehat{Ruggedness}_i + \gamma_2 X_i + u_k + \varepsilon_{2i} \quad (10)$$

$$CCP_{ik} = \pi_3 \#(\widehat{Famine})_i + \gamma_3 X_i + w_k + \varepsilon_{3i} \quad (11)$$

Here i is prefecture, and k is province. The first stage uses the percentage of prefectural borderlines reset by the Mongols to predict the degree of border ruggedness. The second stage uses the fitted border ruggedness in the first stage to predict the occurrence of famines, a direct consequence of governance failure. Finally, the third stage uses the fitted famine outcome as instrumented by border ruggedness to gauge their impact on a local population’s support of the

communists. We estimate using the 3SLS method, and adjust the standard errors based on Angrist and Pischke (2009, chapter 4). The results are in columns (2) to (4) in Table 8.

The fraction of borderlines reset by the Mongols, as before, is negatively related to ruggedness on the border. The part of border ruggedness related to Mongolian demarcation, again as before, has a negative effect on the famines. Finally, the part of famine outcome driven by border ruggedness that is due to Mongolian demarcation has a negative impact on the number of deaths in the communist force. Increasing the number of famines in the prefecture by one standard deviation (0.192) would raise subsequent log war casualties by 1.06, or roughly 30% of the standard deviation of the outcome, a pronounced effect. The positive relation between famines and subsequent Communist war casualties suggests that state failure in providing basic livelihood allowed the CCP to successfully mobilize local residents for its cause.

6.3. Spatial Autocorrelation

A concern is that the correlation between famines and the local CCP war casualties is only the result of spatial autocorrelation. That is, if nearby prefectures have similar famine likelihood and local CCP activities due to other economic, cultural or demographical reasons, then it is likely that the peak famine areas correspond to areas with high CCP war casualties, leading to a positive correlation between the two variables. We therefore conduct the Moran test following Kelly (2019). In particular, we check whether there is any autocorrelation among the residual terms from the cross-sectional regression. The z-value of the test is 0.759, responding to a p-value of 0.224. The null hypothesis of no spatial autocorrelations is not rejected.

6.4. Soldiering for Livelihood or Ideology?

We have argued that famines changed local people's ideology to the point of joining the CCP army. But another possibility is that local people, when poor and starved, just wanted to join *any* army to make a living and stop starving—soldiering, after all, should provide a better livelihood than farming in places that tend to have famines. To consider this possibility, we examine whether famine-laden prefectures during the warlord era also witnessed more local

people joining and dying for the Nationalist party army, which put much less emphasis on ideology.¹⁴

We obtain data on the Nationalist war casualties from the website of the National Revolutionary Martyrs' Shrine of R.O.C in Taiwan, China, which records the names of about 140,000 people who died as members of the Nationalist forces before 1949.¹⁵ We trace the places of birth of these Nationalist soldiers, and see if the number of Nationalist soldiers is related to famines in the 1920s in their home prefectures. In columns 1 and 2 of Table 9, we report the OLS and the 3SLS estimation of the effects of famines in the 1920s on Nationalist war casualties before 1949. The instrumental variables are the same as in the previous section. The number of famines during the warlord period does not have significant impact on the number of subsequent Nationalist soldiers killed in wars. This suggests that Nationalist military forces were unable to—or did not try to—draft more people from regions hit hard by prior famines. We conclude that state failure in the 1920s in China did not have a general impact on people's choice of joining armies for livelihood, but it provoked strong support of the Communist ideology.

6.5. Consideration of Nationalism

Apart from economic hardship and perceived injustice, another factor which also helps explain the ability of CCP to recruit many peasants is peasant nationalism in response to Japanese invasion (Seldon 1971). To see if our explanation remains valid, we drop casualties during the Second World War, known as the Sino-Japanese War (1937-1945) in China—the war casualties during this period could be more motivated by nationalistic sentiments. We still obtain a positive and significant relationship between famines and the Communist war

¹⁴ The difference between the CCP and the Nationalist ideology is evident from the official statements that a new party member of each party has to declare joining. See

https://en.wikipedia.org/wiki/Chinese_Communist_Party_Admission_Oath.

The Nationalist party emphasizes that each member has to obey traditional Chinese values such as courage, filial duty, kindness, keeping promises, peace, courtesy, obedience to supervisors, frugality, tidiness, and helping others. The CCP joining statement, in contrast, focuses on obeying the *principles* of the party, carrying out orders, accepting disciplines, being loyal to the party, and being willing to sacrifice one's life for the party, and never be a traitor to the cause.

¹⁵ The difference in the total numbers of martyrs between the CCP and the KMT largely reflects the CCP's tradition in collecting the identity of their martyrs (see Hung, 2008). Another factor is that the KMT retreated to Taiwan, China, in 1949 and could no longer access detailed personnel data of its casualties on the mainland.

casualties in columns 3 and 4 of Table 9, with the magnitudes very similar to the baseline results in Table 8. This suggests that although nationalist sentiment associated with Japanese invasion may help to explain the CCP’s mobilization ability, it alone could not fully explain peasants’ support of the communist military forces.

6.6. Famines, Land Ownership, and Communism

Land has been the key asset in agrarian societies, and inequality in land ownership has always been a key trigger of violence and rebellion in ancient times (Scheidel 2017). In the Late Roman Republic, Tiberius Gracchus gained popular support by proposing land reforms which attempted to “stem the numerical decline of the free peasantry from which the armies of the Republic were traditionally recruited” (De Ligt and Northwood, 2008, page 1). His assassination marked the beginning of a long period of chaos which ended the Republic. Likewise, the CCP’s advocacy for redistribution of land served as a powerful catalyst to recruit peasants with little or no land (Hsiao 1969). Indeed, ever since its military insurrection, the CCP was keen to carry out land reforms to attract the support of peasants in areas under its control by redistributing land from landowners to peasants, and would later call its revolution the Land Revolution. Fully aware that their distributed land would be gone if the CPP failed, a large number of peasants joined the CCP army, providing the CPP with a large fighting force.

To further our understanding of the underlying mechanism of our previous findings, we collect land ownership data from the Agri-business Statistics of the Republic of China (1918-1921). This data set was compiled from land surveys in 152 prefectures conducted by the then Ministry of Agri-business. Because of the unstable political environment during the warlord period, some prefectures dropped out of the survey, resulting in an unbalanced panel. The data set contains information on the fraction of rural households being tenants, that is, being landless, which is a reasonable measure of rural inequality. Tenant households account for 35% of all sample rural households. We first try to see if famines forced more peasants to sell their land and exacerbated inequality in land ownership:

$$\text{Share of tenant households}_{i,t} = \alpha_1 \text{Famine}_{i,t} + \alpha_2 \text{Famine}_{i,t-1} + v_i + \theta_t + \varepsilon_i \quad (12)$$

The dependent variable *Share of tenant households*_{*i,t*} refers to the fraction of households being tenants in prefecture *i* in year *t* between 1918 and 1921. *Famine*_{*i,t*} is a dummy variable indicating the occurrence of famine in prefecture *i* during the land survey period. We allow both contemporaneous and lagged measures of famines since it might take time for the effects of famines to show up on land ownership. We control for prefecture and year fixed effects and cluster standard errors at the province level.

The first three columns of Table 10 show that the occurrence of a famine is associated with a higher fraction of tenant households by 1.7 percentage points in the following year, indicating that many peasants lost their land completely and had to work on rented land.

The significant increases in the number of landless peasants after famines likely played into the hands of the CCP. To see if this is true, we now assess the association between the share of landless peasants and the subsequent communist revolution:

$$CCP_i = \beta Landless_i + \gamma X_i + v_k + \varepsilon_i \quad (13)$$

Here CCP_i is the logarithm of the number of fallen communist soldiers in the communist revolution, *Landless* takes the form of the fraction of tenant households in 1918. Column (4) of Table 10 shows that the share of landless peasants in a prefecture is positively related to the number of local people who died for communism in subsequent decades. Consistent with the seminal study by Moore (1966), the CCP indeed gained support from landless peasants. We conclude that rural land inequality, exacerbated by the warlord-era famines, was one of the many factors that helped bring down the Republic of China, as it did to the Republic of Rome.

7. Conclusion

A century ago, after millennia of imperial rule, the founding President of a new Republic died. This unexpected death was followed by a dozen years of warlord fragmentation and an increasing incidence of famines. This period also witnessed the spread of Communist ideology into China from Russia and the founding of the Chinese Communist Party. Are there connections between warlord-period famines and the Communist triumph in China? Using prefecture-level data, we find a sharp increase in the number of famines when China fell into

warlord control. Prefectures surrounded by less rugged borders experienced more famines, especially when they faced strong military threat from the neighboring warlords. We interpret the findings as indicating that the lack of border ruggedness raised military threats from neighboring warlords, and made the ruling warlord more a roving bandit without incentives to protect his subjects, as predicted by Olson (1993). Furthermore, more famines in a prefecture led to more rural poverty and inequality as captured by more rural households turning landless tenants, which is correlated with more local residents dying for the Communist movement in subsequent decades. Famines and state failure caused by warlord fragmentation thus turned local residents toward communism, which ultimately facilitated the Communist triumph in China in 1949. The legacy of that decade a century ago continues to shape today's ideological makeup of the world.

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Figure 1. Timeline of historical events

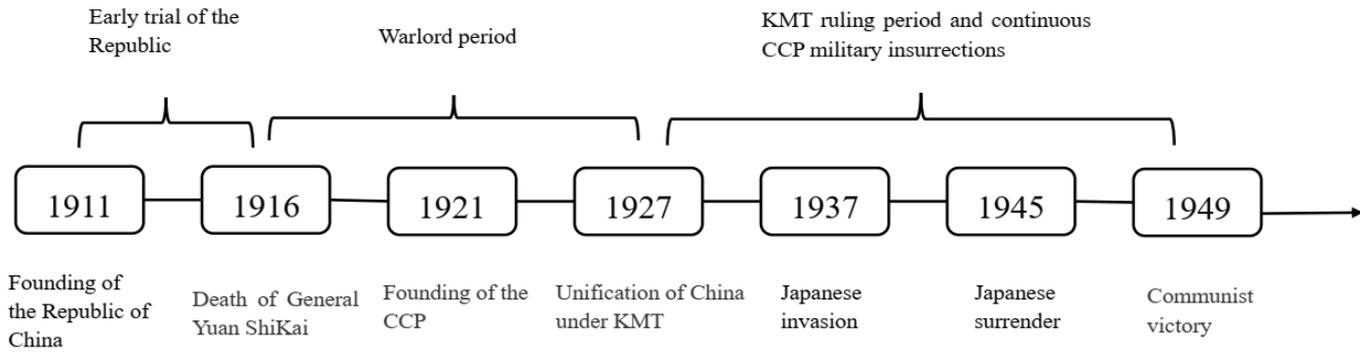
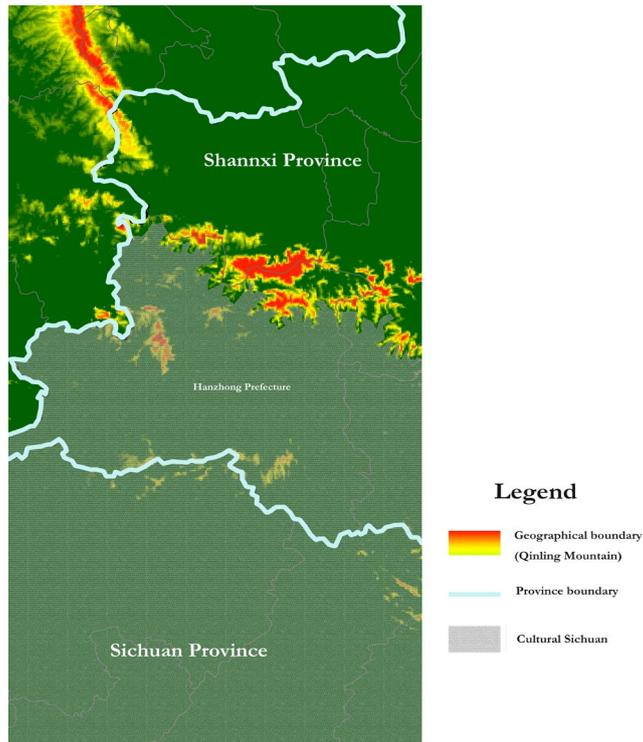
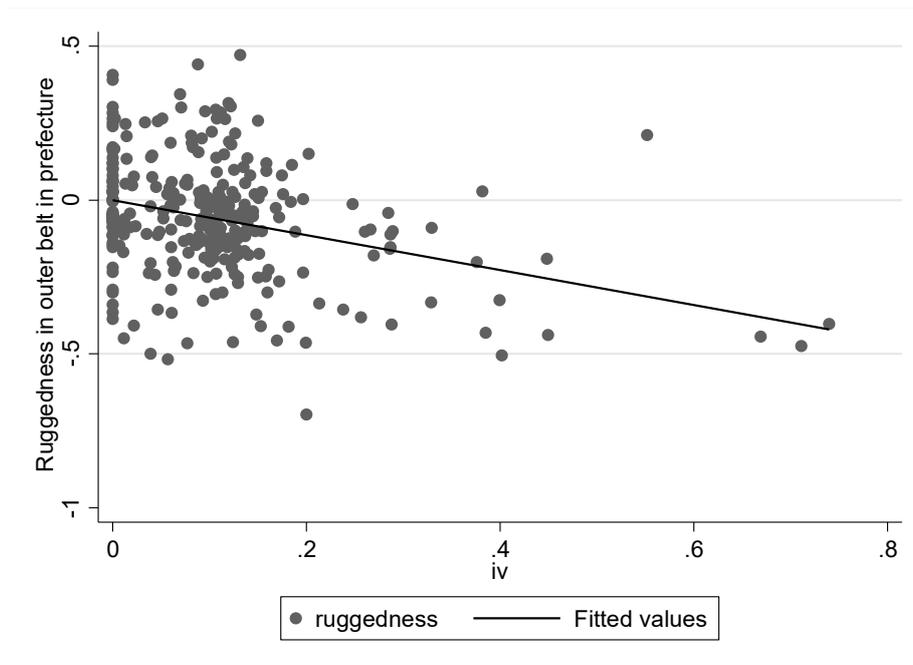


Figure 2. The jigsaw rule: an illustration.



Note: The bright red indicates high altitude. Although Hanzhong prefecture is more connected to Sichuan province, as it is separated from Shanxi province by the mountain at its north (Qinling Mountain), it is a jurisdictional part of Shanxi province.

Figure 3. The correlation between the Mongol Border and border ruggedness



Note: The X-axis is the prefecture's share of border that was changed by the Mongols centuries ago. The Y-axis is its border ruggedness.

Table 1. Descriptive Statistics

Statistic	N	Mean	St. Dev.	Min	Max
<i>Dependent Variable</i>					
Famine	4335	0.039	0.192	0	1
<i>Main Explanatory Variables</i>					
Ruggedness in outer belt of prefecture (10km), the default measure of ruggedness	4335	0.388	0.272	0	1.278
Ruggedness in outer belt of prefecture (10-15km)	4335	0.454	0.352	0	2.153
Ruggedness in outer belt of prefecture (15-20km)	4335	0.451	0.39	0	2.532
Ruggedness in central area (excluding the 20km of outer belt)	4335	0.577	0.589	0	2.425
Post	4335	0.667	0.471	0	1
<i>Instrument Variables</i>					
Share of Yuan Border	4335	0.105	0.109	0	0.74
<i>Independent Variables</i>					
Area	4335	22.999	0.883	18.07	25.62
Latitude	4335	31.093	5.375	20.008	42.269
River Length within prefecture	4335	12.935	1.935	0	17.874
Distance to Yangtze	4335	12.406	1.676	3.311	14.067
Distance to Coast	4335	12.608	1.386	6.062	14.448
Total Population	4335	4.61	1.034	1.459	6.632
Chong	4335	0.561	0.496	0	1
Fan	4335	0.73	0.444	0	1
Pi	4335	0.26	0.438	0	1
Nan	4335	0.633	0.482	0	1
Climate	4335	2.636	1.395	0	5
Disaster	4335	0.522	0.5	0	1
Disaster Seriousness	4335	0.721	0.774	0	2
Riot tradition	4335	2.592	3.773	0	31
Number of Road built during Qing within prefecture	4335	9.498	16.104	0	122
Distance to Beijing	4335	13.77	1.057	0	14.725
Adjacent to Enemy	2890	0.661	0.473	0	1
Adjacent to Enemy with better military training	2890	0.572	0.495	0	1
Adjacent to Enemy in major fraction (with strong allies)	2890	0.369	0.483	0	1
Prefecture taxation	2890	2.705	1.577	0.438	7.484
Warlord taxation	2890	41.941	28.711	1.449	167.584
Warlord area	2890	25.906	0.616	23.523	27.066
#Turnover)	2890	3.945	1.591	1	6
I(Turnover)	2890	0.316	0.465	0	1
Log (1+#CCP war casualties)	289	4.872	3.539	0.511	11.511
Log (1+#KMT war casualties)	289	3.248	3.176	0	9.582

Note: This table presents the descriptive statistics of key variables. Our data set covers 289 prefectures of all 18 provinces in China between 1912 and 1926. China imploded and fell into the hand of warlords after 1916 when then President Yuan passed away. See more detailed variable definitions in Table TA1.

Table 2. Border ruggedness and famine

Dep. Var.	Famine				
		Using Ruggedness in outer belt of prefecture			Ruggedness
		0-10km	10-15km	15-20km	In central
		(default)			area
	(1)	(2)	(3)	(4)	(5)
Post	0.053*** (0.005)				
Post * Ruggedness		-0.095*** (0.016)	-0.033** (0.014)	-0.006 (0.006)	0.004 (0.009)
Post * Total Population		-0.003 (0.005)	-0.004 (0.006)	-0.005 (0.006)	-0.007 (0.006)
Post * Total Area		0.010* (0.005)	0.011* (0.006)	0.013** (0.006)	0.015** (0.006)
Post * Distance to the coastline		0.012*** (0.004)	0.010** (0.004)	0.011*** (0.004)	0.011*** (0.004)
Post * Distance to Yangtze river		0.008*** (0.003)	0.007*** (0.003)	0.007** (0.003)	0.007** (0.003)
Post * Latitude		0.007*** (0.001)	0.006*** (0.001)	0.005*** (0.001)	0.005*** (0.001)
Post * River length within the prefecture		-0.001 (0.002)	0.000 (0.002)	0.000 (0.003)	0.000 (0.003)
Post * Chong (important for transportation)		-0.015 (0.010)	-0.017* (0.010)	-0.019* (0.010)	-0.019* (0.010)
Post * Fan (important for business)		0.003 (0.010)	0.003 (0.011)	0.004 (0.011)	0.006 (0.011)
Post * Pi (difficult to gather taxes)		-0.025** (0.010)	-0.022** (0.011)	-0.019* (0.011)	-0.019* (0.011)
Post * Nan (high in crimes)		0.005 (0.009)	0.003 (0.009)	0.003 (0.009)	0.001 (0.009)
Prefecture FE	Y	Y	Y	Y	Y
Year FE	N	Y	Y	Y	Y
Cluster Level	Prefectures	Prefectures	Prefectures	Prefectures	Prefectures
Observations	4,335	4,335	4,335	4,335	4,335
R-squared	0.084	0.892	0.893	0.892	0.892

Note: This table presents the impact of border ruggedness on the incidence of famines. *Famine* is a dummy variable that equals to 1 for those prefecture-year observations if there was at least a famine and 0 if otherwise. *Ruggedness* measures the local geographical ruggedness following Nunn and Puga (2012). *Post* is a dummy variable that equals to 1 if the time is later than year 1916, when President Yuan passed away. In Column (2)-(4), we use the ruggedness of different outer circles of the prefecture to measure the defender's advantage in the military conflict. In Column (5), we use the ruggedness of prefecture's central area, or the area 20 km away from the border. Standard errors clustered at the prefecture level are reported in brackets. Significance level: *** p<0.01, ** p<0.05, * p<0.1

Table 3. Border ruggedness and famine: robustness

Dep. Var	Disaster		Famines		Famine seriousness	
	(1)	(2)	Exclude inner prefectures	Exclude prefectures with wars	OLS	Ordered Logistic
Post	0.236 (0.338)					
Post * Ruggedness	-0.056 (0.048)	-0.056 (0.048)	-0.096*** (0.017)	-0.096*** (0.020)	-0.170*** (0.025)	-2.277*** (0.341)
Control Variables	Y	Y	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y	Y	N
Year Fixed FE	N	Y	Y	Y	Y	N
Cluster Level	Prefectures	Prefectures	Prefectures	Prefectures	Prefectures	Prefectures
Observations	4335	4335	4245	2708	4335	4335
R-squared	0.234	0.285	0.24	0.381	0.222	

Note: *Ruggedness* is measured as that of the 10-km outer belt. *Disaster* is a dummy variable that equals 1 for those prefecture-year observations if there was a disaster in the prefecture and 0 if otherwise. *Famine seriousness* measures the degree of famine severity and is 2 if the record mentions human casualties, 1 if the record mentions hunger or malnutrition, and 0 otherwise. The control variables include total population, total area, the distance to coastline, the distance to Yangtze River, the latitude, the river length within the prefecture, Chong (i.e., important to transportation), Fan (i.e., important for business, Pi (i.e., difficult to gather taxes) and Nan (i.e., high in crimes). We also include the interactions between those control variables and the post dummy. See Appendix Table A1 for detailed variable definitions. Standard errors clustered at the prefecture level are reported in brackets. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table 4. The instrumental variable: check on exclusion restrictions

Panel A							
Dep. Var	Local transportation		Geographical conditions			Climate conditions	
	Total Population	Road mileage in Qing Dynasty	Distance to Beijing	Distance to Yangtze	Area	Disaster	Climate Shock
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Share of Mongols border	-0.096 (0.569)	-0.043 (0.348)	15.607 (12.584)	-0.657 (0.659)	0.266 (0.838)	-0.824 (0.737)	0.031 (0.233)
Control Variables	Y	Y	Y	Y	Y	Y	Y
Province FE	Y	Y	Y	Y	Y	Y	Y
Observations	289	289	289	289	289	289	289
R-squared	0.689	0.374	0.601	0.736	0.555	0.439	0.374

Panel B					
Dep. Var	Other characteristics				
	Riot tradition	Chong (important in transportation)	Fan (important for business)	Pi (difficult to gather taxes)	Nan (high in crimes)
	(8)	(9)	(10)	(11)	(12)
Share of Mongols border	0.000 (0.000)	-0.610 (2.537)	-0.186 (0.371)	-0.155 (0.316)	-0.591* (0.342)
Control Variables	Y	Y	Y	Y	Y
Province FE	Y	Y	Y	Y	Y
Observations	289	289	289	289	289
R-squared	0.537	0.424	0.477	0.366	0.463

Note: This table presents the exclusiveness checks for the instrumental variable regression. In particular, we test whether the instrumental variable, or the share of prefecture border line reset during Mongol re-demarcation, is correlated with a series of variables that could be related to the local disaster-relief decision. The *share of Yuan border* is the prefecture's share of border stipulated in Yuan as percentage of total border length. Control variables include total population, total area, the distance to coastline, the distance to Yangtze River, the latitude, the length of river within the prefecture, Chong (i.e., important to transportation), Fan (i.e., important for business), Pi (i.e., difficult to gather taxes) and Nan (i.e., high in crimes). See Appendix Table A1 for detailed variable definitions. Standard errors are reported in brackets. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5. The instrumental variable regression

Dep. Var	Post * Ruggedness on prefecture border	Famine
	1st stage result (1)	2SLS results (2)
Post * Share of Mongol Border	-0.267*** (0.037)	
Post * Border ruggedness		-0.556*** (0.210)
Control Variables	Y	Y
Prefecture FE	Y	Y
Year FE	Y	Y
Observations	4,335	4,335
R-squared	0.841	0.172
F	67.71***	

Note: This table presents the 1st and 2nd stage instrumental variable regression. Here the ruggedness refers to the 10-km outer belt of a prefecture. We use the share of Mongol Border as the instrument. The control variables include total population, total area, the distance to coast line, the distance to Yangtze River, the latitude, the length of river within the prefecture, Chong (i.e., important to transportation), Fan (i.e., important for business, Pi (i.e., difficult to gather taxes) and Nan (i.e., high in crimes). See Appendix Table A1 for detailed variable definitions. Standard errors are reported in brackets. Significance level: *** p<0.01, ** p<0.05, * p<0.

Table 6. Mechanism: military threat

Panel A. Dep. Var	Famine		
	<i>Key indicator of military threat</i>		
	Adjacent to Enemy	Adjacent to Warlord with better military training	Adjacent to Enemy in major fraction (with strong allies)
	(1)	(2)	(3)
Key indicator	0.147** (0.074)	0.106** (0.053)	0.186*** (0.062)
Border ruggedness * Key indicator	-0.203* (0.111)	-0.226** (0.096)	-0.318** (0.136)
Control Variables	Y	Y	Y
Prefecture FE	Y	Y	Y
Year FE	Y	Y	Y
Cluster level	Warlords	Warlords	Warlords
Observations	2,890	2,890	2,890
R-squared	0.271	0.276	0.286

Panel B. Dep. Var	Turnover	Turnover Frequency
	(1)	(2)
Border Ruggedness	-0.108*** (0.034)	-0.693** (0.342)
Control variables	Yes	Yes
Data type	Panel	Cross-sectional
Observations	2,890	289
R-squared	0.021	0.229

Note to Panel A: This table presents the impact of the neighboring warlords on the incidents of famines. Here the ruggedness refers to the 10-km outer belt. In Column (1), the key indicator is a dummy variable that equals 1 if the prefecture is adjacent to an enemy warlord and 0 if otherwise. The enemy warlord is referred to warlords not affiliated to the same military faction with the ruling warlord. In Column (2), the key indicator is a dummy variable that equals 1 if the prefecture is adjacent to a warlord with better military training and 0 if otherwise. In Column (3), the key indicator is a dummy variable that equals 1 if the prefecture is adjacent to a hostile warlord with strong military allies and 0 if otherwise. The control variables include total population, total area, the distance to coastline, the distance to Yangtze River, the latitude, the length of river within the prefecture, Chong (i.e., important to transportation), Fan (i.e., important for business, Pi (i.e., difficult to gather taxes) and Nan (i.e., high in crimes). See Appendix Table A1 for the detailed variable definitions. Standard errors clustered at the warlord level are reported in brackets. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Note to Panel B: This table presents the impact of the ruggedness on the warlord turnover. Here the ruggedness refers to the 10-km outer belt. We present panel data regression result in Column (1), where the dependent variable is a dummy variable that equals 1 for those prefecture-year observations where the prefecture was changed hand between warlords. In Column (2), we present the cross-sectional result, where the dependent variable is the total number of times of change hand of the prefecture between 1917 and 1928. The control variables include total population, total area, the distance to coastline, the distance to Yangtze River, the latitude, the length of river within the prefecture, Chong (i.e., important to transportation), Fan (i.e., important for business, Pi (i.e., difficult to gather taxes) and Nan (i.e., high in crimes). See Appendix Table A1 for the detailed variable definitions. Standard errors clustered at the warlord level are reported in brackets. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7. Alternative mechanisms and explanations

Dep. Var	Famine				
	<i>Key indicator of prefecture or warlord characteristics</i>				
	High in crimes (1)	Riot tradition (2)	Prefecture taxation (3)	Warlord taxation (4)	Warlord area (5)
Border ruggedness	-0.111*** (0.022)	-0.090*** (0.025)	-0.154*** (0.045)	-0.131*** (0.042)	-0.191*** (0.049)
Key indicator	-0.008 (0.011)	0.006 (0.010)	-0.009 (0.011)	-0.001 (0.001)	-0.458*** (0.114)
Border ruggedness * Key indicator	0.023 (0.019)	-0.010 (0.021)	0.023 (0.014)	0.001 (0.001)	0.412** (0.163)
Control Variables	Y	Y	Y	Y	Y
Warlords FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Cluster level	Warlords	Warlords	Warlords	Warlords	Warlords
Observations	2,890	2,890	2,890	2,890	2,890
R-squared	0.235	0.235	0.235	0.236	0.250

Note: This table considers alternative explanations. Here the ruggedness refers to the 10-km outer belt. We consider two types of local characteristics that may have impact on the warlords' relief decision: the local violence tradition and the state capacity. *High in crime* is a dummy variable that equals to 1 if the prefecture is categorized as Nan, or high crime rate, by Qing court, and 0 if otherwise. *Riot tradition* is a dummy variable that equals to 1 if there was any riot or rebellion during Qing's rule. *Prefecture taxation* is the total amount of prefecture-level taxation. *Warlord taxation* is the total amount of taxation levied by the ruling warlord. *Warlord area* is the total area of jurisdiction under the warlord's control. Control variables include total population, total area, the distance to coastline, the distance to Yangtze River, the latitude, the length of river within the prefecture, Chong (i.e., important to transportation), Fan (i.e., important for business, Pi (i.e., difficult to gather taxes) and Nan (i.e., high in crimes). See Appendix Table A1 for the detailed variable definitions. Standard errors clustered at the warlord level are reported in brackets. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table 8. The Rise of Communism

Dep. Var	Log (1+CCP	Border	#(Famine)	Log (1+CCP
	“martyrs”)	ruggedness		“martyrs”)
	OLS	OLS	2SLS	3SLS
	(1)	(2)	(3)	(4)
#(Famine)	1.412*** (0.382)			5.870** (2.832)
Border ruggedness			-2.059*** (0.766)	
Share of Mongol Border		-0.568*** (0.183)		
Control Variables	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
Observations	289	289	289	289
R-squared	0.436	0.545	0.663	0.42
z-value of Moran test	0.707			
p-value of Moran test	0.224			

Note: This table presents the result of famine’s impact on the rise of the communism. The OLS result is presented in Column (1). CCP war casualties is the prefecture s’ total number of communism war casualties between 1927 and 1949. In Column (2), we report the cross-sectional 1st stage estimate: the impact of the share of border being determined by Mongols in the Yuan Dynasty on the prefecture’s border ruggedness during the warlord era. In Column (3), we report the 2SLS estimate of the total number of famines on the prefecture border ruggedness, with the instrumental variable being the share of borders determined by Mongols. In Column (4), we report the 3SLS estimate of the 3rd stage: the impact of predicted famine on the CCP war casualties. The control variables include total population, total area, the distance to coastline, the distance to Yangtze River, the latitude, the length of river within the prefecture, Chong (i.e., important to transportation), Fan (i.e., important for business, Pi(difficult to gather taxes) and Nan (i.e., high in crimes). See Appendix Table A1 for detailed variable definitions. We follow Becker and Woessmann (2009, p. 47, Table VIII) and D’Acunto, Prokopczuk and Weber (2019, p 25, Table 6) to adjust the standard errors. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table 9. The Rise of Communism: robustness

Dep. Var	Log (1+KMT “martyrs”)		Log (1+CCP “martyrs”)	
			Exclude Sino-Japanese War	
	OLS	3SLS	OLS	3SLS
	(1)	(2)	(3)	(4)
#(Famine)	-0.156 (0.240)	0.806 (1.433)	1.414*** (0.382)	5.755** (2.753)
Control Variables	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
Observations	289	289	289	289
R2	0.738	0.738	0.415	0.415
z-value of Moran test			0.559	
p-value of Moran test			0.288	

Note: This table presents the results of robustness checks on famine’s impact on the rise of the communism. In columns 1 and 2, the dependent variable is the log of KMT war casualties in a prefecture between 1927 and 1949. In columns 3 and 4, the dependent variable is the log of KMT war casualties in a prefecture between 1927 and 1949. The procedure for the 3SLS is the same as in Table 8. We follow Becker and Woessmann (2009, p. 47, Table VIII) and D’Acunto, Prokopczuk and Weber (2019, p 25, Table 6) to adjust the standard errors. Control variables include total population, total area, the distance to coastline, the distance to Yangtze River, the latitude, the length of river within the prefecture, Chong (i.e., important to transportation), Fan (i.e., important for business, Pi (i.e., difficult to gather taxes) and Nan (i.e., high in crimes). See Appendix Table A1 for detailed variable definitions. Standard errors are reported in brackets. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 10. Effect of famine on land inequality

Dependent Variable	Share of tenant households			Log(1+CCP “martyrs”)
	(1)	(1)	(3)	(4)
<i>Famine</i>	-0.008 (0.007)		-0.002 (0.008)	
<i>Famine</i> _{<i>t</i>-1}		0.017** (0.007)	0.017** (0.007)	
Share of tenant households				8.204** (3.224)
Prefecture FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Control variables	N	N	N	Y
Observations	376	376	376	151
R-squared	0.932	0.933	0.933	0.381

Note: This table tests the impact of famines on land concentration. The famine is a dummy variable that equals to 1 if there was a famine in the prefecture in the observation year and 0 if otherwise. *Share of tenant households* is the share of tenant households, or those households who rely on the rented land from the landowners, as the percentage of the total number of households. Control variables include total population, total area, the distance to coastline, the distance to Yangtze River, latitude, the length of river within the prefecture, Chong (i.e., important to transportation), Fan (i.e., important for business, P i(i.e., difficult to gather taxes) and Nan (i.e., high in crimes). See Appendix Table A1 for detailed variable definitions. Standard errors clustered on the province level are reported in brackets. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Table 11. Land inequality and the rise of communism

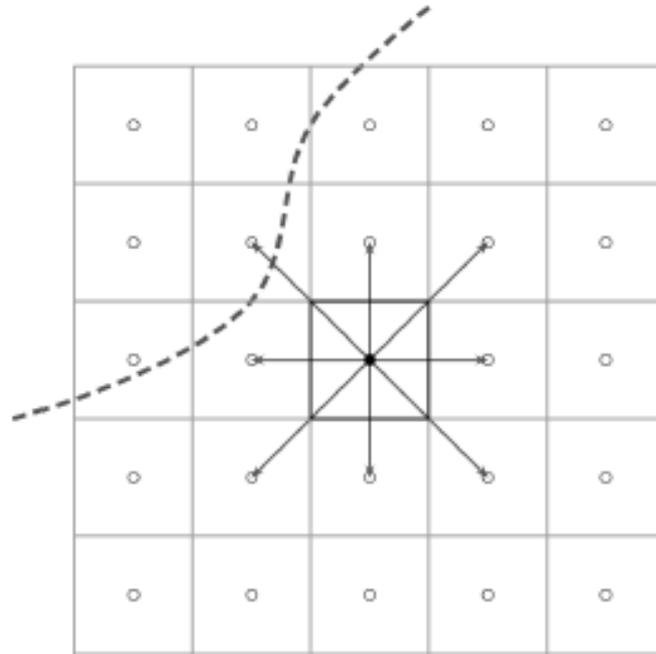
Dependent Variable	Log(1+CCP “martyrs”) (1)	Log(1+CCP “martyrs”) (2)
Share of tenant households	8.204** (3.224)	
Share of rented land		6.171* (2.905)
Control variables	Y	Y
Province FE	Y	Y
Year FE	Y	Y
Observations	152	151
R-squared	0.381	0.366

Note: This table presents the results of testing the impact of land concentration on the rise of communism. *Share of tenant households* is the tenant households, or those households who rely on the rented land from the landowners, as the percentage of total number of households. *Share of tenant land* is the land that were rented by the tenant household from the landowner, as the percentage of total area of land. CCP war casualties is the prefecture s’ total number of communism war casualties between 1927 and 1949. Control variables include total population, total area, the distance to coastline, the distance to Yangtze River, latitude, the length of river within the prefecture, Chong (i.e., important to transportation), Fan (i.e., important for business, P i(i.e., difficult to gather taxes) and Nan (i.e., high in crimes). See Appendix Table A1 for detailed variable definitions. Standard errors clustered at the province level are reported in brackets. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Appendix

Figure A1. Schematic of the Terrain Ruggedness Calculation

FIGURE 1.—SCHEMATIC OF THE TERRAIN RUGGEDNESS CALCULATION



Note: This is Figure 1 in Nunn and Puga(2012). Starting from GTOPO30 (U.S. Geological Survey, 1996), a global elevation data set, in which elevations are regularly spaced at 30-arc seconds across the entire surface of the earth. This figure represents 30-by-30 arc-second cell. Ruggedness calculation takes a point on the earth's surface like the solid circle at the center of the figure. The calculation takes 8 major direction (North, northeast, east, southeast, south, southwest, west, and northwest). The ruggedness at the central point of the figure is given by the sum of absolute value of line slope. More formally, let $x_{r,c}$, $y_{r,c}$ and $z_{r,c}$ donate the X-axis, Y-axis and Z-axis of the point located at row r and column c . The $slope_{r,c}$ can be calculated as $\sum_{i=r-1}^{r+1} \sum_{j=c-1}^{c+1} (|z_{i,j}| / \sqrt{x_{i,j}^2 + y_{i,j}^2})$.

As an example, according to the Food and Agriculture Organization (1993), ruggedness over 2 indicates the benefits of cultivation do not cover the necessary costs. In Henan province, only 8.3% of its borderlines fall into this category. From the perspective of agricultural production, lack of ruggedness makes disaster relief easier. However, this also indicates vulnerability in defense.

Table A1

Statistic	Description	Source
Famine	Indicator of the prefecture experiencing famine in a particular year.	1, 2
Disaster	Indicator that the prefecture experienced a natural disaster in a particular year.	1, 2
Warlord area	Logarithm of the total area ruling by this warlord (unit: meter ²)	3
Ruggedness in outer belt of prefecture (10km)	Slope for the 0-10km outer belt of a prefecture	3
Ruggedness in outer belt of prefecture (10-15km)	Slope for the 10-15km outer belt of a prefecture	3
Ruggedness in outer belt of prefecture (15-20km)	Slope for the 15-20km outer belt of a prefecture	3
Using Ruggedness in central area (20km)	Slope for the central area of a prefecture (exclude 0-20km outer belt)	3
Post	Post-1916 dummy	3
Area	The logarithm of the area of the prefecture (unit: meter ²)	3
Latitude	Latitude of the prefecture	3
River Length within prefecture	The total length of river within each prefecture (unit: meter ²)	3
Distance to Yangtze	The logarithm of the distance from the city center of the prefecture to the nearest point of Yangtze river (unit: meter)	3
Distance to Beijing	The logarithm of the distance from the city center of the prefecture to Beijing (unit: meter)	3
Distance to Coast	The logarithm of the distance from the city center of the prefecture to the nearest point of coastline (unit: meter)	3
Share of Yuan Border	length of border coinciding with Yuan border / length of prefecture border.	4
Total Population	Total population of prefectures in 1911 (unit: 10,000)	5
Prefecture taxation	Total taxation collected in the prefecture (unit: millions Liang)	6
Warlord taxation	Total taxation collected by this warlord (unit: millions Liang)	6
Chong	Dummy variable that equals to one if the prefecture is important in transportation	7
Fan	Dummy variable that equals to one if the prefecture is important for business	7
Pi	Dummy variable that equals to one if the prefecture is difficult to gather taxes	7
Nan	Dummy variable that equals to one if the prefecture is high in crimes	7

Table A1 (continued)

Statistic	Description	Source
Riot tradition	Number of Riots in Qing	8
Road Mileage in Qing	Mileage of roads built in Qing	9
Adjacent to Enemy	Dummy variable that equals to one if the prefecture was adjacent to an enemy warlord.	10
Adjacent to Enemy with better military training	Dummy variable that equals to one if the prefecture was adjacent to an enemy warlord with better military training	10
Adjacent to Enemy in major bloc (with strong allies)	Dummy variable that equals to one if the prefecture was adjacent to an enemy warlord with strong allies	10
Turnover Frequency	The total number of turnovers of the ruling warlord government of the prefecture between 1917 and 1926	10
Turnover	Whether the ruling warlord government was replaced during the year	10
Log (1+# (CCP “martyrs”))	The logarithm of the total number of CCP war casualties in this prefecture	11
Log (1+# (KMT “martyrs”))	The logarithm of the number of KMT war casualties in this prefecture	12,13
Share of tenant households	The percentage of the tenant households as the total number of rural households.	14

Source:

- 1 The chronicles of natural disaster and famine of China. (中国灾荒纪年)
- 2 The sequel to the chronicles of natural disaster and famine of China. (中国灾荒纪年续编)
- 3 Qing-period data set, CHGIS, Version: 6. (c) Fairbank Center for Chinese Studies of Harvard University and the Center for Historical Geographical Studies at Fudan University, 2016.
- 4 Time-series data set, CHGIS, Version: 4. (c) Fairbank Center for Chinese Studies of Harvard University and the Center for Historical Geographical Studies at Fudan University, 2016.
- 5 Statistics on hukou, farmland and land tax in various dynasties in China(中国历代户口、田地、田赋统计)
- 6 Financial History of the Republic of China(民国财政史) Shiyi, Jia(贾士毅), 1934.
- 7 The draft of Qing dynasty(清史稿)
- 8 Qing historical archive(清实录)
- 9 Memorials of the engineering department (工科题本), First Archives of Chinese History
- 11 The chronicles of officials of Beiyang Government (北洋政府职官年表)
- 11 China war casualties: <http://www.chinamartyrs.gov.cn/> (中华英烈网)
- 12 https://afrc.mnd.gov.tw/faith_martyr/ (国民革命忠烈祠)
- 13 Directory of the names of the loyal soldiers of the Republic of China, second Archives of Chinese History
- 14 Four achieves of Statistical data of the Republic of China (民国统计资料四种)