NORTHWESTERN UNIVERSITY

The 1933 Soviet Famine: Causes and Consequences

A DISSERTATION

SUBMITTED TO THE GRADUATE SCHOOL
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

for the degree

DOCTOR OF PHILOSOPHY

Field of Economics

By

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EVANSTON, ILLINOIS

September 2018

Abstract

According to contemporary estimates, the 1933 Soviet famine killed six to eight million people, more than two million of them in Ukraine. This dissertation studies causes and consequences of this famine.

Chapter one evaluates the causes of the 1933 famine offered by historians in Ukrainian context. Three main explanations have been offered: negative weather shock, poor economic policies, and genocide. This chapter uses variation in exposure to poor government policies and in ethnic composition within Ukraine to study the impact of policies on mortality, and the relationship between ethnic composition and mortality. It documents that (1) the data do not support the negative weather shock explanation: 1931 and 1932 weather predicts harvest roughly equal to the 1925 – 1929 average; (2) bad government policies (collectivization and the lack of favored industries) significantly increased mortality; (3) collectivization increased mortality due to drop in production on collective farms and not due to overextraction from collectives (although the evidence is indirect); (4) back-of-the-envelope calculations show that collectivization explains at least 31% of excess deaths; (5) ethnic Ukrainians seem more likely to die, even after controlling for exposure to poor Soviet economic policies; (6) Ukrainians were more exposed to policies that later led to mortality (collectivization and the lack of favored industries); (7) enforcement of government policies did not vary with ethnic composition (e.g., there is no evidence that collectivization was enforced more harshly on Ukrainians). These results provide several important takeaways. Most importantly, the evidence is consistent with both sides of the debate (economic policies vs genocide). (1) backs

those arguing that the famine was man-made. (2) – (4) support those who argue that mortality was due to bad policy. (5) is consistent with those who argue that ethnic Ukrainians were targeted. For (6) and (7) to support genocide, it has to be the case that Stalin had the foresight that his policies would fail and lead to famine mortality years after they were introduced (and therefore disproportionately exposed Ukrainians to them).

Chapter two complements the above analysis by studying the government grain procurement system, and its impact on the 1933 death toll in the context of Belarus, Russia, and Ukraine. By demonstrating that there was a positive correlation between grain production in 1932 and mortality in 1933, it reproduces the results of Meng et al. (2015) in the context of the 1933 Soviet Famine. The chapter argues that the inflexible procurement policy under which the government did not sufficiently adjust procurement quotas to realized harvest explains the peculiar positive correlation between grain production and mortality during the famine year.

Finally, the third chapter studies the impact of the 1933 Soviet famine on population and urbanization patterns. It documents that, although most of the direct victims lived in rural areas, the famine had a persistent negative impact on the urban population. In fact, the rural population gradually recovered while urban settlements in more affected areas became permanently smaller. The paper argues that the shortage of labor during the crucial years of rapid industrialization hindered the development of cities in areas struck by the famine. Thus, the timing of the shock to population appears to be an important factor. While established urban networks tend to recover from large temporary adverse shocks, the lack of people during construction and rapid growth might have a permanent negative impact.

Acknowledgments

I express my deepest gratitude to my mentors Joel Mokyr and Nancy Qian. Joel's enthusiasm and unwavering support is the main reason I started studying the 1933 famine. Nancy's highest standards of research conduct and analysis taught me the essential research tools and improved the quality of my work. I would also like to mention Joseph Ferrie, Carola Frydman, Andrei Markevich, Cormac Ó Gráda, Yohanan Petrovsky-Shtern, and the economic history group at Northwestern University. They provided support and inspiration during various stages of this work.

I also thank my dear friends Luyba and Anton Babkiny whose steady presence in my life gave me much needed feelings of belonging and love. My classmates and officemates, in particular, Arjada Bardhi, Pom Chirakijja, and Sharlene He, made the years I spent in graduate school happy and fulfilling.

Finally, I would like to thank my grandmother, Maria Sidorovna Scherba, whose stories of dekulakization, famine, and survival, captivated me long before I knew Russian economic history would become my profession. This work is dedicated to her.

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Chapter 1

The political economy of famine: the Ukrainian famine of 1933

1.1 Introduction

By the beginning of 20th century Europe was free from peacetime famine (Alfani and Ó Gráda, 2017). However, without any conflict to trigger food shortages, the 1933 Soviet famine[1] killed six to eight million people[2], and at least 40% of the deaths occurred in Soviet Ukraine. By 1928, measuring wealth by real GDP per capita, Soviet Union belonged to the 30 richest countries in

[1]The famine spanned several years, according to historical reports some areas of Ukraine started to starve already in 1932, and some excess mortality occurred as late as 1934. However, the peak of the famine occurred in 1933 and therefore for simplicity I call it the 1933 famine.

[2]Conquest estimates population losses due to collectivization, arrests and deportations, and famine to be 14.5 million, 7 million deaths directly due to the famine (Conquest, 1986, Chapter 16, p. 306). Andreyev et al. (1990) measure excess mortality due to the famine to be 8.5 million. Davies and Wheatcroft argue that Andreyev et al. (1990) projections do not account for underregistration of infant mortality and of mortality in less-developed Soviet republics, and estimate excess mortality to be 5.7 million (Davies and Wheatcroft, 2009, Chapter 13, p 415). In 2008 Russian parliament issued a special decree stating that 7 million people perished in the Soviet Union during this famine, Duma (2008). In Ukraine a team of researchers from the Institute for Demography and Social Studies headed by Ella Libanova estimates direct losses for Ukraine alone to be 3.4 million, Libanova (2008). In a more recent work, Mesle et al. (2013) argue that Ukraine was "missing" 4.6 million people by the 1939 census, including 2.6 million due to excess mortality. A team of researchers associated with the Harvard Ukrainian Research Institute estimate direct population losses in Ukraine to be 4.5 million, including 3.9 million excess deaths and 0.6 million lost births (Rudnytskyi et al., 2015).

the world (Maddison, 1995, Appendix D), and Soviet economy was rapidly growing (Markevich and Harrison, 2011). How is it possible then that almost 10% of population died of starvation and hunger-induced disease in Ukraine, a territory famous for its grain production and known to be the "grain-basket" of the Soviet Union?

Three main explanations have been offered: negative weather shock, poor economic policies, and genocide. Davies and Wheatcroft (2009), while documenting all the imbalances and atrocities of Soviet economic policies, argue that the negative weather shock of 1931 has triggered the famine. The proponents of the genocide theory argue that no weather shock could have created a disaster of such scale, and that therefore the famine must have been a result of the government policy targeting Ukrainians. This is essentially the argument in Conquest (1986), Snyder (2010), and Graziosi (2015). The most recent book raising a similar argument is written by a Pulitzer-winning journalist Anne Applebaum (Applebaum, 2017). Finally, although poor economic policies have been extremely well documented, until now there has been little quantitative evidence of their impact on famine mortality.

The main limitation of the previous literature is the lack of systematic disaggregated data that is large enough for rigorous statistical analysis. This is the principal contribution of my paper. I have spent two years searching, cataloging, and hand-collecting data on the course of 1933 famine in Ukraine. This is the richest[3] disaggregated district-level[4] dataset combining 1933 mortality data from the archives in Moscow with district characteristics from published sources found in libraries of Kiev, Kharkiv, United States, and even Canada.

In summary, the findings reject the negative weather shock explanation and provide support to both sides of the debate of whether the famine in Ukraine was a result of poor economic policies or an attempted genocide towards Ukrainians. They show that (1) 1931 and 1932 weather pre-

[3]A team of devoted researchers at Harvard Ukrainian Research Institute Mapa project reports 1933 mortality and ethnic composition of Ukraine as of 1927 census, but does not have much information on the state of Ukrainian economy before or during the famine: http://harvard-cga.maps.arcgis.com/apps/webappviewer/index.html?id=d9d046abd7cd40a287ef3222b7665cf3 [Online; last accessed on October 28, 2017]

[4]District was the smallest administrative unit in Ukraine, with average population of about 40 thousand.

dicts harvest roughly equal to the 1925 – 1929 average, and therefore bad weather could not have been the main reason of the famine; (2) bad government policies (collectivization and the lack of favored industries) significantly increased mortality; (3) there is indirect evidence that collectivization increased mortality due to drop in production on collective farms and not due to overextraction from collectives; (4) back-of-the-envelope calculations show that collectivization explains at least 31% of excess deaths; (5) ethnic Ukrainians seem more likely to die, even after controlling for exposure to poor Soviet economic policies (although this result is underpowered); (6) Ukrainians were more exposed to policies that later led to mortality; (7) conditional on being exposed to the same bad economic policy, Ukrainians are not more likely to die (e.g., there is no evidence that collectivization was enforced more harshly on Ukrainians).

These results provide several important takeaways. Most importantly, the evidence is consistent with both sides of the debate of whether the famine was a result of poor economic policies or was a genocide of ethnic Ukrainians. (1) backs those arguing that the famine was man-made. (2) – (4) support those who argue that mortality was due to bad policy. (5) is consistent with those who argue that ethnic Ukrainians were targeted. For (6) and (7) to support genocide, it must be the case that Stalin had the foresight that his policies would fail and lead to famine mortality years after they were introduced (and therefore disproportionately exposed Ukrainians to them). I acknowledge that answering the question of foresight is beyond the scope of this paper. This is an important avenue for future research.

My study proceeds as follows. First, I investigate the reports of severe drought in June of 1931 and unfavorable weather in 1932. Raw weather data do not confirm the drought: June 1931 temperature in Ukraine is very close to the 1900 – 1970 average, and June 1931 precipitation is only slightly below the 1900 – 1970 average. To further investigate if weather conditions were particularly unfavorable for grain cultivation in 1931 and 1932, I estimate grain production function using pre-1917 data and predict the amount of grain that would have been produced in Ukraine if no economic reforms affecting grain production took place. Predicted 1931 and 1932 harvest is very close to the 1925 – 1929 average. Nevertheless, I argue that there is a strong evidence that the actual 1931 and especially 1932 harvests were lower than predicted by the weather. Therefore, poor weather could not have been the reason of the famine in Ukraine.

Next, I investigate economic policies specific to the 1933 famine. In 1929 the government launched a comprehensive collectivization campaign. Peasants were forced to give up their land, implements, and livestock and join collective farms where they were supposed to work together. The government procured grain from the countryside and distributed it in the urban areas. Motivated by the historical context, I focus on three related policies that affect food production, procurement and distribution: the extent of collectivization, procurement, and the presence of industries that received preferential treatment[5]. Importantly, all the policies that I investigate began their implementation two or more years prior to the famine.

I show that a higher share of rural households in collective farms is associated with higher 1933 mortality and argue that the relationship is causal. Importantly, the effect of collectivization is not explained by differences in wealth, economic development, or weather. I present aggregated data to show that there is evidence that relatively *less* grain per capita was extracted from collective farm members. I also demonstrate that, consistent with historical accounts, collectivization of agriculture led to a drop in livestock and sown area. The effect on sown area is especially strong in areas where collective farms had a large number of households per farm, presumably because of higher managerial and monitoring costs on larger collectives. I conclude that the above findings are consistent with collectivization decreasing agricultural productivity. Back-of-the-envelope calculations show that collectivization raised the 1933 death toll by at least 31%.

In addition, although the magnitude of the effect is smaller than the impact of collectivization, I show that areas with favored industries, the industries important for the implementation of the five-year plan and therefore receiving better food supply, experienced lower mortality in 1933,

[5] I describe these policies and the historical context in detail in Section 1.2, and the way that I measure these policies in Section 1.4.2.

consistent with the accounts that these areas were better supplied[6].

Next, I use the variation in ethnic composition within Ukraine to examine whether districts with a higher share of ethnic Ukrainian population experienced higher mortality in 1933. I show that there is a positive though statistically weak relationship between ethnic Ukrainians and mortality rates. I find that even when poor economic policies are controlled for, there is still a positive relationship between share of ethnic Ukrainians in rural population and 1933 mortality, although the estimates are underpowered and not statistically significant. This positive relationship, importantly, is not explained by other factors that could have a direct effect on mortality: wealth, grain and potato productivity, weather shock, differences in urbanization, or access to healthcare facilities. Therefore, genocide claims are not entirely unfounded and deserve further investigation.

Finally, to investigate whether *exposure* to the above policies varied with ethnic composition, I examine the rate of exposure of different ethnic groups to the Stalinist policies that I discuss earlier. I find that areas with a higher share of rural population belonging to Ukrainian ethnicity had higher collectivization rates. I also document that industries which received favorable treatment in terms of food provision (industries that produced the means of production as opposed to consumer goods, e.g., coal mining or armament production) were less likely to be allocated in districts with a higher share of Ukrainians. Finally, to examine whether *enforcement* of the policies varied with ethnic composition, I study the relationship between 1933 mortality and the interaction between the share of Ukrainians in rural population and policy proxies. I find no evidence that enforcement of the government policies varied with ethnic composition.

The finding that Ukrainians were more likely to be collectivized and less likely to have favored industries, together with the finding that both these policies affected famine mortality, suggests that higher Ukrainian famine mortality is partly a product of higher Ukrainian exposure to bad Soviet economic policy.

[6]Surprisingly, I find no evidence that access to railroads, which I use to proxy procurement (the closer the district was to a railroad, the cheaper it must have been to extract grain from it), affected mortality.

This paper belongs to several strands of literature. First, it contributes to a vast body of works studying famines in world history. Among the key works in this literature is Sen (1981) that stresses the importance of not only aggregate food availability, but also the distribution of food in the society, or, in Sen's terminology, the *entitlement* to food. Ó Gráda (2009) gives an overview of the famines in world history, and Alfani and Ó Gráda (2017) analyze famines in European history. Mokyr and Ó Gráda (2002) discuss the causes of deaths during famines.

This work also contributes to the historical literature on the causes of the 1933 Soviet famine. Davies and Wheatcroft (2009) give a detailed account on grain production and procurement and argue that the negative weather shock of 1931 triggered the famine. Viola (1996) and Hunter (1988) document that collectivization resulted in a significant drop in the amount of livestock and discuss the negative effects of it. Conquest (1986) noted that killing and deportation of the richest and most productive peasants must have had a negative effect on grain production. Graziosi (2015) and Snyder (2010), along with many Ukrainian historians, argue that the famine in Ukraine was a genocide against Ukrainians. Ellman (2007) claims that starvation was a cheap substitute for deportations and mass killings, and that Stalin starved the disobedient rural population to death instead of deporting and shooting more peasants.

In addition, my paper contributes to a small but growing literature on famines in command economies. In an important work studying famine that occurred after collectivization of agriculture in China, Li and Yang (2005) attribute 61% of the drop in agricultural output to the government policies of collectivization and grain procurement. Meng et al. (2015) show that in contrast to "usual" famines, the great Chinese famine of 1959–1961 was more severe in more productive areas. Thus, provinces that usually had higher yields per capita suffered higher human losses from 1959 to 1961. Chen and Lan (forthcoming) study the killing of draft animals during collectivization in China and its impact on grain production. Lin (1990) offers a theoretical model arguing that, after exiting from collectives was banned in China, peasants lost the incentives to discipline themselves, and the resulting drop in production contributed to the famine.

Finally, this work adds to the literature on transformation and industrialization of the Soviet economy. Allen (2003) argues that Soviet economy was one of the most successful developing economies in the 20th century. Hunter (1988) shows that without collectivization Soviet agriculture would have grown faster, and that because of collectivization both rural and urban living standards were lowered. Cheremukhin et al. (2013) argue that Stalin's economic policies created large short-run welfare losses from 1928 to 1940 and moderate long-run welfare gains after 1940. Cheremukhin et al. (2017) investigate the transformation of Soviet economy from agrarian to industrialized and argue that reducing entry barriers to manufacturing and not the "big push" policies was a driver behind the rapid Soviet industrialization.

The rest of the chapter is organized as follows. Section 1.2 gives background information and chronicles the events that led to the 1933 famine, Section 1.3 describes the data, Section 1.4 presents the results, and Section 1.5 concludes.

1.2 Background

This section describes the institutional background, summarizes the events that led to the famine of 1932–1933 and the course of the famine, and briefly describes a history of Ukrainian ethnicity within Russian Empire and Soviet Union. For information on the state of Soviet agriculture and a much more detailed history of the famine see, for example, Lewin (1968), Conquest (1986), Davies and Wheatcroft (2009). Ó Gráda (2009) and Alfani and Ó Gráda (2017) put the 1933 famine in the context of famines in world history.

1.2.1 Economy

1922–1928, New Economic Policy

After the revolution of 1917, the Civil War and the famine of 1921–22, experiments with "communism" (abolishing money and the prohibition of private trade), unable to organize production on the nationalized factories and desperately trying to recover the ruined economy, Lenin declared a temporary retreat from pure socialist ideals and introduced New Economic Policy (NEP) in 1921. Under NEP most industrial enterprises were denationalized allowing firms to make their own decisions. In the countryside *prodnalog* (agricultural tax proportional to production) replaced hated food requisitions. After paying taxes peasants were free to sell their produce to several competing government procurement organizations or to deliver it to the markets in the cities directly. This resulted in rapid economic growth. Gregory estimates that in 1928 agricultural output was 111% of the 1913 level, and industrial output was 129% of the 1913 level (Gregory, 1994, Chapter 5, Table 5.2); according to Soviet data, sown area increased from 79 million hectares in 1922 to 118 million hectares in 1929, exceeding pre-war level of 105 million hectares (Vlasov, 1932, p. 73).

Despite the success of the NEP, before 1930 Soviet Union was still a largely agrarian country. In 1927 peasants constituted 80% of the population. The peasantry was generally regarded as a backward class. More than half of the rural population was illiterate, and among women as many as two thirds were illiterate (Lewin, 1968). The agricultural technology was backward relative to the developed European countries. Most of the peasants still used the three-field system, and strip farming was widespread. Application of modern machines and tractors was limited.

Gradually, the government started attempting to extract more resources from the countryside. In 1927 the government reduced price of grain, while not affecting the prices of industrial goods. Peasants started substituting away from grain to more favorably priced animal products and industrial crops (flax, sugar beets, sunflowers). In addition, peasants preferred to keep harvested grain to themselves, either waiting for prices to rise again, or using the grain as forage. In the winter of 1927–1928 a procurement crisis followed: procurement figures were much lower than planned, and the food supply of cities was in danger. The government responded with “extraordinary measures” – searches, forced sales of the grain (though still paid for), arrests. By next winter most private dealers were driven out of the market, and the extraordinary measures became a new norm.

1928–1933, launch of the industrialization policies

By the end of the 1920's Stalin consolidated power within the Communist Party, and in 1928 he launched the first five-year plan for economic development of the Soviet Union. In the end of 1929 comprehensive collectivization and *dekulakization* (the liquidation of 'kulaks' – relatively well-off peasants) campaigns were launched.

The Communist Party sent a massive body of Communists and Komsomol[7] members to the countryside. Those sent to the countryside employed all available methods to induce peasants to join collective farms, from promises of future prosperity[8], agronomists and tractors, to open threats and coercion. Peasants, either attracted by the promises or scared by the threat of dekulakization started joining collective farms. In Ukraine collectivization rate increased from a mere 3.8% in June 1928 to 8.5% in June 1929, to 16% in October 1929, and to 45% in May 1930 (Figure 1.1). By 1932 approximately 70% of the rural households were members of the collective farms.

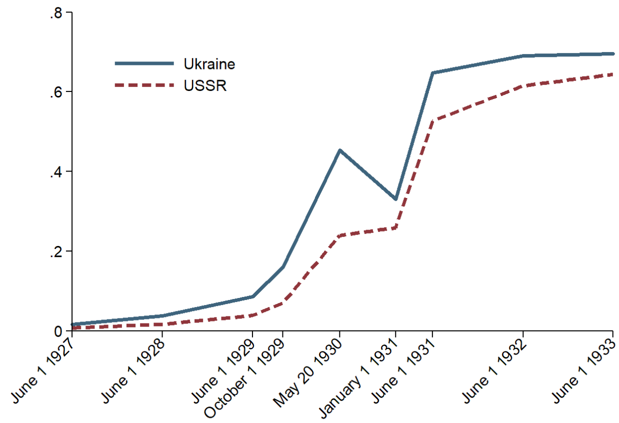
On collective farms peasants were supposed to work the land and to care for the livestock together. In some cases, peasants managed to preserve the ownership of some livestock, but most of it was transferred to the collective farm property. Although there were inevitable delays in the chaos of collectivization campaign, village land was repartitioned so that collective farms obtained unbroken consecutive fields. As a rule, collectives were allocated the best land.

The newly created collective farms were remarkably poorly managed. There were no instructions on how to organize collective farms, various planning and managing organizations sent late and contradictory directives on what and where to sow. Grain collections were also unpredictable – local officials, struggling to fulfill their procurement quota could impose additional grain collection demand on a more successful collective farm if its neighbors were not able to deliver their quota.

[7] Political youth organization controlled by the Communist Party

[8] A Komsomol member talking to a young peasant: "Just think about it [...] All the land will be collectivized, so the kolkhoz will have plenty of it; all the horses will be in the same stable in the large collective farm yard; all the machines – harvesting, sowing, and threshing – will stand next to each other in the same collective farm yard. With all that land and all those horses and machines – if you just work hard, you will be well-fed and well-dressed" (Solovieva, 2000, p. 237)

Figure 1.1: Share of households in collective farms



Sources: Data for June 1, 1927 – May 20, 1930 are from (Gosplan SSSR i RSFSR. Ekonomiko-statisticheskiy sektor, 1931, p XIV); data for January 1, 1931 – June 1, 1933 are from (Davies and Wheatcroft, 2009, Table 27)

Collective farm chairmen lacked necessary education and sometimes were sent from the factories having zero agricultural experience. Finally, it was unclear how to remunerate collective farm members for their work. In theory, the work done by each person was supposed to be registered, and after the harvest and paying the government its share, the remaining produce should have been distributed among peasants in proportion to the amount of work done. But in many cases the books were kept haphazardly, and the grain was distributed simply according to the number of "eaters" in the family. Davies (1980) notes that "no adequate incentives or controls were established [. . .] to replace the motives which impelled the peasants into backbreaking labor when they were entirely responsible for their own economy – the need to feed themselves and their children by their own efforts, the desirability of selling their own products for a money income so that they could pay their debts and taxes, and acquire manufactured goods, materials and implements" (Davies, 1980, p. 300)

In addition, since peasants perceived collectivization as their livestock and their implements being confiscated from them, many simply preferred eating their animals rather than giving them away for free. Massive slaughtering of livestock has followed. According to Viola (1996), the number of cattle decreased from 70.5 million in 1928 to 52.5 million in 1930, pigs from 26 million to 13.6, sheep and goats from 146.7 million to 108.8 (Viola, 1996, p. 70). Consequently, the newly created collective farms had few draft animals, which meant diminished draught power, reduced availability of transport, and lower amounts of fertilizer. In addition, livestock served as a natural insurance against famine – in case of food shortage peasants could consume their animals. Now this alternative source of food was significantly depleted.

In the cities private trade of grain and foodstuffs was mostly banned, and an elaborate system of food rationing started being implemented since 1928. By 1932 some 38 million urban dwellers had a right to receive rations (Davies and Wheatcroft, 2009, Chapter 13, p. 406). The rations varied depending on the nature of the employment and on geographical location. As a rule, establishments important for industrialization, like coal mines and iron and steel factories, as well as defense enterprises, were better supplied (Davies, 1996, Chapter 9, p 178).

1933 and after

In 1933 the government changed the system. Procurement quotas were to be determined by the sown area of the collective farm, and local officials were banned from imposing additional quotas. Collective farm members were allowed to have a small plot of land, to keep some livestock, and, after paying taxes, to sell the produce in the cities on so-called "kolkhoz markets" with free prices. Thus, unable to sustain collective farm members, the government guaranteed them subsistence by allowing them to use small private plots. For decades to come, these small private plots produced most of the vegetables and animal products available to Soviet citizens. The collectivization campaign continued and by 1939 99% of the peasants belonged to collective farms.

1.2.2 Timeline of the famine

1930, the first year when collectivized sector was a significant share of agriculture, was a good year – the harvest was good, grain collections went smoothly, and the government was very optimistic.

However, a disaster followed in 1931 and 1932. Bad weather, the lack of draught power, and late and low quality sowing, all led to a poor harvest. The government was not willing to accept the low harvest estimates and made an extreme effort to procure as much grain as planned. As a result, already in the winter of 1932 some rural areas started starving. The peak of the famine occurred in the spring and summer of 1933, before the new 1933 harvest. Trying to hide the scale of the disaster the government organized road blocks and prohibited rural inhabitants to buy train tickets, thus preventing starving peasants from escaping and searching for food elsewhere. And the little assistance given to the starving areas mostly took form of the seed loans for the 1933 spring sowing: Davies and Wheatcroft (2009) report that during February–July of 1933 1.3 million tons of grain was allocated as state seed loans while only 0.3 million tons of grain was provided as food aid (Davies and Wheatcroft, 2009, Tables 22 and 23). In some areas the mortality was so high that whole villages were depopulated.

1.2.3 Ethnic question

Although ethnic Russians constituted 95% of the population of the Russian state in 1646, due to the vast expansion of the territory, by the 1897 census only 44% of the inhabitants of the Russian Empire belonged to the titular nation.

Left-bank Ukrainian territories[9] joined Russia in 1667, after the 1648 Ukrainian Cossack rebellion against the Polish magnates and the subsequent war between Russian and Polish states. The Right-bank territories (together with the territories of contemporary Belarus, Latvia and Lithuania) were added to the Russian Empire after the partitions of Poland during 1772–1795. By 1897 nine provinces (gubernias) within the Russian Empire had a predominantly Ukrainian population.

The government had to constantly make an effort to preserve the territorial integrity of the empire. Boris Mironov documents that ethnic Russians paid higher taxes per capita, and that

[9] Left-bank Ukraine – territories to the East of the river Dniepr, Right-bank Ukraine – territories to the West of the river Dniepr.

provinces with a majority of non-Russian population enjoyed higher government spending per capita (Mironov and Eklof, 2000, Chapter 1). When a new territory was acquired, local elites were usually granted the noble status equal to the status of ethnically Russian elites. Predominantly non-Russian territories enjoyed a higher degree of autonomy relative to the core Russian provinces, although never a full autonomy.

Despite the relatively higher autonomy and lower taxes, any hint of a national movement within non-Russian territories was severely suppressed. In 1863, after the Polish rebellion, the government issued a secret decree restricting publication of children's books and schoolbooks, as well as religious texts in the "little Russian dialect", that is, in Ukrainian language. In 1876, after a report that an enthusiast translated into Ukrainian and distributed among peasants a novel "Taras Bulba" written in Russian by Nikolai Gogol, a writer born in Ukraine, the government decree banned publication and import of all books in Ukrainian language except reprinting of old documents. It also prohibited staging plays and performing public lectures in Ukrainian or teaching in Ukrainian at elementary schools.

After the 1917 revolution Ukraine experienced a strong national uprising. The nine predominantly Ukrainian provinces declared an independent Ukrainian state in January 1918. However, already in February 1918 Ukraine was occupied by the Germans. After the German forces retreated, the chaos and disintegration of the Civil war, and a brief Polish occupation, Ukraine (Ukrainian Soviet Socialistic Republic) became one of the founding republics of the newly created Soviet Union signing the Union Treaty on December 30, 1922.

The newly formed Soviet state was still relatively weak and to a large extent owed its creation to the Lenin's principle of "self-determination" – the national republics were nominally free to leave the Union if they so wished. In line with the above principle, during the 1920s the government promoted a policy of *indigenization*[10]. Indigenous population was encouraged to take part in managing the local affairs, schools started teaching in local languages, and publication of books in

[10] Russian: *korennizatsia*. The translation of the term is by Graziosi (2015).

non-Russian languages surged. According to Graziosi (2015), by 1931 77% of all books published in Ukraine were published in Ukrainian language.

However, by the late 1920s and early 1930s the *indigenization* policy was gradually reversed. According to Graziosi (2015), on December 14 and 15, 1932 the Politburo issued two secret decrees reversing the official nationality policies in Ukraine. On December 19 a similar decree stopped *indigenization* policies in Belarus. This marked the beginning of prosecution of Ukrainian intelligentsia, transitioning of Ukrainian schools into teaching in Russian, and a general subordination of Ukrainian language as a second-rank language. The Russification of Ukraine continued well after Stalin's death – students in schools had the right to learn in Russian or Ukrainian (and many parents opted for Russian as a more "useful" language), and most of the technical universities in Ukraine taught in Russian language only.

1.3 Data

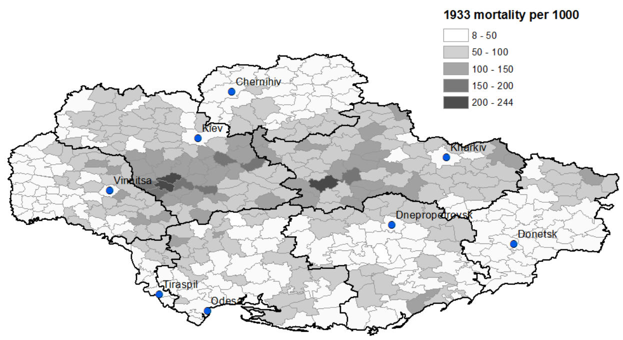
I use three main data sources: famine mortality statistics from the Russian State Archive of the Economy (RSAE) in Moscow, pre-famine data on economic development from published statistical books gathered in Kiev and Kharkiv libraries, and data from the 1927 Soviet census[11]. Table A.2 shows the exact source of each variable used.

I collected 1933 district mortality data in the Russian State Archive of the Economy (RSAE). These data have been recently discovered by Stephen Wheatcroft in a secret part of TsUNKhU[12] archives. Wheatcroft and Garnaut (2013) explain that, possibly due to unbelievably high province level mortality figures, TsUNKhU demographers in Moscow requested district level data from province statisticians. Consequently, very fine disaggregated data survived in the Russian State

[11] The exact date of census is December 17, 1926. As all other Soviet censuses were run in Januaries I label this as 1927 census.

[12] Central Administration of Economic Accounting of Gosplan; Russian: Tsentral'noye upravleniye narodnokhozyaystvennogo ucheta Gosplana SSSR (TsUNKhU).

Figure 1.2: Mortality 1933



Mortality 1933 is a number of deaths per average 1933 population multiplied by 1000. *Source:* RSAE 1562/329/18. Thick lines are 1933 province borders.

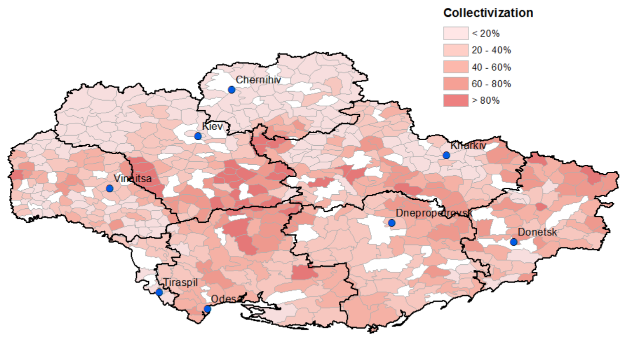
Archive of the Economy. Wheatcroft (2013) provides more information on demographic data in Russian archives and argues that the data were of very high quality.

The 1933 district level demographic data include: average population in 1933, number of deaths, births, and deaths of children younger than 1 year, and number of marriages and divorces. For Ukraine there are two slightly different versions of demographic data: the first includes in death figures only residents of the area, and the second adds all the dead with unknown residence to the rural area of the district where they died[13]. I use the first version (RSAE 1562/329/18, pp 1-16), as the correlation between the two versions is 0.995[14]. I calculate mortality as the number of deaths divided by the average population and natality as the number of live births divided by the average population. Figure 1.2 plots mortality rates on 1933 Ukrainian map.

The 1930 district level collectivization data come published sources. In late 1930 the disastrous famine was not yet anticipated, and many state organizations celebrated and advertised collectivization. In particular, a lot of information on collectivization and collective farms was published. As a primary source of collectivization data, I use Gosplan SSSR. Upravleniye narodnokhozyaystvennogo ucheta (1931), a comprehensive publication covering the whole Soviet Union. From this source I also collect data on the average number of households in collective

[13]See comment in RSAE 1562/329/18, pp 77-80
[14]Estimates using the second version of mortality rates are available upon request.

Figure 1.3: Collectivization 1930



Collectivization rate is share of rural households in collective farms. *Source:* Gosplan SSSR. Upravleniye narodnokhozyaystvennogo ucheta (1931).

farms and information on whether a district had a machine-tractor station, that is, whether a district had access to some modern equipment. Two additional publications list collectivization rates for Ukrainian districts only (Derzhavna Planova Komisiya USRR. Ekonomychno–statystychnyy sektor (1930a) and Derzhavna Planova Komisiya USRR. Ekonomychno–statystychnyy sektor (1930b)) and I use these data for robustness checks. Unfortunately, although I have data for all districts, I don't have the exact 1930 administrative map (see the discussion of administrative borders in the Section 1.3.1 below). I omit districts for which I don't know the exact boundaries. Figure 1.3 shows collectivization rate for districts with known borders.

Pre-famine characteristics also come from published sources. 1920's were years of rapid advancement of Soviet statistics. The brightest and most qualified economists worked for the Soviet statistical institutions (Nikolai Kondratiev, Alexander Chayanov, Lev Litoshenko), and large amount of statistical data were collected and published. In 1926 Central Statistical Office of Ukraine published a series of books describing districts in all okrugs[15] of Ukraine: "Materials to describe Ukrainian okrugs". I have collected 39 out of 41 of these books in Ukrainian libraries in Kharkiv and Kiev. The *okrug* books present extremely detailed district level data on agriculture, manufacture, and public services.

[15] At the time Ukraine was divided into 41 okrugs that were in turn divided into approximately 600 districts. More details on administrative division of Ukraine are in section 1.3.1 below.

From *okrug* books I use data on agriculture: amount of arable land, sown area and yield of various crops, livestock, and agricultural implements. Importantly, these books report *actual* 1925 sown area by crop, but only *normal* yield – not the actual yield observed in 1925, but the usual average yield. I multiply the actual sown area by normal yield to obtain estimated 1925 production. I also collect number of the rural soviets[16], agricultural cooperatives, collective farms in 1925, and other variables (full list presented in Table A.2).

Data on urbanization, literacy, and national composition come from the 1927 census. This was the most detailed census ever published in the Soviet Union. Figures 1.4a, 1.4b, 1.4c, 1.4d display distribution of correspondingly rural ethnic Ukrainians, Russians, Germans, and Jews within Ukraine.

Combining all the above sources, I constructed a cross-section of 280 districts grouped into 8 provinces according to 1933 administrative division. For this cross-section I have data on 1933 mortality and pre-famine district characteristics. Table 1.1 shows summary statistics of the main variables.

In addition, I collected 1927 and 1928 mortality data from the Ukrainian statistical yearbooks published in 1928 and 1929 respectively. These data are more aggregated, only *okrug*-level figures are available. I calculate all variables in 1927 okrug borders to construct a short panel of 1927, 1928, and 1933 mortality in 41 okrugs, and okrug characteristics.

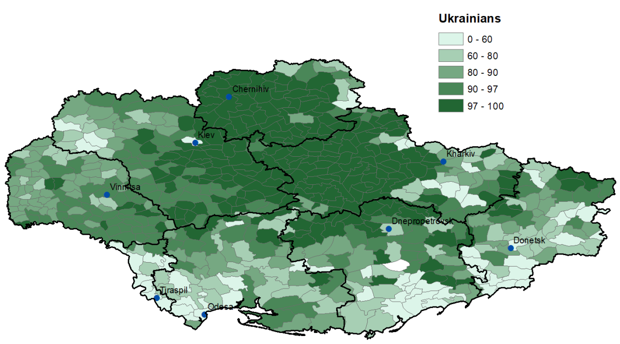
1.3.1 Maps and administrative division

The administrative division of Ukraine was constantly changing at the time. After all, the Bolsheviks were building a new society, and, among other things, they were looking for the best administrative division. Before the 1917 revolution a two-step administrative division was in place:

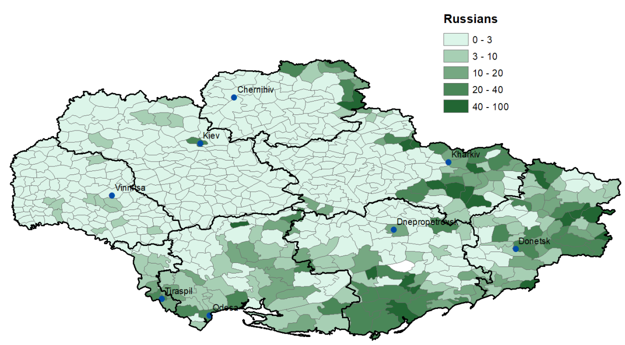
[16]Rural soviet (rural council) was the lowest administrative unit subordinate to the district administration. There was usually one soviet per a couple of villages. According to Lewin (1968), soviets played a minor role in governing the countryside during the 1920s but were an important source of information about local affairs for the government officials.

Figure 1.4: Ethnic composition

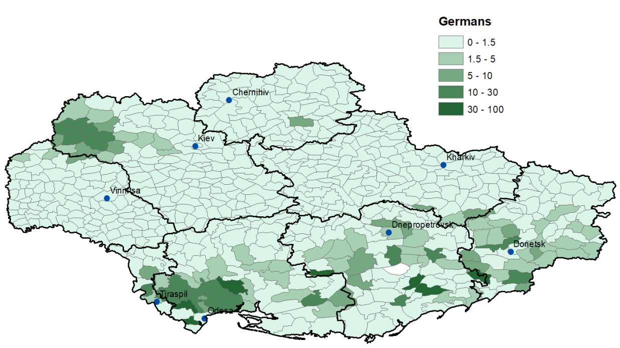
(a) Ukrainians



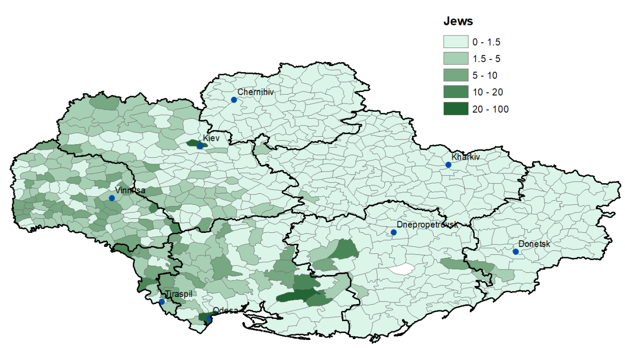
(b) Russians



(c) Germans



(d) Jews



Source: Tsentral'noye Statisticheskoye Upravleniye SSSR. Otdel perepisi (1929).

Table 1.1: Summary statistics of the main variables used

	Observations	Mean	Standard deviation	Min	Max
Mortality 1933	280	0.063	0.035	0.011	0.175
Natality 1933	280	0.015	0.006	0.004	0.032
Ethnic composition					
Ukrainians 1927	280	0.844	0.171	0.068	0.995
Russians 1927	280	0.051	0.081	0.002	0.503
Germans 1927	280	0.031	0.093	0.000	0.869
Jews 1927	280	0.019	0.023	0.000	0.158
Other ethnicities 1927	280	0.054	0.095	0.001	0.658
Baseline controls					
Wheat and rye harvest per capita 1925, c	280	3.834	2.002	0.655	11.095
Sown area of potato per capita 1925, ha	280	0.034	0.017	0.002	0.080
Livestock per capita 1925	280	0.480	0.128	0.201	0.895
Value of agricultural equipment pc 1925, 100s rub	280	0.073	0.039	0.022	0.205
Urbanization 1927	280	0.115	0.134	0.000	0.877
Rural literacy rate 1927	280	0.406	0.075	0.230	0.684
Rural population density 1927, 100s per km^2	280	0.232	0.089	0.077	0.544
Polissia region indicator	280	0.136	0.343	0.000	1.000
Policy controls					
Collectivization 1930	280	0.366	0.203	0.028	0.904
HH per collective farm 1930	280	0.934	0.621	0.224	4.741
Ln(distance to a railroad)	280	2.042	1.268	-3.575	4.359
Group A factories per 1000, 1930	280	0.017	0.030	0.000	0.207
Group A workers per capita 1930	280	0.007	0.031	0.000	0.249

Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used.

the Russian Empire was divided into gubernias and then into uyezdy; the 1933 Ukraine occupied the territory of approximately ten of these gubernias and some hundred uyezdy. In 1925 – 1930 a 3-step division was used: there were 4-5 regions (Polissia, Left Bank, Right Bank, Steppe, and sometimes Donbass separately), regions were then divided into 41 okrugs, and then okrugs were further divided into approximately 600 districts. On September 15, 1930 the 3-step division was abandoned, some districts were merged or dissolved, and till late 1931 502 modified districts were governed directly from Kharkiv, the capital of Ukraine at the time. Finally, at the end of 1931 a 2-step administrative division was introduced: Ukraine was divided into provinces and then into districts. By the end of 1933 there were 7 provinces plus the Autonomous Republic of Moldova divided into 392 districts.

This is important for three reasons. First, I only have the 1925, 1927, and 1933 administrative maps. As I was not able to obtain the 1930 map, I constructed wherever possible 1930 district borders from 1927 districts map using the decree of September 15, 1930 that abandoned okrugs and modified districts (Ofitsiyne vydannya Narodnoho Komysariyatu Yustytsiyi, 1930). I merged districts that were merged according to the decree. Unfortunately, some districts were dissolved among the neighboring 3 or 4 districts, so I don't know the new 1930 borders and don't use these districts in my estimates.

Second, I have to bring the 1925, 1927, 1930 and 1933 data into common administrative borders. I assume that all variables I use are distributed uniformly over corresponding territories and recalculate all data in 1933 administrative borders. This is a standard assumption made in the literature; recent works using this assumption include Alesina et al. (2013) and Hornbeck and Naidu (2014). As the number of districts was gradually decreasing (from 625 in 1927 to 392 in 1933), 1933 district borders is the most conservative choice.

And third, some data are only available in a more aggregated form. For example, 1927 and 1928 mortality rates are only available for regions (41 regions in Ukraine at the time), not for smaller districts. Therefore, when I want to include these data in my estimates, I calculate everything in the administrative borders corresponding to the most aggregated variable used, relying again on the assumption that every variable used is distributed uniformly across its corresponding territory. This procedure is legitimate because I always aggregate up, never create more observations than is actually available from the sources.

1.4 Results

This section presents the empirical results. First, Section 1.4.1 investigates to what extent drop in production in 1931 and 1932 can be attributed to the weather. Next, Section 1.4.2 studies famine-specific policies in detail and demonstrates their contribution to 1933 mortality. Then Section 1.4.3 investigates the relationship between ethnic composition and mortality. Finally, Sections 1.4.3 and 1.4.3 analyze how exposure to and enforcement of the government policies varied with ethnic composition. The Appendix presents additional robustness checks.

1.4.1 Weather and famine accounting

Multiple sources report severe negative weather shocks that reduced the harvest in 1931 and 1932 in Volga region of Russia and in Ukraine. Davies and Wheatcroft (2009) explain that the spring of 1931 was late and cold, and that there was a severe drought in June of 1931. They also report that in 1932 spring was late and cold again, and June was too hot, although severe drought did not repeat itself. It would be interesting to measure the intensity of the weather shock in Ukraine.

Figure 1.5 plots demeaned temperature and precipitation during 1920 – 1940 for the months of April, May, June, and July. Figure 1.5a demonstrates that, consistent with the reports of cold and late spring, April 1931 was colder than the average. However, April 1929 was even worse, and no significant disaster was reported. And figure 1.5b shows that May 1931 was slightly warmer than the average. According to figure 1.5c, June 1931 temperature was very close to the average June temperature, in direct contradiction with the reports of a severe heat and drought. And although

June 1931 precipitation was slightly below average, in 1924, 1934, and 1935 the rainfall was much lower without resulting in a national-scale disaster. Finally, Figure 1.5d shows that July 1931 was warmer than average, but there was a normal amount of rainfall; and again, there were years when July temperature was much higher (for example, 1936 and 1938) but no large-scale famine followed. In addition, July temperature is less important for grain production than June temperature since winter grain begin being harvested in July.

Similarly, April 1932 temperature was below average, although higher than April temperature in 1931. Thus, consistent with the historical reports, spring of 1932 was relatively late and cold. However, June and July temperature in 1932 were very close to the average, and June precipitation was much higher than average in 1932. This again directly contradicts the reports of hot and dry summer of 1932. To conclude, raw weather data do not appear to confirm the reports of severe negative weather shocks of 1931 and 1932.

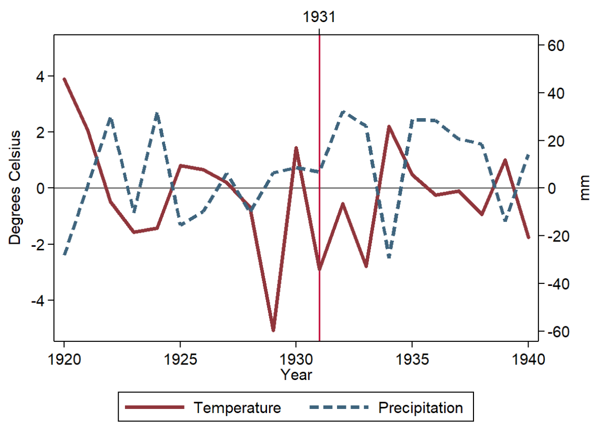
One might argue that Ukrainian temperature and precipitation might not reflect the severity of the drought if only a small share of the territory of Ukraine was affected by the disaster. In that case, June temperature and precipitation would be close to normal and would not reflect the extent of the disaster. However, if only a small area was affected, then the impact on total harvest should have been small as well. And if much of the Ukrainian territory suffered from the drought, this should have been reflected in the temperature and precipitation figures.

Another concern is that monthly temperature and precipitation figures might be too aggregated and might not reflect poor weather. For example, if half of June was extremely hot and dry, and another half was very cold and rainy, then the reported June temperature might look normal. Unfortunately, I do not have disaggregated daily weather data to address this concern directly. However, it would be demonstrated below that monthly (and even seasonal) temperature and precipitation figures predict harvest extremely well. If monthly weather data were averaging out severe weather shocks, these data would not have been able to predict harvest so well.

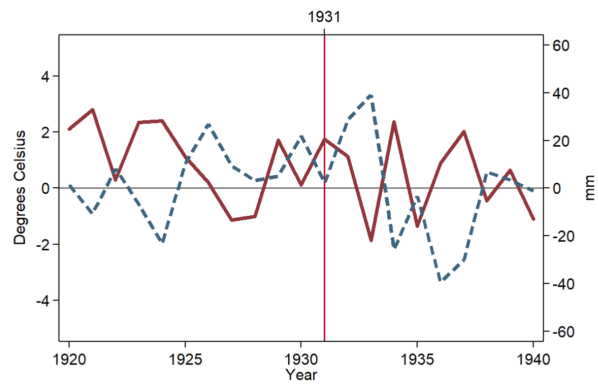
Finally, one more concern is that although specific temperature and precipitation figures do not

Figure 1.5: Demeaned temperature and precipitation in Ukraine

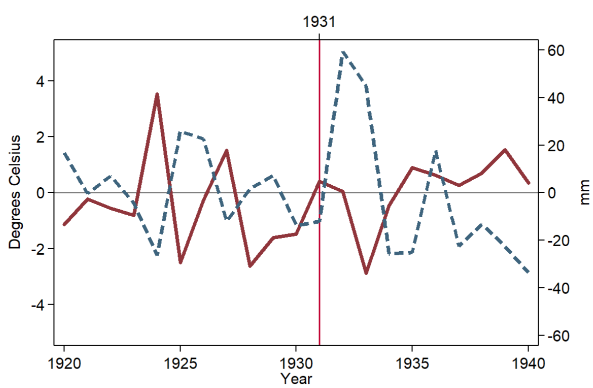
(a) April



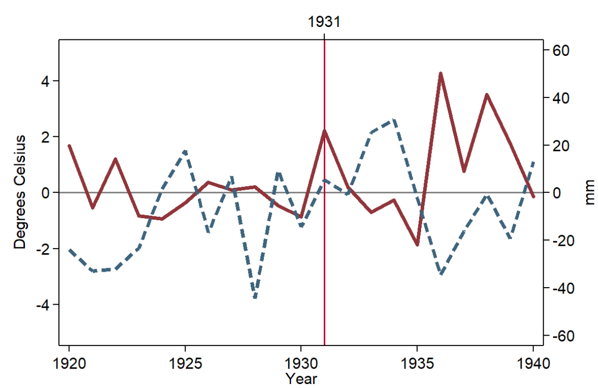
(b) May



(c) June



(d) July



Source: Terrestrial Air Temperature and Precipitation: 1900–2014 Gridded Monthly Time Series, Version 4.01, Matsuura and Willmott (2014). Demeaned temperature (precipitation) is the difference between the reported temperature (precipitation) and the average temperature (precipitation) during 1900-1970.

look too extreme, maybe their combination in 1931 and 1932 was particularly unfavorable for grain cultivation. To address this, instead of analyzing raw temperature and precipitation figures, a better way to measure how favorable or unfavorable the weather was, is to estimate grain production function and to predict how much grain there should have been produced in Ukraine in 1931 and 1932 if no reforms affecting rural economy have taken place, and only weather has changed relative to the previous years.

According to Kabanov (1975), a handbook for agronomists on grain cultivation in the Volga region in Russia[17], where agroclimatic conditions are similar to the ones in Ukraine, many conditions should be met to achieve good harvest: there should be enough precipitation during the previous fall to allow land to accumulate moisture in the deep layers of soil. But not too much, otherwise winter sowing might be delayed. Winter should not start too late or too early, and there should be enough snow to protect winter crops and again to provide moisture for the land in the spring. Spring should not start too late and should not be too cold. But too early and too hot spring is also undesirable. There should be some rainfall in spring and early summer, but not too much. The optimal temperature in the summer should be between 25 and 30 degrees Celsius[18], and prolonged periods of heat above 30 degrees are very detrimental.

To estimate grain production function, I use data on harvests during 1901 – 1915 in 50 European provinces of Russian Empire. Using the information from Kabanov (1975), I regress log of grain harvest produced in province p and year t on the following production inputs: log province area, wheat suitability, interaction of log province area and wheat suitability, fall, winter, spring, and summer temperature and precipitation, their squared terms and double interactions of temperature and precipitation. I do not include a constant in the production function regression. The resulting production function regression has an adjusted R-squared of 0.999, that is, the input

[17] Volgra region, as well as Ukraine, were considered "grain surplus" areas of the Soviet Union.
[18] 77 to 86 degrees Fahrenheit.

variables explain 99.9% of the variation in output[19,20]. To preserve space, and also because the large number of inputs makes interpretation of coefficients difficult, I do not report the estimated production function.

I use the estimated production function to predict aggregate harvest in Ukraine during 1924 – 1935. Figure 1.6 plots reported harvest and predicted harvest with its 95% confidence interval (the exact reported and estimated harvest figures are presented in Table 1.2). Three important takeaways can be made. First, starting in 1926 reported harvest is very close to predicted harvest. Thus, it appears that by mid-1920s Ukrainian agriculture recovered from the shocks of World War I, the 1917 revolution, the Civil War, and the famine of 1921–1922. Second, predicted harvest in 1931 and 1932 is very close to the 1925 – 1929 average. Thus, if the government did not intervene, changing the production function in 1930, there would have been no significant drop in harvest in 1931 or 1932. And third, reported 1931 and 1932 harvest is very close to predicted harvest. It appears that Soviet statisticians took weather into account when calculating harvest estimates.

The estimated grain production function is fairly robust to data manipulation by the Communist government. It is estimated using pre-Communist era data. Area of Ukraine is calculated by the author using 1933 administrative map of Ukraine. There are no reports that Soviet adminis-

[19] I do not include rural population in the production function. There is still a debate on whether there was labor surplus in Russian agriculture. Robert Allen documents that Russian yields per hectare were comparable to or even better than yields in the Great Plains and Canadian Prairies, where agroclimatic conditions were similar, but eight times more labor per hectare was employed (Allen, 2003, Chapter 4). He argues that most of this labor was underutilized. On the other hand, Dower and Markevich (2016) study mobilization during World War I and argue that there was no labor surplus in the village, finding that "the removal of one percent of the labor force decreases a district's grain-cropped area by around three percent". However, since the production function regression has an adjusted R-squared of 0.999 I conclude that during 1901 – 1915 there was enough agricultural labor and other inputs explain variation in output. The population of Ukraine appears to have survived the shocks of World War I, the 1917 revolution, the Civil War, and the famine of 1921-1922: according to 1927 census rural population of Ukraine was 24 million, compared to only 18 million in 1897. It is possible that after the onset of rapid industrialization campaign in 1928 rural population migrated to the cities creating labor shortages in the village. Available data, however, indicate that rural population of Ukraine was growing until 1932, although its growth was slower than growth of urban population. Finally, on December 27, 1932 Soviet Government introduced passport system designed to restrict population mobility. Individuals without passports could not legally live or work in urban areas, and peasants were not eligible to receive passports. I conclude that until the shock of the 1933 famine there must have been enough agricultural labor and other factors determined the variation in output.

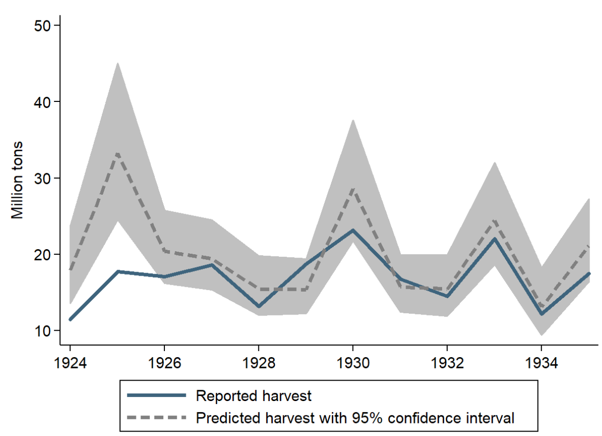
[20] When levels are used instead of logs the adjusted R-squared is only 0.855. I conclude that production function with logs of area and output captures the functional form of the relationship between inputs and output better.

Table 1.2: Reported and predicted harvest in Ukraine

Year	Reported harvest, mln t (1)	Predicted harvest, mln t (2)
1924	11.5	18.0 [13.6, 23.7]
1925	17.8	33.3 [24.6, 45.1]
1926	17.1	20.4 [16.2, 25.7]
1927	18.6	19.4 [15.4, 24.5]
1928	13.2	15.5 [12.1, 19.8]
1929	18.7	15.4 [12.2, 19.4]
1930	23.2	28.6 [21.8, 37.6]
1931	16.8	15.8 [12.4, 20.0]
1932	14.5	15.5 [12.0, 20.0]
1933	22.0	24.5 [18.7, 32.1]
1934	12.2	13.1 [9.4, 18.2]
1935	17.5	21.2 [16.4, 27.3]

Column (1) presents reported harvest. *Source:* see notes to Table 1.3. Column (2) presents predicted harvest calculated by the author. 95% confidence interval is reported in brackets. See section 1.4.1 for details.

Figure 1.6: Reported and predicted harvest in Ukraine



Sources: Reported harvest: see notes to Table 1.3. Predicted harvest: calculated by the author. See Table 1.2 for the exact figures.

trative maps at the time overstated or understated the Ukrainian territory. Wheat suitability index is time-invariant and is constructed by the Agro-Ecological Zones (GAEZ) model developed by the Food and Agricultural Organization (FAO). The only data from the famine period are weather data. Matsuura and Willmott (2014) integrate archival weather stations data and report monthly temperature and precipitation figures for 0.5-degree latitude by 0.5-degree longitude global grid. There are no indications that the Soviet government manipulated weather stations data. Therefore, predicted harvest figures must be close to the harvest that would have been produced if production function did not change, that is, if the government did not introduce changes in economic policies associated with the first five-year plan.

Although reported harvest is very close to predicted harvest, there is a reason to believe that the actual 1931 and 1932 harvest was lower than reported. Davies and Wheatcroft (2009) explain that in agricultural economies most of the grain is consumed in the countryside and never enters the market, and therefore measuring the actual harvest is extremely difficult. They argue that 1932 harvest must have been much lower than the 1931 harvest (Davies and Wheatcroft, 2009, p. 442). Collective farms were required to submit reports on their operations, and these reports, among other data, included yield figures on collective farm fields. Yields reported by collective farms were much lower than the total average yields reported by the government[21].

Yields reported by collective farms should be taken with a grain of salt. Collective farm chairmen probably had incentives to understate yields to reduce grain collections by the government. On the other hand, the government preferred putting outsiders in charge of collective farms, not people from the village. These chairmen might have had more incentives to carry out government orders than to protect their fellow villagers. In addition, collective farm chairmen were punished

[21] To construct harvest estimates in time for grain collections government statisticians had to rely on weather reports and on a few reports from sampled fields. Submitting and processing collective farm reports required considerable time. For example, a summary report on the state of collective farms during 1930–1931 was only constructed in 1934. My 1932 harvest data are from a document constructed in 1944 (see notes to Table 1.3), so statisticians must have had enough time to correct harvest estimates. However, by that time any mentioning of the famine was dangerous and therefore government statisticians might have had no incentives to construct more realistic harvest figures.

for the low performance and therefore could have had incentives to overstate yields. Finally, only 47.3% collective farms submitted the reports on their operations in 1932. Presumably, these were the better organized ones, and the situation on the non-reporting farms might have been even worse. Overall, although it is difficult to assess the degree of misreporting of collective farms yields, these data deserve serious consideration.

Table 1.3 presents aggregate harvest, total yield reported by the government, yield reported by collective farms, grain collections, and rural food availability. Column (1) shows total harvest in Ukraine reported by the government during 1924 – 1934. Column (2) presents total yield (harvest divided by sown area) reported by the government. Column (3) displays yields reported by collective farms during 1931 – 1933. Column (4) calculates yields individual peasants must have had during 1931 – 1933 to achieve total yields as reported in Column (2). To calculate individual peasants' yields I assume that sown area was divided in proportion with collectivization rate[22,23]. Figure 1.7 plots reported total yields, reported collective farms yields, and calculated individual peasants' yields. The calculated individual yields are unrealistically high. In particular, individual peasants must have produced 15.1 centners per hectare in 1932, and 18.3 centners per hectare in 1933 for reported total yields to be correct. Reported yield was never higher than 14 centners per hectare before World War II. Therefore, I conclude that reported total yield and reported total harvest must have been exaggerated and the true harvest and yield were lower during 1931 – 1933.

The true harvest figures are impossible to recover, but some corrections are feasible. Since reported harvest is very close to the harvest predicted by the weather, reported total yields must have been close to the yields that would have been achieved if production function did not change.

[22]Collectivization rate was 33.1% on January 1, 1931; 69.2% on January 1, 1932; 69.5% on January 1, 1933 (Davies and Wheatcroft, 2009, Table 27).

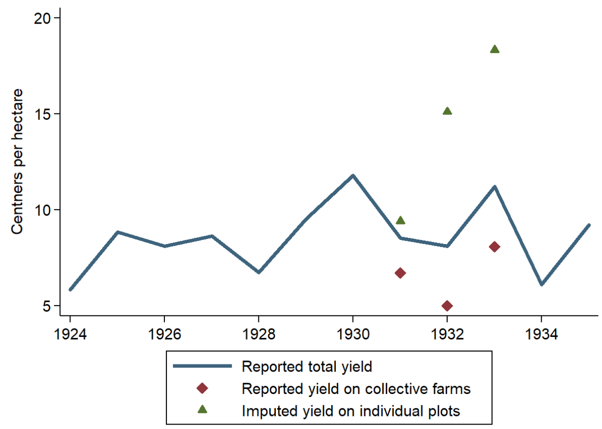
[23]According to historical accounts, land was divided roughly in proportion with collectivization rate, although collective farms usually received the best land. Below Section 1.4.2, Table 1.12 demonstrates that in 1930 collective farms had slightly more land per capita than individual peasants. Collective farms were under pressure from the government to maintain high sown areas while less control was imposed on individual peasants. The assumption that sown area was divided in proportion to collectivization rate is against individual peasants' yields and in favor of collective farms yields. If the actual individual peasants' sown area was smaller, then they must have had even higher yields to achieve reported average total yields.

Table 1.3: Aggregate harvest, yield, and procurement in Ukraine

Year	Reported harvest, mln t (1)	Reported total yield, c/ha (2)	Collective farms yield, c/ha (3)	Individual peasants yield, c/ha (4)	Corrected harvest, mln t (5)	Grain collections, mln t (6)	Rural food availability, mln t: Reported (7) (1) – (6)	Rural food availability, mln t: Corrected (8) (5) – (6)
1924	11.5	5.8				0.9	10.5	
1925	17.8	8.8				2.7	15.1	
1926	17.1	8.1				3.1	13.9	
1927	18.6	8.6				4.3	14.4	
1928	13.2	6.7				1.8	11.4	
1929	18.7	9.5				5.3	13.4	
1930	23.2	11.8				7.7	15.5	
1931	16.8	8.5	6.7	9.4	15.6	7.3	9.5	8.3
1932	14.5	8.1	5.1	15.1	10.7	4.2	10.3	6.4
1933	22.0	11.2	8.1	18.3	17.7	6.1	15.9	11.6
1934	12.2	6.1						

Sources: (1) Reported harvest: 1924–1927 figures are from (Publishing house Narkomtorg USSR and the RSFSR , Izdatel'stvo Narkomtorga SSSR i RSFSR, Table 136); 1928 figure is from (Tsentralna Statystychna Uprava USRR, 1929); 1929–1931 figures calculated using amount of procured grain from SNABTEHIZDAT (1932) and share of procured harvest from Statistical tables of indicators for the implementation of the First Five-Year Plan for the Development of Agriculture (Statisticheskiye tablitsy pokazateley vypolneniya I pyatiletnego plana razvitiya sel'skogo khozyaystva), RSAE 4372/30/871, page 30; 1932–1935 figures are from Tables of the dynamic series of the Central Statistical Board of the USSR data on sown areas, yields and total yields of all cereal crops (for all categories of farms) in the USSR, the RSFSR and the economic regions for 1913, 1928, 1932 - 1944 (Tablitsy dinamicheskikh ryadov TSSU SSSR dannykh o posevnykh ploshchadyakh, urozhaynosti i obshchikh razmerakh urozhaya vsekh zernovykh kul'tur (po vsem kategoriyam khozyaystv) v tselom po SSSR, RSFSR i ekonomicheskim rayonam za 1913, 1928, 1932 - 1944 gg.), RSAE 1562/329/1409. (2) Reported total yield is reported harvest divided by sown area; sown area 1925 – 1928 figures are from (Tsentralna Statystychna Uprava USRR, 1929); sown area 1932 – 1935 figures are from RSAE 1562/329/1409; sown area 1924 and 1929 – 1931 are imputed as average of sown area in 1925 – 1928 and 1932 – 1935. (3) Collective farms yield: 1931 figure is from Dinamika kolkhozov za 1930 – 1932 g.g., RSAE 1562/76/158 page 41; 1932 – 1933 figures are from Dinamika khozyaystvennogo sostoyaniya kolkhozov za 1932 i 1933 g., RSAE 1562/77/70 page 39. (4) Individual peasants yield: calculated by the author using (2) and (3) and assuming that sown area is divided in proportion to collectivization rate. Collectivization rate is from (Davies and Wheatcroft, 2009, Table 27). (5) Corrected harvest: calculated by the author assuming individual peasants had yield as in (2), and collective farms had yield as in (3). (6) Grain collections: 1924 – 1926 figures are from Publishing house Narkomtorg USSR and the RSFSR (Izdatel'stvo Narkomtorga SSSR i RSFSR); 1927 figure is from Tsentralna Statystychna Uprava USRR (1929); 1928 figure is calculated using (1) and the share of procured harvest from Statistical tables of indicators for the implementation of the First Five-Year Plan for the Development of Agriculture (Statisticheskiye tablitsy pokazateley vypolneniya I pyatiletnego plana razvitiya sel'skogo khozyaystva), RSAE 4372/30/871, page 30; 1929 – 1933 figures are from SNABTEHIZDAT (1932). (7) Reported rural food availability is a difference between reported harvest (1) and grain collections (6). (8) Corrected rural food availability is a difference between corrected harvest (5) and grain collections (6).

Figure 1.7: Yield



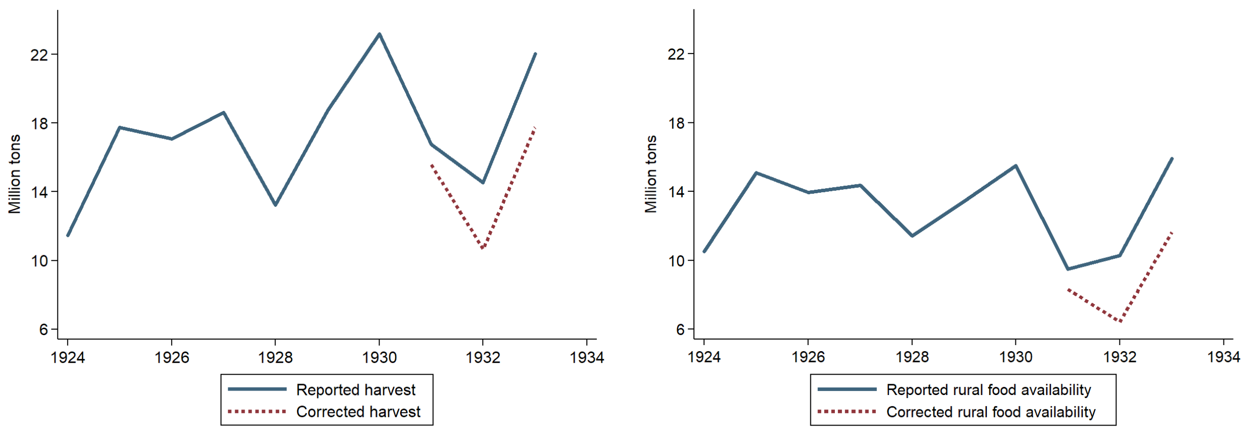
Sources: see notes to Table 1.3. See section 1.4.1 for details.

Therefore, the simplest way to correct reported harvest figures is to assume that sown area was divided in proportion with collectivization rate and that individual peasants had yields equal to reported total yields (consistent with the weather), and that collective farms had yields as reported by collective farms. Table 1.3 Column (5) presents corrected harvest for the years of 1931 – 1933, and Figure 1.8a plots reported and corrected harvest. This correction is the most optimistic for the harvest. If individual peasants had less than proportional share of sown area, or achieved lower than reported total yields (for example, because as a rule they were allocated worse land), then the true harvest would have been even lower than corrected harvest. However, even this optimistically corrected harvest is 37% lower than the 1925–1929 average.

Table 1.3 Column (6) reports grain collected by the government. In 1932 the government reduced grain collections by 44% relative to 1930 and 1931 levels, from more than 7 million tons to 4.2 million tons. Column (7) presents reported rural food availability – reported harvest minus grain collections. Because grain collections were lower in 1932, reported rural food availability in 1932 is higher than in 1931. Moreover, reported food availability in 1932 (10.3 million tons) is only slightly lower than average rural food available during 1925 – 1929 (13.1 million tons). This is inconsistent with the fact that the peak of the famine occurred after the 1932 harvest. Since grain

Figure 1.8: Harvest and rural food availability

(a) Harvest (b) Rural food availability



Sources: see notes to Table 1.3. See section 1.4.1 for details.

collections are well documented, the true 1932 harvest must have been lower than reported harvest. Column (8) shows corrected rural food availability – corrected harvest minus grain collections. For illustration, Figure 1.8b plots reported and corrected rural food availability. Corrected rural food availability in 1932 is 53% lower than the 1925–1929 average.

To conclude, this section demonstrates that there was no significant drop in harvest due to the negative weather shocks of 1931 and 1932: if production function did not change, then 1931 and 1932 harvests would have been roughly equal to the 1925–1929 average in Ukraine. However, using collective farms reports, it demonstrates that the actual harvest must have been much lower in 1931 and 1932 than the harvest predicted by the weather and reported by the government. Therefore, other explanations of the famine (economic policies and genocide) are worth exploring.

1.4.2 Policies

This section studies famine-specific policies. Motivated by the historical accounts summarized in Section 1.2, I start with studying the three following policy measures. First, to examine the impact of government policies on agricultural productivity and ultimately on mortality, I consider the collectivization rate, that is, the share of rural households in collective farms in 1930 (the last year disaggregated data are available for). Next, to investigate the impact of grain collections on mortality, I study how district mortality rates varied with the distance to a railroad. Presumably, the closer a district was to a railroad, the cheaper it was to extract grain from it. And third, to investigate how food distribution impacted mortality I study the relationship between the number of workers employed in so-called Group A industries and mortality (Group A were industries producing means of production, e.g. coal mining, as opposed to Group B industries producing consumer goods). Producing means of production was important for industrialization and implementation of the first five-year plan, and therefore factories and establishments belonging to these industries had a higher chance of being placed in a higher priority supply list.

This section documents that both collectivization and the lack of favored industries increased mortality. It also studies the mechanism through which collectivization increased mortality. Using aggregate data, it demonstrates that, although higher share of harvest was extracted from collectives, in per capita terms collective farm members delivered less grain to the government than individual peasants. It also shows that districts with larger collective farms experienced higher mortality, and that, consistent with historical accounts, collectivization led to a drop in livestock and sown area.

Since all policy measures (collectivization rate, number of Group A workers per capita, distance to a railroad) were not exogenously determined, before studying their impact on mortality, I investigate how district characteristics varied with the intensity of the policies. First, I indicate districts that had collectivization rate above the median and regress all available district characteristics on this indicator, value of agricultural equipment per capita in 1925, livestock per capita in 1925, Polissia region indicator[24], and province fixed effects[25]. The value of agricultural equipment per capita and livestock per capita should capture district's wealth and economic development level, and Polissia region indicator marks an agroclimatic zone significantly different from the rest of the Ukrainian territory. Table 1.4 Column (1) reports the coefficients of the collectivization above the median dummy. All but one coefficient are small and not statistically significant, and the only statistically significant difference is in the number of horses per capita. Although significant, the magnitude of the difference is very small: districts with collectivization above the median had on average 0.013 more horses per capita, while on average districts had 0.187 horses per capita. Thus, the assumption that conditional on livestock, agricultural equipment, Polissia indicator, and province fixed effects collectivization rate was as good as random is likely satisfied.

Next, I do the same with food distribution: I mark districts that had more than median number of Group A workers per capita, and regress each district characteristic on this indicator and on livestock per capita, value of agricultural equipment per capita, Polissia region indicator, and province fixed effects. Table 1.4 Column (2) reports the "Group A workers per capita is above the median" dummy coefficients. Districts with more Group A industry had lower rural population density and higher urbanization rates. This difference should have been expected – more urbanized and industrially developed areas have higher probability of having an industry producing means of production. To account for these differences, in all subsequent estimates I control for urbanization

[24] As reported by the documents, Soviet territory was divided into three groups according to collectivization priority: group 1 was to be collectivized as soon as possible, group 2 next, and group 3 the last. Whole Ukraine was in group 1, except the northern region of Polissia (some 12% of the territory of Ukraine, 10% of the population) was in group 2 (Danilov et al., 1999, volume 2, pp 570–575). Therefore, there was less pressure on Polissia districts to form collective farms.

[25] To be precise, for each district characteristic x_d I estimate the following equation:

$$x_d = \alpha_p + \beta\mathbb{I}[z_d > median] + \gamma livestock_d + \delta equipment_d + \theta polissia_d + \epsilon_d$$

where d stands for district, p – province, α_p – province fixed effect, z_d – policy intensity measure (collectivization rate, number of Group A workers per capita, or log distance to a railroad), $\mathbb{I}[z_d > median]$ indicates if the value of policy intensity measure is above the median, $livestock_d$ is district's livestock per capita in 1925, $equipment_d$ – value of agricultural equipment per capita in district d in 1925, $polissia_d$ – Polissia region indicator, and ϵ_d is an error term. Table 1.4 reports β coefficients for each policy z_d (Column (1) for collectivization rate, Column (2) – number of Group A workers per capita, Column (3) – log distance to a railroad), and for each district characteristic x_d.

Table 1.4: District characteristics by collectivization rate. Comparison of residuals conditional on value of agricultural equipment per capita, livestock per capita, polissia region indicator, and province fixed effects

	Collectivization 1930 (1)	Group A workers pc 1930 (2)	Ln(distance to a railroad) (3)
Rural characteristics:			
Rural literacy rate 1927	0.003	-0.001	-0.005
	(0.008)	(0.006)	(0.007)
Cows per capita 1925	-0.000	-0.002	-0.002
	(0.003)	(0.003)	(0.003)
Horses per capita 1925	0.013**	-0.007	-0.000
	(0.006)	(0.005)	(0.005)
Arable land per capita 1925, ha	0.065	-0.050	0.069*
	(0.050)	(0.038)	(0.037)
Sown area of grain per capita 1925, ha	0.008	-0.029	0.069***
	(0.026)	(0.018)	(0.018)
Sown area of potato per capita 1925, ha	-0.001	-0.000	-0.001
	(0.002)	(0.001)	(0.001)
Grain harvest per capita 1925, grain, c	-0.130	-0.260	0.354
	(0.274)	(0.220)	(0.241)
Potato harvest per capita 1925, c	0.008	-0.217	0.099
	(0.205)	(0.185)	(0.187)
Rural population density 1927,	-0.001	-0.013**	-0.009
100s per km^2	(0.007)	(0.006)	(0.006)
Urban characteristics:			
Urbanization 1927	0.001	0.031**	-0.064***
	(0.019)	(0.015)	(0.015)
Distance to 1933 province center, km	2.704	-1.113	5.673
	(7.390)	(6.685)	(6.913)

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Column (1) reports coefficients from regressing district characteristics on an indicator for district having above median collectivization rate, conditional on value of agricultural equipment per capita in 1925, livestock per capita in 1925, Polissia region indicator, and province fixed effects following the specification in Footnote 25. Robust standard errors are reported in brackets. Column (2) reports coefficients from regressing district characteristics on an indicator for district having above median number of Group A workers per capita, conditional on value of agricultural equipment per capita in 1925, livestock per capita in 1925, Polissia region indicator, and province fixed effects following the specification in Footnote 25. Robust standard errors are reported in brackets. Column (3) reports coefficients from regressing district characteristics on an indicator for district having above median distance to a railroad, conditional on value of agricultural equipment per capita in 1925, livestock per capita in 1925, Polissia region indicator, and province fixed effects following the specification in Footnote 25. Robust standard errors are reported in brackets.

and population density.

Finally, similar to the previous estimates, I compare districts with distance to a railroad below and above the median. Table 1.4 Column (3) reports the results. Districts located farther from a railroad had lower urbanization rates and had more arable land per capita and higher sown area of grain per capita. Nevertheless, these districts did not produce more grain per capita. All in all, the sample appears well balanced across all the policy proxies, and the minor differences can be controlled for.

As Section 1.3 explains, I have district-level 1933 mortality data, policy intensity measures, and pre-famine characteristics, and in addition I have more aggregated region-level 1927 and 1928 mortality data. Ex ante, it is not clear which approach to take: to use more disaggregated data and only 1933 mortality, or to employ more aggregated data and make use of 1927 and 1928 mortality in addition to 1933 mortality. There are pros and cons to both approaches. As Section 1.3.1 explains, regions ceased to exist in the early 1930, when a two-step province-district administrative division begun being introduced. Regions don't fit into subsequently created provinces, many were split between two provinces. Therefore, using variation in policy intensities on a district level with province fixed effects seems reasonable. But on the other hand, provinces were only introduced starting in 1931, and it is not clear how much of the government policies was implemented on a province level, and how much was decided on a district level directly in Kharkiv[26]. By construction, provinces united similar districts, and therefore province fixed effects may be taking away important variation. There are more districts than regions (280 districts in my sample and only 36 regions), so using districts as a primary unit of observation increases statistical power. On the other hand, policy intensities are measured with error. For example, collectivization rate was measured in May of 1930, and much changed from 1930 to 1932, some households left collectives, many more joined. Using more aggregated regions might help differencing out measurement error and therefore produce more accurate estimates. But regions might be too large and using regions may

[26]Kharkiv was the capital of Ukraine at the time.

destroy important variation in policy intensities. Since it is not clear which empirical strategy is better, below I report estimates using three strategies: (1) cross-section estimates using districts as a primary unit of observation, (2) for comparison, cross-section estimates using regions, and (3) differences-in-differences estimates using regions.

First, to study the relationship between government policies and mortality using a cross-section of districts I estimate the following specification:

$$mortality_d = \alpha_p + \beta z_d + X_d'\gamma + \epsilon_d \tag{1.1}$$

where d stands for district, p – province where the district was located, $mortality_d$ – district death rate in 1933, z_d – measure of intensity of the government policy in district d discussed above, X_d – a vector of district-specific characteristics, and α_p – province fixed effect.

There are two main empirical challenges. First, reverse causality – what if the observed relationship between policy intensity and mortality is a *result* of the famine, instead of policies impacting mortality. For example, what if more severe famine made peasants join collective farms at a higher rate? However, this concern can be eliminated because all policies are measured *before* the famine, in 1930. A more serious problem is omitted variable bias. What if the relationship between policies and mortality is driven by some omitted factor correlated with the intensity of the policy? For example, what if poor peasants were more willing to join collective farms, and districts with higher collectivization rate had higher mortality not because of collectivization itself but because the population there had less resources to survive crop failure. The discussion above alleviates this concern – it shows that conditional on livestock per capita, value of agricultural equipment per capita, Polissia region indicator, and province fixed effects there seem to be very few differences between districts whose exposure to policies was above or below the median. Nevertheless, to account for possible omitted variable, I control for every possible factor that could have had a direct effect on mortality in 1933 and could have been correlated with the intensity of the policies.

Therefore, in all subsequent estimates district characteristics include factors that could have affected mortality directly. I control for food sources: wheat and rye production per capita in 1925, sown area of potato per capita in 1925, and livestock per capita in 1925. I also include wealth and economic development proxies in district controls: value of agricultural equipment per capita in 1925, rural literacy rate in 1927, urbanization in 1927, and rural population density in 1927. Finally, to account for varying agroclimatic conditions I also include Polissia region indicator in district controls. The identifying assumption is that, if not for the different exposure to government policies, districts with similar pre-famine characteristics should have had similar mortality in 1933.

Table 1.5 Panel A reports the estimates of the impact of government policies on mortality using model (1.1). Column (1) reports the relationship between collectivization rate in 1930 and mortality in 1933. The collectivization coefficient is positive and highly statistically significant (p-value below 0.1%). Moreover, it is very large in magnitude – one standard deviation increase in collectivization rate (some 20% increase) raises 1933 mortality by 0.23 of a standard deviation, or by 8 people per 1000. This is a very large effect given that mortality in non-famine years was approximately 18 per 1000.

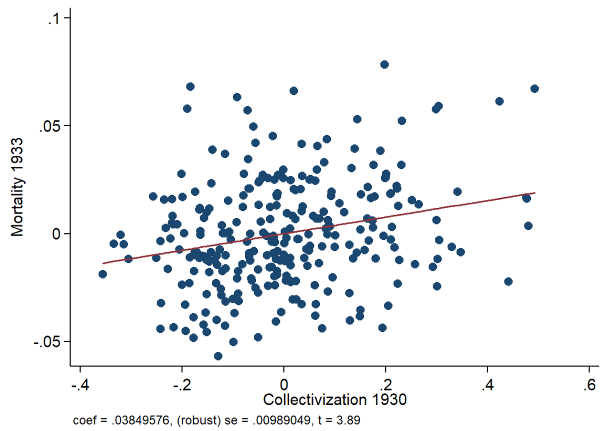
Figure 1.9 plots conditional scatter plot and fitted values corresponding to the estimates in Column (1). It demonstrates that the relationship between collectivization and mortality is not driven by one observation or a group of observations. And to check that this relationship is not driven by one province I estimate specification (1.1) with baseline controls dropping each of the eight Ukrainian provinces one by one. Figure 1.10 shows collectivization coefficients with their 95% confidence intervals estimated on a sample without one of the provinces. Since Kiev province had the highest mortality in 1933 it is not surprising that the magnitude of the coefficient decreases slightly when Kiev province is taken out of the sample. By the same token, Odesa province had high collectivization rates and the lowest mortality in 1933, and therefore taking it out of the sample increases collectivization coefficient. Nevertheless, removing both Kiev and Odesa provinces still leaves a highly statistically significant coefficient, its magnitude almost identical to the baseline

Table 1.5: Policies and mortality

Dependent variable: Mortality 1933	(1)	(2)	(3)	(4)
Panel A: cross-section, districts				
Collectivization 1930	0.038***			0.038***
	(0.010)			(0.010)
Group A workers pc 1930		-0.080**		-0.068*
		(0.037)		(0.041)
Ln(distance to a railroad)			0.001	0.001
			(0.001)	(0.001)
Baseline controls, Province FE	✓	✓	✓	✓
Observations	280	280	280	280
R^2	0.517	0.489	0.486	0.520
Panel B: cross-section, regions				
Collectivization 1930	0.061**			0.063**
	(0.023)			(0.024)
Group A workers pc 1930		0.012		0.042
		(0.119)		(0.114)
Ln(distance to a railroad)			-0.003	-0.002
			(0.002)	(0.003)
Baseline controls	✓	✓	✓	✓
Observations	38	36	38	36
R^2	0.626	0.506	0.546	0.630
Panel C: diff-in-diff, regions				
Collectivization 1930 × Famine	0.062***			0.063***
	(0.022)			(0.022)
Group A workers pc 1930 × Famine		0.008		0.032
		(0.113)		(0.106)
Ln(distance to a railroad) × Famine			-0.003	-0.002
			(0.002)	(0.002)
Year FE, Region FE, Baseline controls × Famine	✓	✓	✓	✓
Observations	114	108	114	108
R^2	0.883	0.853	0.859	0.891

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

Figure 1.9: Collectivization and mortality. District level estimates



Conditional scatter plot and fitted values between collectivization in 1930 and mortality in 1933 conditional on baseline controls: wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

estimate. Thus, the positive relationship between collectivization in 1930 and mortality in 1933 appears not to be driven by a particular region or a territory inside Ukraine.

As another robustness check, I estimate the relationship between collectivization and natality, Table 1.6 reports the results. The effect on birth rates, if any, should be small because usually natality reacts on famine conditions with a several months delay. Although small, the collectivization coefficient is negative and highly statistically significant. One standard deviation increase in collectivization rates decreases 1933 natality by 16% of a standard deviation, or by 0.8 births per 1000.

Finally, I estimate specification (1.1) using three alternative 1930 collectivization data versions (Table 1.7), and alternative 1933 mortality data from HURI (Table 1.8). The alternative estimates are very similar to the baseline estimates in Table 1.5 Column (1) both in magnitude and statistical significance.

In addition, Appendix Section A.1 offers an instrumental variable strategy to estimate the impact of collectivization on mortality. The IV estimates are much higher than the baseline OLS estimates. One possible explanation for this fact is that the government could have been putting

Figure 1.10: Collectivization and mortality. District level estimates (specification (1.1)) dropping provinces one by one

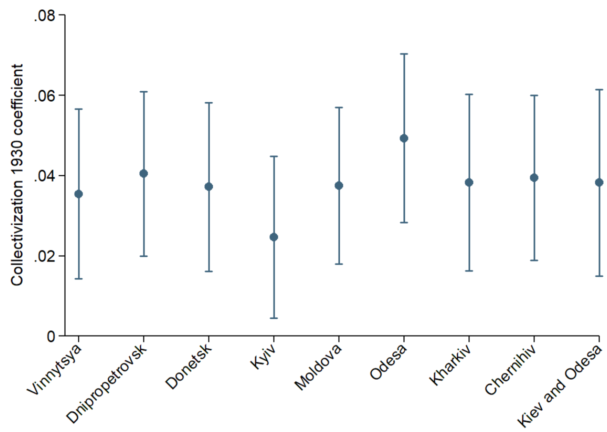


Figure displays impact of collectivization 1930 on mortality 1933 with 95% confidence intervals estimated using specification (1.1) on a sample without one of the provinces. See section 1.4.2 for details.

Table 1.6: Collectivization and natality. District level estimates

Dependent variable: Natality 1933	(1)	(2)
Collectivization 1930	-0.010***	-0.004***
	(0.002)	(0.001)
Baseline controls		✓
Province FE	✓	✓
Observations	280	280
R^2	0.299	0.505
Magnitude: Standardized beta coefficients		
Collectivization 1930	-0.348	-0.159

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

Table 1.7: Collectivization and mortality. District level estimates. Alternative collectivization data

Dependent variable: Mortality 1933	v2	v3	v4
	(1)	(2)	(3)
Collectivization 1930	0.048***	0.034**	0.048***
	(0.015)	(0.014)	(0.017)
Baseline controls	✓	✓	✓
Province FE	✓	✓	✓
Observations	232	272	217
R^2	0.486	0.496	0.469
Magnitude: Standardized beta coefficients			
Collectivization 1930	0.209	0.153	0.190

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

Table 1.8: Collectivization and mortality. District level estimates.
Alternative mortality data from HURI

Dependent variable: Mortality 1933 from HURI	(1)	(2)
Collectivization 1930	0.127***	0.091***
	(0.026)	(0.024)
Baseline controls		✓
Province FE	✓	✓
Observations	280	280
R^2	0.354	0.533
Magnitude: Standardized beta coefficients		
Collectivization 1930	0.296	0.212

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

pressure extracting grain from districts that were subsequently more collectivized. The inhabitants of these districts could have learned to deal with the government pressure relatively better. For example, peasants in these districts could have learned to hide their grain better. Wealth and grain controls do not fully account for this "ability to hide grain" factor. Most importantly, the impact of collectivization is positive, large, strongly statistically significant, and robust.

Table 1.5 Panel A Column (2) reports the relationship between Group A industry workers per capita in 1930 and mortality in 1933 estimated according to the specification (1.1). It shows that more Group A workers per capita reduced 1933 mortality, the coefficient is highly statistically significant. The magnitude of the effect is also not negligible – one standard deviation increase in the number of Group A workers per capita (0.03 more Group A workers per capita) reduces mortality by 0.07 of a standard deviation, or by 3 people per 1000.

Table 1.5 Panel A Column (3) estimates the relationship between log distance to a railroad and mortality in 1933. The coefficient is statistically zero – either distance to a railroad is a bad proxy for grain collections, or grain collections are captured by the collectivization rate (*if* more grain was extracted from the collectives).

Finally, Table 1.5 Panel A Column (4) includes all three policy intensity measures on the right-hand side of the regression. The estimated coefficients are very similar to the ones reported in Columns (1) – (3) both in statistical significance and magnitude: collectivization increases 1933 mortality, having more Group A workers per capita decreases mortality, and there is no relationship between distance to a railroad and mortality.

Next, for comparison, I estimate the relationship between policy intensity measures and mortality on a cross-section of regions instead of districts. I use specification similar to specification (1.1) but without province fixed effects since regions don't fit into provinces. Table 1.5 Panel B reports the estimates. There are few important differences. First, the collectivization coefficient increases significantly: 20% increase in collectivization rate raises 1933 mortality by 12 people per 1000. There are two explanations for this increase: first, without province fixed effects there is more useful variation in collectivization rates and in baseline region characteristics, and second, measurement error is smaller when more aggregated regions are used. Next, Group A workers per capita coefficient becomes statistically zero. One possible explanation for this is that there are very few districts with many Group A workers and the majority of districts has zero Group A workers, and when data are aggregated to the region level there is no variation in the industry composition. Finally, as before, there is no relationship between distance to a railroad and mortality in 1933.

Finally, although I control for as many factors that could have been affecting mortality as possible, some aspects cannot be easily measured. To account for potential unobserved heterogeneity, I offer a differences-in-differences estimates using region level data that allow me to control for region fixed effects. I estimate the following specification:

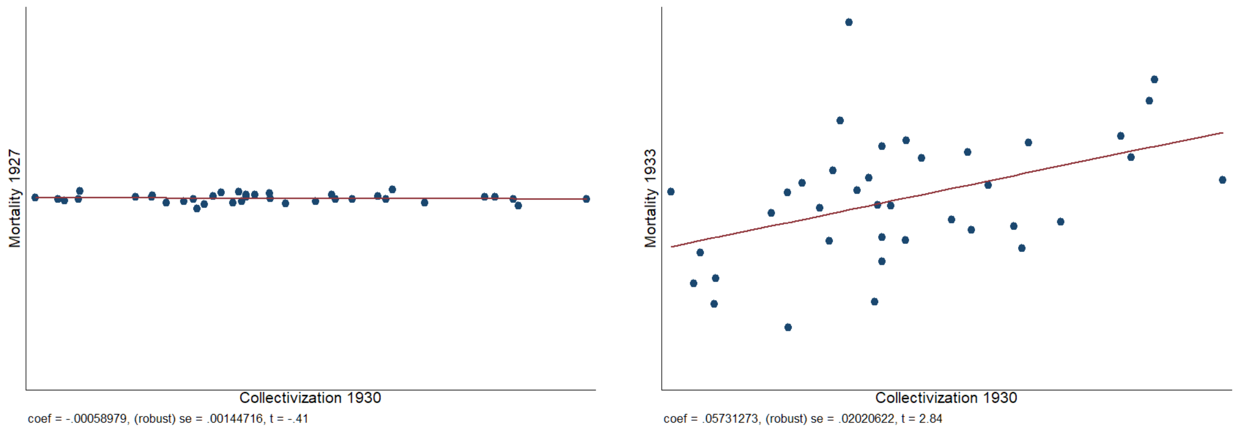
$$mortality_{i,t} = \beta z_i I_t^{fam} + X_i' I_t^{fam} \gamma + \alpha_i + \tau_t + \epsilon_{i,d} \tag{1.2}$$

where i stand for region, t for year (1927, 1928, and 1933), and $mortality_{i,t}$ is mortality in region i in year t; $z_i I_t^{fam}$ is a policy measure interacted with the famine indicator that equals to one in 1933 and to zero otherwise, and $X_i' I_t^{fam}$ are region characteristics interacted with the famine dummy. I do not include province fixed effects because regions don't fit into subsequently created provinces (many were split between two provinces). The identifying assumption is that, if not for the differences in policy intensities, the change in mortality from non-famine years to famine year would have been similar among regions with similar characteristics.

Table 1.5 Panel C presents the estimates. The coefficients are extremely close the the corresponding coefficients obtained on a cross-section of regions and reported in 1.5 Panel B, only more statistically significant. Column (1) shows that in the difference in differences setting the collectivization coefficient interacted with famine dummy is positive and highly statistically significant. For illustration, Figure 1.11 plots relationship between collectivization and mortality in 1927 and in 1933 conditional on baseline controls. There is no relationship in 1927, and there is a

Figure 1.11: Collectivization in 1930 and mortality in 1927 and in 1933. Okrug level data

(a) 1927 (b) 1933



Conditional scatter plot and fitted values between rural share of ethnic Ukrainians in 1927 and mortality in 1927 (a) and in 1933 (b). Conditional on baseline controls: cows per capita 1925, horses per capita 1925, rural literacy rate 1927, agricultural equipment per capita 1925, urbanization 1927, rural population density 1927, Ln(distance to province center 1933), Ln(distance to a railroad 1933), Polissia region indicator.

strong positive one in 1933. Column (2) demonstrates that the coefficient of Group A workers per capita interacted with famine dummy is statistically zero. Colum (3) shows that, as before, there is no relationship between log distance to a railroad interacted with famine dummy and mortality. Column (4) includes in the estimates all three policy measures interacted with famine dummy. The magnitude and statistical significance of collectivization coefficient does not change. Thus, difference-in-difference estimates are in line with the main cross-section estimates, and it is unlikely that the results are driven by an omitted factor.

The next subsection attempts to shed more light on what made collectivization so deadly. It considers two mechanisms that could have affected food availability and productivity: a drop in sown area and a drop in livestock.

Mechanisms: why collectivization increased mortality

This section undertakes to understand why exactly did collectivization led to higher mortality. There are two main possible (not mutually exclusive) mechanisms: the government might have extracted relatively more grain from collectives, and collective farms could have been less productive. This section presents evidence against relatively higher procurement from collectives, and for a drop in production. Using aggregated data, it demonstrates that in 1932 collective farm members delivered less grain per capita to the government than individual peasants. It then shows that, consistent with the drop in production hypothesis, collectivization led to a drop in sown area and a drop in livestock.

Procurement from collectives

Unfortunately, there are no disaggregated enough data on grain production or procurement. Therefore, I consider aggregated data on 1932 harvest and procurement (the last harvest before the peak of famine mortality in the winter and spring of 1933). These data are collected figure by figure from different sources and therefore might present an inconsistent picture and should be taken with extreme caution. Nevertheless, it is worth looking at them. Table 1.9 Panel A shows the official data[27] on collectivization rate, yield, harvest, and grain procurement in 1932; Panel B shows a more pessimistic scenario for Ukraine (to be explained three paragraphs below).

[27] I must emphasized that all these data were classified until recently, and official does not mean publicly available during or after the famine. This is what the top Soviet officials knew and believed about the state of agriculture in 1932.

Table 1.9: 1932 aggregated yield, harvest, and procurement

	Collectivi-zation, %	Yield, c/ha			Harvest, mln t			Procurement			
								share, %		mln t	
	Jan 1, 1932 (1)	total (2)	coll (3)	ind (4)	total (5)	coll (6)	ind (7)	coll (8)	ind (9)	coll (10)	ind (11)
Panel A: Using official data											
USSR	63.7	7	5.4	*9.8*	69.9	*34.3*	*35.5*	30.6	21.1	*10.5*	*7.5*
						49.1%	*50.9%*			*58.3%*	*41.7%*
Ukraine	69.2	8.1	5.1	*14.8*	14.5	*6.3*	*8.2*	45.1	40.6	*2.8*	*3.3*
						43.4%	*56.6%*			*45.9%*	*54.1%*
Panel B: Most pessimistic scenario for Ukraine											
Ukraine	69.2	6.1	5.1	*8.3*	*10.9*	*6.3*	*4.6*	45.1	40.6	*2.8*	*1.9*
						57.8%	*42.2%*			*59.6%*	*40.4%*
						(6) + (7) = 100%				*(10) + (11) = 100%*	

Sources: Column (1) is from Davies and Wheatcroft (2009, Table 27); Columns (2) and (5) are from Tables of the dynamic series of the Central Statistical Board of the USSR data on sown areas, yields and total yields of all cereal crops (for all categories of farms) in the USSR, the RSFSR and the economic regions for 1913, 1928, 1932 - 1944 (Tablitsy dinamicheskikh ryadov TSSU SSSR dannykh o posevnykh ploshchadyakh, urozhaynosti i obshchikh razmerakh urozhaya vsekh zernovykh kul'tur (po vsem kategoriyam khozyaystv) v tselom po SSSR, RSFSR i ekonomicheskim rayonam za 1913, 1928, 1932 - 1944 gg.), RSAE 1562/329/1409; Column (3) is from Tables of data on the state of the collective farms in 1932, compiled from the materials of the annual reports (Tablitsy dannykh o sostoyanii kolkhozov v 1932 g., sostavlennyye po materialam godovykh otchetov), RSAE 7486/3/4456, Table 19, page 22; Columns (8) and (9) are from Statistical tables of indicators for the implementation of the First Five-Year Plan for the Development of Agriculture (Statisticheskiye tablitsy pokazateley vypolneniya I pyatiletnego plana razvitiya sel'skogo khozyaystva), RSAE 4372/30/871, page 30; all the rest (italized) figures are calculated using the above data and assuming that collective farms and individual peasants had same sown area per capita in 1932. See section 1.4.2 for details.

First, consider Table 1.9 Panel A. Column (1) presents collectivization rate for the whole Soviet Union and for Ukraine on January 1, 1932. Column (2) presents the total grain yield (grain harvest per hectare of sown area) from the official statistics. Column (3) presents yield on collective farms from a report on the state of collective farms. This report contains data only on the farms that actually sent details on their operations to the officials, that is, on better organized collective farms (some 40% of all Soviet collective farms and 47% of Ukrainian collective farms). That is, the yields presented in this column are probably higher than the actual yields on collective farms if data on *all* collective farms were available. Using collectivization rate, total yield, yield on collective farms, and assuming that collective farms and individual peasants had equal sown area per capita[28], I can calculate the individual peasants' yield, Table 1.9 Column (4). The calculated individual peasants' yield is much higher than yield on collective farms, consistent with the hypothesis that collective farms were less productive.

Next, using total harvest from official data (Table 1.9 Column (5)), individual and collective yields, and assuming again that individual peasants and collective farms had the same sown area per capita, it is possible to calculate amount of grain produced by collectives and by individual peasants. Columns (6) and (7) present the results. In the USSR individual peasants, 36.3% of all peasants, produced 50.9% of grain; in Ukraine the proportion was even more striking, individual peasants (31.8% of all) produced 56.6% of grain. This is again consistent with collectivization increasing mortality due to drop in production on collective farms.

Finally, Table 1.9 Columns (8) and (9) present official data on shares of harvest extracted from individuals and collectives. Consistent with the observation that extracting grain from collectives was relatively easier, a higher *share* of harvest was taken from collective farms. Using the grain production figures from Columns (6) and (7) and procurement shares from Columns (8) and (9), I calculate the amount of grain procured from individuals and collectives, Columns (10) and (11)

[28]This assumption is in favor of collective farms. If individual peasants had lower sown area per capita their yields must have been even higher.

report the result. Even though a lower *share* of the harvest was taken from individual peasants, they still delivered **more** in per capita terms. In the whole USSR individual peasants (36.3% of all peasants) delivered 41.7% of all procured grain, and in Ukraine alone individual peasants (31.8% of all) delivered 54.1% of procured grain.

It is possible however that the total yield figures presented in Table 1.9 Panel A Column (2) are too optimistic. These are the official estimates, and even though they were very low for the Soviet agriculture at the time[29], the authorities were under pressure to procure more grain from the countryside and therefore may not have been willing to believe that the real yields were even lower. Therefore, I construct a more pessimistic scenario for Ukraine, using the lowest yield observed during 1932–1944 (the yield used is from the year 1934). Table 1.9 Panel B shows the results. Lowering the total yield lowers the yield individual peasants must have had, the total harvest and the harvest produced by individual peasants, and the amount of grain procured from individual peasants. Nevertheless, even in this more pessimistic (or rather more realistic) scenario, individual peasants in Ukraine (31.8% of all peasants) produced 42.2% of the 1932 harvest and delivered to the government 40.4% of all procured grain. Thus, even this pessimistic scenario is consistent with the observation that **less** grain per capita was extracted from collective farm members relative to individual peasants.

Production

This section presents further evidence suggesting that collective farms were less productive. First, I consider the factor most often mentioned in the literature – a drop in livestock. According to historical accounts, during early comprehensive collectivization drive peasants preferred slaughtering their animals instead of giving them to collective farms for free, so collectivization resulted in substantial drop in livestock. Therefore, collectivization could have increased mortality if more collectivized districts had higher drop in livestock. As a measure of drop in livestock I use the

[29] For example, Ukraine had higher yields even after the German occupation during WW2.

Table 1.10: Drop in livestock. District level estimates

Dependent variable: Drop in livestock pc 1930	Cows	Horses	Sheep	All livestock
	(1)	(2)	(3)	(4)
Collectivization 1930	0.019	0.050***	0.068*	0.067**
	(0.013)	(0.016)	(0.036)	(0.031)
Cows pc 1925	✓			
Horses pc 1925		✓		
Sheep pc 1925			✓	
Baseline controls	✓	✓	✓	✓
Province FE	✓	✓	✓	✓
Observations	233	233	232	233
R^2	0.571	0.536	0.691	0.642
Magnitude: Standardized beta coefficients				
Collectivization 1930	0.074	0.185	0.081	0.103

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

difference between cows, horses, and sheep per capita in 1925 and in 1930[30].

Table 1.10 investigates the impact of collectivization on the drop in livestock. Columns (1), (2), (3), and (4) report the relationship between 1930 collectivization rate and, respectively, the drop in cows, horses, sheep, and all livestock per capita controlling for all baseline controls and, in addition, respectively, cows, horses, and sheep per capita in 1925. Consistent with historical accounts, all coefficients are positive, although, only the impact on drop in cows is not statistically significant.

Next, I demonstrate that collectivization disrupted production, and that due to mismanagement and disruption to incentives to work collective farms reduced output relative to individual peasants. Unfortunately, there is no disaggregated data on collective farms output, and even the available aggregate figures are debated by historians. Thus, I must rely on indirect evidence.

Collective farms varied in size – from some 20 households per kolkhoz to more than 400. Table 1.11 demonstrates that it is the size of collective farms that drove mortality up in 1933. It

[30]This is an imperfect measure if livestock growth rates varied in different areas during 1925–1929. But it is the best I have.

Table 1.11: Mortality and the average size of collective farms. District level estimates

Dependent variable: Mortality 1933	(1)	(2)
Collectivization 1930	-0.016	-0.005
	(0.015)	(0.013)
HH per collective farm 1930	0.027***	0.017***
	(0.005)	(0.004)
Baseline controls		✓
Province FE	✓	✓
Observations	280	280
R^2	0.442	0.546
Magnitude: Standardized beta coefficients		
Collectivization 1930	-0.094	-0.032
HH per collective farm 1930	0.477	0.304

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

presents estimates of specification (1.1), adding average size of collective farms in a district to the controls. The two variables, collectivization rate and number of households per collective farm, are positively correlated, but are not identical, the correlation between the two equals 0.66. But, adding average size of collective farms to the controls makes collectivization coefficient statistically zero, it loses its magnitude and statistical significance. One standard deviation increase in the number of households per collective farms, that is, increasing average collective farm size in a district by 62 households, raises mortality by some 0.3 of a standard deviation, or, depending on a specification by 11 deaths per 1000. Thus, opposite to the hopes of the government ideologues, collectivization seems to have created *diseconomies* of scale – the larger the collective farms were in a district, the higher mortality the district experienced in 1933.

To check that the above effect is not driven by collective farm members being crammed on a tiny plot of land I study the relationship between the collectivization rate and the share of socialized land in 1930[31]. I regress the difference of share of socialized land and collectivization rate on col-

[31] Share of socialized land is the amount of land used by collective farm members divided by the amount of land used by collective farm members plus the amount of land used by individual peasants.

Table 1.12: Socialized land. District level estimates

	Share of socialized land – Collectivization, 1930
Collectivization 1930	0.079**
	(0.031)
Constant	0.030***
	(0.006)
Observations	311
R^2	0.029

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Share of socialized land is land used by collective farms divided by land used by collective farms plus land used by individual peasants.

lectivization rate in 1930. Table 1.12 reports the estimates. If the land was divided proportionally among individual peasants and collective farm members, the constant and the slope coefficients should be equal to zero. However, both are positive and highly statistically significant. That is, collective farm members had on average 3% more land (the constant coefficient equals 0.03), and the higher collectivization rate was, the more *additional* land collective farm members had (slope coefficient is positive). Thus, the effect of collectivization on mortality cannot be explained by a lower land to labor ratio on collective farms.

Finally, although I don't have disaggregated data on collective farm yields, I observe the sown area in 1930. Table 1.13 estimates the impact of collectivization rate and average collective farm size in 1930 on the sown area of collective farm members and individual peasants. All specifications control for sown area per capita in 1925 and all baseline controls. Columns (1) and (3) show that collectivization decreased the sown area for both collective farms and individual peasants. Columns (2) and (4) show that collective farms reduced the sown area in the districts with larger collective farms, while size of the collectives did not affect sown area of individual peasants. Thus, although all the evidence presented is indirect, it is consistent with collective farms reducing productivity. That is, collectivization led to large amount of land being uncultivated.

Total impact of collectivization on death toll

Table 1.13: Sown area. District level estimates

Dependent variable: Sown area per capita 1930	Collectives		Individual peasants	
	(1)	(2)	(3)	(4)
Collectivization 1930	-0.570***		-0.168**	
	(0.191)		(0.070)	
HH per collective farm 1930		-0.156***		-0.028
		(0.051)		(0.023)
Sown area pc 1925	1.092***	1.185***	0.453***	0.482***
	(0.213)	(0.208)	(0.156)	(0.157)
Baseline controls	✓	✓	✓	✓
Province FE	✓	✓	✓	✓
Observations	232	232	231	231
R^2	0.784	0.783	0.767	0.763
Magnitude: Standardized beta coefficients				
Collectivization 1930	-0.140		-0.097	
HH per collective farm 1930		-0.120		-0.050

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

Finally, it would be interesting to estimate how many deaths were added by collectivization[32]. In the subsequent calculations, I follow Meng et al. (2015). First, *reported deaths* is a sum of 1933 deaths in my sample. Next, *predicted deaths* is a sum of mortality rates predicted by my estimates multiplied by population. Third, *benchmark deaths* is a sum of mortality rates predicted for zero collectivization rate multiplied by population. Presumably, benchmark deaths is a number of deaths that would have occurred if the weather and all government policies were the same except agriculture was not collectivized. By construction, benchmark deaths do not take into account general equilibrium effects, that is, the change of procurement that could have occurred if without collectivization peasants had produced more. *Increase in deaths due to collectivization* is a ratio of predicted deaths to benchmark deaths minus 1.

Table 1.14 reports the results. Because of the large number of controls and fixed effects, pre-

[32]Location of favored industries affects distribution of food, not the aggregate food availability, and therefore estimating how a different location of Group A industries would have affected total death toll does not make much sense.

Table 1.14: Total impact of government policies on death toll

Unit of observation:	District	Region	
Specification:	Cross-section		Diff-in-diff
	(1)	(2)	(3)
(1) Deaths if no famine, 1000s	353	446	446
(2) Reported deaths, 1000s	1,260	1,586	1,586
(3) Predicted deaths, 1000s	1,269	1,562	1,570
Alternative scenarios:			
(4a) Deaths if collectivization = 0, 1000s	975	946	948
Share of excess deaths explained, $1 - \frac{(4)-(1)}{(2)-(1)}$	0.31	0.56	0.56
(4b) Deaths if Group A workers pc = 0.025, 1000s	1,249		
Share of excess deaths explained	0.01		
(4c) Deaths if collectivization = 0 and Group A workers pc = 0.025, 1000s	955		
Share of excess deaths explained	0.34		

Section 1.4.2 provides details on the estimates construction

dicted deaths are very close to the actual reported deaths in all projections. Column (1) reports projections using district level estimates according to the estimates presented in Table 1.5 Panel A Column (4). It demonstrates that collectivization raised total death toll by 30%. Column (2) takes a more cautious stance and shows the projections when 1931 and 1932 weather is taken into account, using estimates presented in Table 1.15, Column (4). According to the projections in this column, collectivization raised 1933 death toll by 19%. Next, Column (3) uses okrug level difference-in-differences estimates presented in Table 1.5 Panel C Column (4). When okrug-level data are used, collectivization is projected to raise death toll by a staggering 45%. Finally, for robustness check, Column (4) presents okrug-level estimates when, in addition to all okrug controls, 1931 and 1932 weather is controlled for[33]. However, when the weather is taken into account, collectivization is projected to have increased mortality by an unbelievable 49%.

To conclude, this section demonstrates that government policies made a sizeable contribution to 1933 mortality. Collectivization raised total death toll by at least 19%, probably due to the drop in production on collective farms. Location of favored industries also affected mortality probably

[33]To preserve space, these estimates are not presented, they are available upon request.

Table 1.15: Collectivization and mortality. District level estimates.
Controlling for the weather in 1931 and 1932

Dependent variable: Mortality 1933						
Weather controls:	Absolute values		Demeaned			
	1931	1932	1931	1932	1931	1932
	(1)	(2)	(3)	(4)	(5)	(6)
Collectivization 1930	0.034***	0.036***	0.040***	0.037***	0.034***	0.035***
	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)	(0.010)
Group A workers pc 1930	-0.068*	-0.063	-0.061	-0.067	-0.083**	-0.084**
	(0.039)	(0.039)	(0.042)	(0.042)	(0.040)	(0.040)
Ln(distance to a railroad)	0.001	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Spring temperature	-0.013	-0.032***	-0.018	-0.028***		
	(0.010)	(0.009)	(0.014)	(0.011)		
Spring precipitation	-0.000	-0.000	-0.000	-0.000		
	(0.000)	(0.000)	(0.000)	(0.000)		
June temperature	-0.008	0.013***	-0.035***	0.027***		
	(0.006)	(0.004)	(0.010)	(0.007)		
June precipitation	0.000**	0.000**	0.000	0.000		
	(0.000)	(0.000)	(0.000)	(0.000)		
Grain pc predicted					-0.037***	-0.032***
					(0.012)	(0.012)
Baseline controls	✓	✓	✓	✓	✓	✓
Province FE	✓	✓	✓	✓	✓	✓
Observations	280	280	280	280	280	280
R^2	0.541	0.545	0.553	0.545	0.535	0.530

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Weather controls are average spring and June temperature and precipitation.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

because these industries had a higher priority for the government and were better supplied.

1.4.3 Ethnic composition and mortality

This section tests the hypothesis that within Ukraine districts with higher share of ethnic Ukrainians experienced higher mortality in 1933. First, I consider a simple OLS estimates using district level data on 1933 mortality, and then offer a battery of robustness checks, including difference-in-difference okrug level estimates, to make sure that the results are not driven by some omitted variable.

I estimate the following specification:

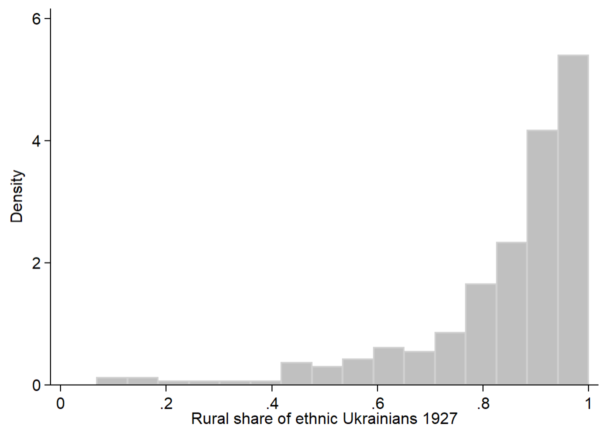
$$mortality_d = \alpha_p + \delta ethnicity_d + Z_d'\beta + X_d'\gamma + \epsilon_d \tag{1.3}$$

where, as before, d stands for district, p – province where the district was located, $mortality_d$ – district death rate in 1933, $ethnicity_d$ – rural share of a particular ethnicity in district d, X_d – a vector of district-specific characteristics (all of the baseline controls discussed earlier in Section 1.4.2), Z_d – policy measures (collectivization rate, number of Group A workers per capita, log distance to a railroad), and α_p – province fixed effect. I consider four ethnicities that had some variation within Ukraine that allowed me to test the relationship between ethnicity and mortality: Ukrainians, Russians, Germans, and Jews. Figure 1.12 shows histograms of the rural share of population belonging to one of these ethnicities. I also construct a synthetic group "other ethnicities", share of rural population belonging to this group equals one minus the sum of rural shares of Ukrainians, Russians, Germans, and Jews.

Table 1.16 presents estimates of the effect of ethnicity on mortality using model (1.3). Column (1) tests the relationship between rural share of ethnic Ukrainians and mortality in 1933 when only baseline controls are included in the estimate. It appears that the more ethnic Ukrainians there was in the district, the higher 1933 mortality was, ethnicity coefficient in Column (1) is positive

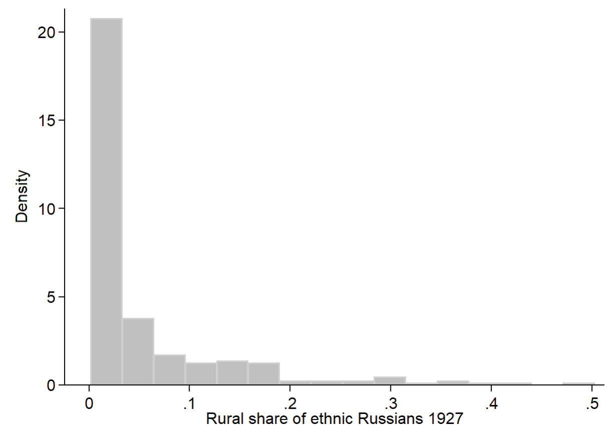
Figure 1.12: Histograms of rural shares of ethnic Ukrainians, Russians, Germans, and Jews

(a) Ukrainians



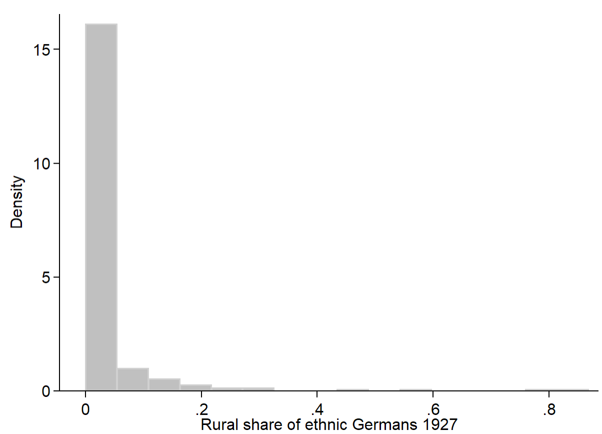
mean = .844, sd = .172

(b) Russians



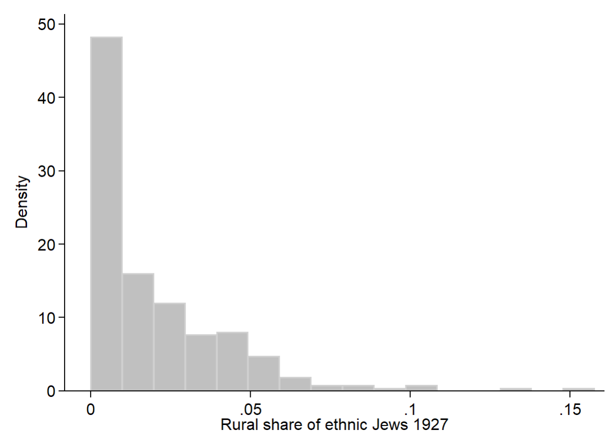
mean = .051, sd = .081

(c) Germans



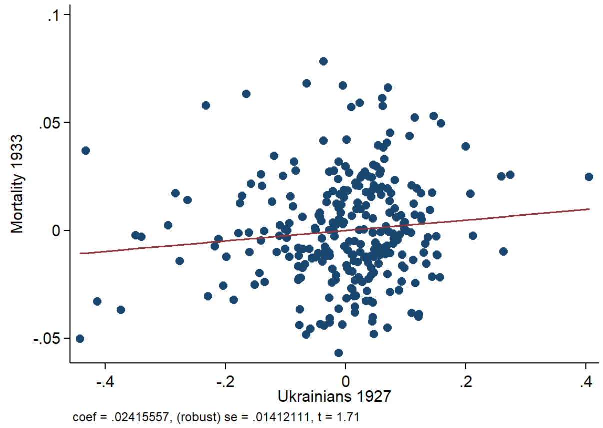
mean = .032, sd = .093

(d) Jews



mean = .019, sd = .023

Figure 1.13: Ethnic Ukrainians and 1933 mortality



Conditional scatter plot and fitted values between rural share of ethnic Ukrainians in 1927 and mortality rate in 1933. Conditional on baseline controls: wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

though barely statistically significant. Figure 1.13 shows conditional scatter plot and fitted values of the relationship between rural share of ethnic Ukrainians and mortality in 1933 conditional on baseline controls. The effect seems not to be driven by just a few observations or a group of observations. On the other hand, Figure 1.14 shows the Ukrainian coefficient with its 95% confidence interval estimated on a sample without one of the provinces. Without Kiev or Moldova provinces the coefficient loses its magnitude and becomes statistically indistinguishable from zero. Thus, although there appears to be a positive association between ethnic Ukrainians and 1933 mortality, this relationship is barely statistically significant and very fragile – dropping a group of observations kills it.

Column (2) estimates the relationship between ethnic Ukrainians and mortality in 1933 adding policy controls. The Ukrainian coefficient loses statistical significance, but it might be due to lack of statistical power, as I cannot reject the hypothesis that coefficients in Column (1) and Column (2) are the same (p-value of the difference is 0.9).

To better understand the relationship between ethnic composition and 1933 mortality, Column (3) estimate the relationship between 1933 mortality and all ethnic groups excluding only share of

Table 1.16: Ethnic composition and mortality

Dependent variable: Mortality 1933	(1)	(2)	(3)	(4)
Panel A: cross-section, districts				
Ukrainians 1927	0.024*	0.017	0.041*	0.030
	(0.014)	(0.014)	(0.022)	(0.021)
Germans 1927			0.052*	0.044
			(0.028)	(0.031)
Jews 1927			-0.016	0.014
			(0.088)	(0.088)
Other ethnicities 1927			-0.005	-0.009
			(0.034)	(0.034)
Baseline controls, Province FE	✓	✓	✓	✓
Policy controls		✓		✓
Observations	280	280	280	280
R^2	0.491	0.523	0.500	0.530
Panel B: cross-section, regions				
Ukrainians 1927	0.066**	0.057*	0.022	0.042
	(0.030)	(0.032)	(0.035)	(0.051)
Germans 1927			0.203*	0.300
			(0.113)	(0.191)
Jews 1927			-0.941***	-0.879***
			(0.235)	(0.229)
Other ethnicities 1927			-0.004	0.021
			(0.042)	(0.057)
Baseline controls	✓	✓	✓	✓
Policy controls		✓		✓
Observations	38	36	38	36
R^2	0.581	0.668	0.732	0.818
Panel C: diff-in-diff, regions				
Ukrainians 1927 × Famine	0.066**	0.056*	0.023	0.046
	(0.028)	(0.028)	(0.042)	(0.050)
Germans 1927 × Famine			0.210**	0.303**
			(0.096)	(0.138)
Jews 1927 × Famine			-0.933***	-0.884***
			(0.214)	(0.194)
Other ethnicities 1927 × Famine			-0.004	0.025
			(0.055)	(0.060)
Baseline controls × Famine, Year FE, Region FE	✓	✓	✓	✓
Policy controls × Famine		✓		✓
Observations	114	108	114	108
R^2	0.868	0.901	0.914	0.944

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Policy controls are collectivization rate in 1930, number of Group A workers per capita in 1930, and Ln(distance to a railroad)
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

Figure 1.14: Estimates of the impact of rural share of ethnic Ukrainians in 1927 on mortality in 1933 dropping provinces one by one

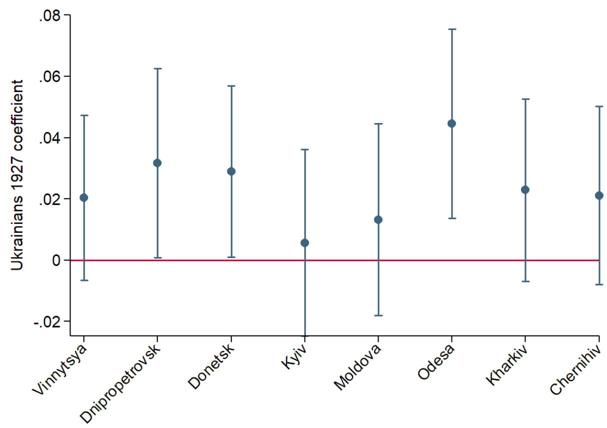


Figure displays impact of rural share of ethnic Ukrainians on mortality 1933 with 95% confidence intervals estimated using specification (1.3) on a sample without one of the provinces. District controls are all baseline controls: wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

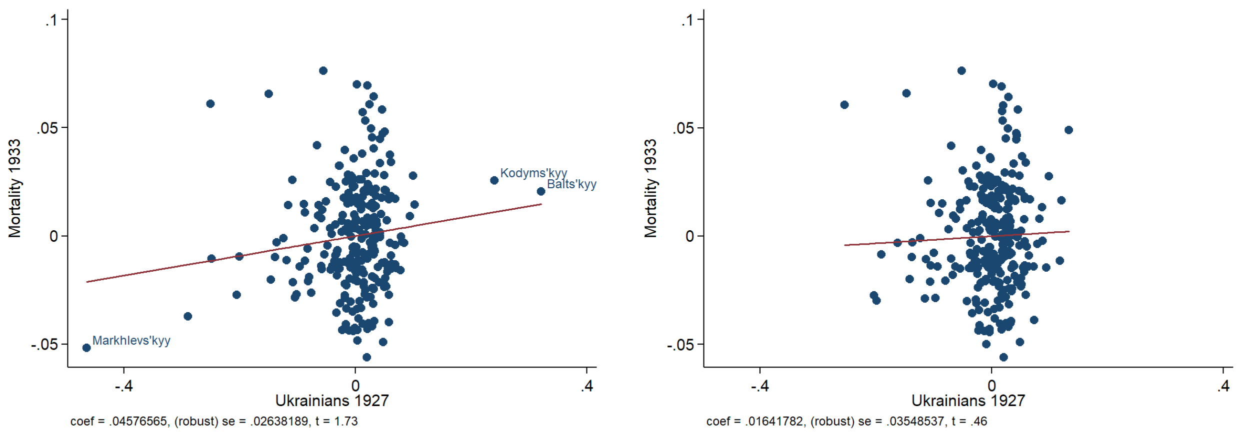
ethnic Russians, and controlling for all baseline controls. The picture changes slightly. It appears that districts with more ethnic Ukrainians or Germans had higher mortality in 1933 relative districts with higher share of ethnic Russians.

To investigate this relationship in more details, Figure 1.15a plots conditional scatter plot and fitted values of the relationship between share of ethnic Ukrainians and mortality in 1933 conditional on the baseline controls and shares of ethnic Russians, Germans, and Jews (as in Column 6). The positive relationship seems to be driven by three districts: Baltskyy, Kodymskyy, and Markhlevskyy. Figure 1.15b demonstrates that dropping these three districts from the sample produces a flat relationship between the share of ethnic Ukrainians in the district and 1933 mortality.

Similarly, Figure 1.16a plots conditional scatter plot and fitted values of the relationship between share of ethnic Germans and mortality in 1933 conditional on the baseline controls and shares of ethnic Ukrainians, Russians, and Jews. The positive relationship seems to be driven by four districts: Karl-Libknekhtivskyy, Lyuksemburzkyy, Spartakivskyy, and Vysokopilskyy. And indeed, Figure 1.16b shows that dropping these four districts from the sample results in a relation-

Figure 1.15: Ethnic Ukrainians and 1933 mortality

(a) Full sample (b) Without three observations



Conditional scatter plot and fitted values between rural share of ethnic Ukrainians in 1927 and mortality rate in 1933. Conditional on baseline controls: wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator (See also Table 1.16, Column (4)).

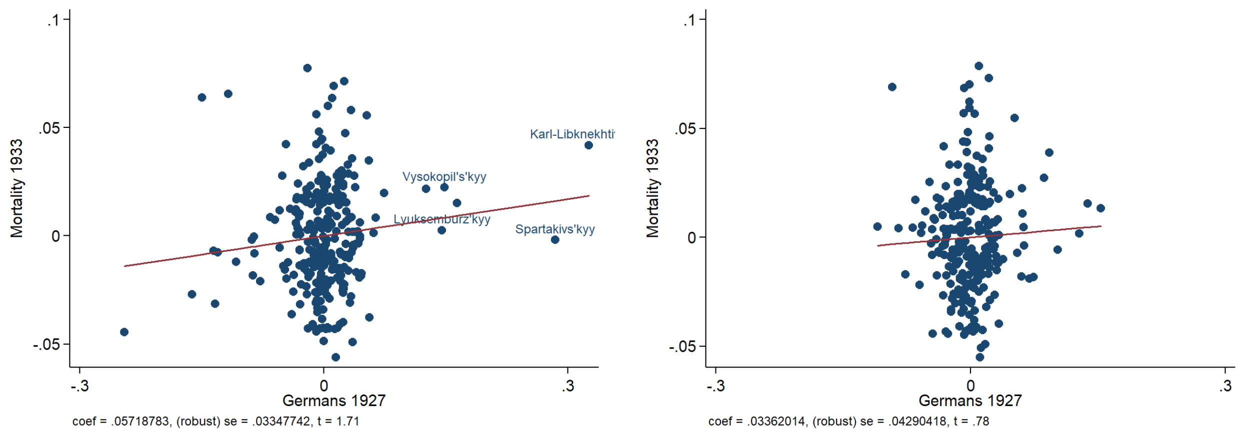
ship statistically indistinguishable from zero between the share of ethnic Germans in the district and 1933 mortality.

Finally, Table 1.16 estimates the relationship between ethnic composition and mortality when in addition to Column (3) policy measures are controlled for. As before, ethnicity coefficients lose statistical significance, but I cannot reject the hypothesis that they are equal to the coefficients in Column (3).

The magnitude of the relationship between share of ethnic Ukrainians in rural population and 1933 mortality is limited. 10% increase in the rural share of ethnic Ukrainians raises 1933 mortality by 2.4 (Column 1) to 3 (Column 4) people per thousand. This is a sizable effect given that the average 1927 mortality was 18 per 1000, but is but a small figure compared to the average 1933 mortality of 64 per 1000. Thus, although the relationship between share of ethnic Ukrainians in rural population and 1933 mortality is positive, it explains but a small share of all the increase in mortality compared to non-famine years. Similarly, the relationship between rural share of

Figure 1.16: Ethnic Germans and 1933 mortality

(a) Full sample (b) Without four observations



Conditional scatter plot and fitted values between rural share of ethnic Germans in 1927 and mortality rate in 1933. Conditional on baseline controls: wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator (See also Table 1.16, Column (4)).

ethnic Germans and 1933 mortality is very limited: 5% increase in ethnic German population (and Germans constituted less than 5% of all Ukrainians population) raises 1933 mortality by 2.2 people per 1000 (Column 4).

To check that the positive association between ethnic Ukrainians and mortality in 1933 is not driven by some omitted factor I run a battery of robustness checks.

First, I test that the positive relationship between ethnic Ukrainians and mortality is not explained by different exposure to a negative weather shock of 1931 and 1932. To account for this, I include the average spring and June temperature and precipitation in 1931 and 1932 in district controls. Table 1.17 reports the results. Although rural share of ethnic Ukrainians coefficient loses statistical significance, its magnitude does not change, higher share of ethnic Ukrainians in the district is still associated with higher mortality in 1933. Thus, the effect is not driven by the weather.

It is possible that more Ukrainian districts just happened to have less developed healthcare net-

Table 1.17: Ethnic composition and mortality in 1933.
Controlling for the weather in 1931 and 1932

Dependent variable: Mortality 1933	(1)	(2)	(3)	(4)
Ukrainians 1927	0.020	0.021	0.047*	0.050*
	(0.015)	(0.015)	(0.024)	(0.026)
Germans 1927			0.077**	0.063**
			(0.031)	(0.030)
Jews 1927			-0.024	0.062
			(0.089)	(0.088)
Other ethnicities 1927			-0.002	0.015
			(0.036)	(0.038)
Weather 1931	✓		✓	
Weather 1932		✓		✓
Baseline controls	✓	✓	✓	✓
Province FE	✓	✓	✓	✓
Observations	280	280	280	280
R^2	0.518	0.518	0.534	0.527
Magnitude: Standardized beta coefficients				
Ukrainians 1927	0.099	0.105	0.232	0.247
Germans 1927			0.207	0.170
Jews 1927			-0.016	0.041
Other ethnicities 1927			-0.005	0.042

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Weather controls are average spring and June temperature and precipitation.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

works. People, weakened by hunger and inadequate diet, succumbed to disease easier. Epidemics followed. Although I control for population density (the higher population density, the easier the disease spreads), if Ukrainian districts had fewer doctors and hospitals they might have been prone to disease at a higher rate. Table 1.18 tests this hypothesis. Column (1) reports the baseline estimates similar to the one presented in Table 2 Column (6) on a subsample for which I have the data on healthcare. The Ukrainians coefficient is very similar in magnitude and statistical significance to the baseline estimate, reducing the sample does not change it. Columns (2) – (4) report the estimates controlling for the number of hospitals per capita, number of hospital beds per capita, and number of doctors per capita. The healthcare proxies appear to have no impact on mortality whatsoever, consistent with the historical accounts of very rudimentary and undersupplied healthcare system that could not help starving peasants. Furthermore, the ethnic Ukrainians coefficient is not affected by adding these controls – its magnitude and statistical significance do not change. Thus, differential access to healthcare does not drive the relationship between ethnic Ukrainians and mortality.

Next, Table 1.19 tests the relationship between relative shares of various ethnic groups and natality in 1933. Columns (1) shows that there is a strong negative and statistically significant association between rural share of ethnic Ukrainians and natality in 1933. Column (2) demonstrates the reverse association between ethnic Russians and natality – the more ethnic Russians there were in the district, the higher the birth rates were, and the relationship is highly statistically significant. Similarly, Column (3) demonstrates a positive association between ethnic Germans and natality in 1933. Columns (4) and (5) show that there seem to be no statistically significant relationship between the rural share of Jews and other ethnicities in the district and the 1933 birth rate. Column (6) demonstrates, that Russians and Germans had relatively higher 1933 birth rates than other ethnicities. Similarly, Column (7) reports relatively lower 1933 birth rates among Ukrainians and other ethnicities compared with Russians. These findings are generally consistent with the observation that higher share of ethnic Ukrainians in the district is associated with worse famine conditions.

Table 1.18: Ethnic Ukrainians and mortality in 1933.
Controlling for access to healthcare facilities

Dependent variable: Mortality 1933	(1)	(2)	(3)	(4)
Ukrainians 1927	0.042*	0.041*	0.035	0.043*
	(0.023)	(0.023)	(0.023)	(0.023)
Germans 1927	0.053*	0.053*	0.046	0.055*
	(0.030)	(0.030)	(0.030)	(0.030)
Jews 1927	-0.044	-0.045	-0.053	-0.042
	(0.081)	(0.081)	(0.081)	(0.082)
Other ethnicities 1927	-0.006	-0.007	-0.017	-0.004
	(0.034)	(0.035)	(0.035)	(0.035)
Hospitals per 1000		-0.017		
		(0.113)		
Hospital beds per 1000			-0.006	
			(0.005)	
Doctors per 1000				0.015
				(0.037)
Baseline controls	✓	✓	✓	✓
Province FE	✓	✓	✓	✓
Observations	262	262	262	262
R^2	0.515	0.515	0.517	0.515
Magnitude: Standardized beta coefficients				
Ukrainians 1927	0.210	0.206	0.178	0.214
Germans 1927	0.147	0.145	0.126	0.150
Jews 1927	-0.029	-0.030	-0.035	-0.028
Other ethnicities 1927	-0.016	-0.020	-0.046	-0.012

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

Table 1.19: Ethnicities and natality in 1933

Dependent variable: Natality 1933	(1)	(2)	(3)	(4)	(5)	(6)
Ukrainians 1927	-0.010***					-0.014***
	(0.003)					(0.004)
Russians 1927		0.012***				
		(0.004)				
Germans 1927			0.015***			0.003
			(0.003)			(0.004)
Jews 1927				0.008		0.011
				(0.014)		(0.014)
Other ethnicities 1927					-0.001	-0.015*
					(0.008)	(0.009)
Baseline controls	✓	✓	✓	✓	✓	✓
Province FE	✓	✓	✓	✓	✓	✓
Observations	280	280	280	280	280	280
R^2	0.529	0.507	0.528	0.490	0.489	0.555
	Magnitude: Standardized beta coefficients					
Ukrainians 1927	-0.302					-0.439
Russians 1927		0.169				
Germans 1927			0.258			0.045
Jews 1927				0.031		0.045
Other ethnicities 1927					-0.011	-0.262

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

Table 1.20: Ethnicities and mortality in 1933. Alternative mortality data

Dependent variable: Mortality 1933 from HURI	(1)	(2)	(3)	(4)	(5)	(6)
Ukrainians 1927	0.050					0.099*
	(0.035)					(0.056)
Russians 1927		-0.100*				
		(0.054)				
Germans 1927			0.038			0.126*
			(0.047)			(0.073)
Jews 1927				-0.047		0.008
				(0.222)		(0.224)
Other ethnicities 1927					-0.091	0.014
					(0.062)	(0.081)
Baseline controls	✓	✓	✓	✓	✓	✓
Province FE	✓	✓	✓	✓	✓	✓
Observations	280	280	280	280	280	280
R^2	0.510	0.511	0.506	0.506	0.510	0.516
Magnitude: Standardized beta coefficients						
Ukrainians 1927	0.099					0.196
Russians 1927		-0.093				
Germans 1927			0.040			0.136
Jews 1927				-0.013		0.002
Other ethnicities 1927					-0.100	0.015

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

Finally, Table 1.20 tests the relationship between ethnic Ukrainians and mortality using alternative mortality data. Oleh Wolowyna has kindly shared with me district mortality data that Harvard Ukrainian Research Institute (HURI) published in their Mapa project. These mortality figures are strongly correlated with the mortality data I have collected in the archives (the correlation coefficient equals 0.98), but are at least two times higher, the average 1933 district mortality HURI reports is above 100 per 1000. Estimates using these figures are similar to the ones reported in Table 1.16, but less statistically significant. Because 1933 HURI mortality is higher, the coefficients are larger, but the pattern is the same – a higher share of ethnic Ukrainians is associated with higher 1933 mortality (although this association is not statistically significant), higher share of ethnic Russians is associated with lower 1933 mortality, and there is no strong relationship between ethnic Germans and Jews and 1933 mortality.

Finally, to account for unobserved heterogeneity, I offer difference-in-difference estimates using okrug level data that allow me to control for okrug fixed effects. I estimate the following specification:

$$mortality_{i,t} = \delta ukrainians_i I_t^{fam} + X_i' I_t^{fam} \gamma + Z_i' I_t^{fam} \beta + \alpha_i + \tau_t + \epsilon_{i,d} \tag{1.4}$$

where, as before, i stand for okrug (41 okrugs in the sample), t for year (1927, 1928, and 1933), and $mortality_{i,t}$ is mortality in okrug i in year t; $ukrainians_i I_t^{fam}$ is a share of ethnic Ukrainians in rural population interacted with the famine indicator that equals to one in 1933 and to zero otherwise, and $X_i' I_t^{fam}$ are okrug characteristics interacted with the famine dummy, $Z_i' I_t^{fam}$ are policy measures interacted with the famine dummy, and α_i and τ_t are okrug and year fixed effects.

Table 1.16 Panel C presents the estimates. Columns (1) and (2) estimates the relationship between ethnic Ukrainians and mortality first without, and then with policy controls. In both columns the Ukrainian coefficient is positive but not statistically significant. It is hard to tell whether this coefficient is actually zero, or whether there is not enough statistical power. Next, Columns (3) and (4) estimate the relationship between all ethnic groups except Russians and mortality, again without and with policy controls. Relative to Russians, ethnic Ukrainians and ethnic Germans die at a higher rate[34], the coefficients are large and highly statistically significant. Thus, difference-in-difference estimates are in line with the main cross-section estimates, and it is unlikely that the results are driven by an omitted factor.

I conclude that there is a positive association between ethnic Ukrainians and 1933 mortality. Although statistically weak, this relationship is not explained by differences in grain productivity and wealth, weather, access to healthcare, or culture.

[34]"Other ethnicities" seem to have higher mortality as well, but this finding is not confirmed by district level estimates in Table 1.16.

Exposure

This section investigates the relationship between ethnic composition and exposure to bad government policies. I consider two policies that have been shown to affect mortality: collectivization and the lack of favored industries. I estimate the following specification:

$$z_d = \alpha_p + \beta ethnicity_d + X_d'\gamma + \epsilon_d \tag{1.5}$$

where, as before, d stands for district, and p – province where the district was located. z_d – policy proxy, $ethnicity_d$ – rural share of a particular ethnicity in district d according to 1927 census, X_d – a vector of baseline district-specific characteristics discussed earlier, and α_p – province fixed effect. As before, I consider four ethnic groups: Ukrainians, Russians, Germans, and Jews, plus a synthetic group "Other ethnicities".

Table 1.21 reports the estimates. Column (1) shows that there is a strong positive and statistically significant relationship between rural share of ethnic Ukrainians and 1930 collectivization rate. One standard deviation increase in ethnic Ukrainians (some 17% increase) raises 1930 collectivization by approximately 0.15 of a standard deviation, or by 3%. To check that this effect is not driven by a few observations Figure 1.17 reports conditional scatter plot and fitted values of the relationship between ethnic Ukrainians and collectivization rate conditional on baseline controls (as in Table 1.21, Column (1)). It demonstrates that the positive association between rural share of ethnic Ukrainians and collectivization rate in 1930 is not driven by one observation or a subsample of observations.

Columns (2) investigates the relationship between ethnic composition and collectivization rate when all ethnicities are taken into account (the omitted category is Russians). Although the Ukrainian coefficient loses statistical significance, I cannot reject that it is the same as a coefficient in Column (1) (p-value of the difference equals 0.74). Thus, ethnic Ukrainians seem to be more exposed to collectivization.

Table 1.21: Exposure to the government policies. District level estimates

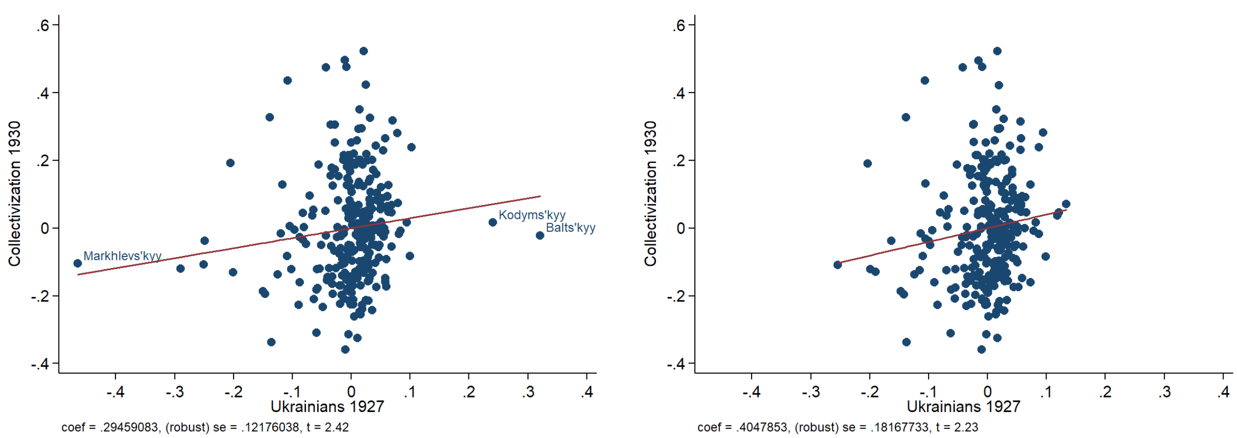
Dependent variable:	Collectivization 1930		Group A workers pc 1930	
	(1)	(2)	(3)	(4)
Ukrainians 1927	0.177**	0.138	-0.007	-0.087**
	(0.076)	(0.140)	(0.012)	(0.035)
Germans 1927		0.045		-0.096**
		(0.211)		(0.038)
Jews 1927		-0.780		-0.006
		(0.519)		(0.045)
Other ethnicities 1927		-0.156		-0.131***
		(0.196)		(0.051)
Baseline controls	✓	✓	✓	✓
Province FE	✓	✓	✓	✓
Observations	280	280	280	280
R^2	0.389	0.396	0.304	0.343
Magnitude: Standardized beta coefficients				
Ukrainians 1927	0.150	0.117	-0.039	-0.482
Germans 1927		0.021		-0.292
Jews 1927		-0.089		-0.004
Other ethnicities 1927		-0.073		-0.404

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

Figure 1.17: Ukrainians and 1930 collectivization rate

(a) Full sample

(b) Without three observations



Conditional scatter plot and fitted values between rural share of ethnic Ukrainians in 1927 and mortality rate in 1933. Conditional on shares of Russians, Germans, Jews, and baseline controls: wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator (See also Table 1.21, Column (2)).

Columns (3) and (4) test the relationship between ethnic composition and the presence of Group A industry. Column (4) shows that relative to ethnic Russians, all other groups had less Group A workers per capita.

Ethnic Ukrainians could have just liked the idea of collectivization relatively more. To test this, I consider the relationship between ethnicity and share of rural population in collective farms in 1927, before the comprehensive collectivization campaign. Only okrug level data are available for 1927, therefore I run the regressions for 1927 and 1933 on okrug data. Table 1.22 reports the results. Columns (1) and (2) show the relationship between rural share of ethnic Ukrainians and collectivization rate in 1927. Column (1) shows that, conditional on baseline controls, the relationship is negative and highly statistically significant. Column (2) add region fixed effects, this moves the coefficient towards zero and kills statistical significance. Nevertheless, there these estimates show that there was no positive relationship between ethnic Ukrainians and collectivization rate *before* the comprehensive collectivization campaign, when joining collectives was voluntary. Columns (3) and (4) reproduce the estimates of the relationship between ethnic Ukrainians and collectivization in 1930. Similar to Table 1.21, the coefficients are positive, but, due to small sample size and large number of controls, not statistically significant. Nevertheless, these estimates demonstrate that there is no evidence that a relatively higher preference for collectivization among ethnic Ukrainians drove collectivization rates up in 1930.

Finally, Table 1.24 estimates the relationship between ethnic Ukrainians and the collectivization rate in 1930 using three alternative versions of collectivization rates collected from statistical books published in Ukraine. In all specifications the ethnic Ukrainians coefficients are positive, highly statistically significant, and their magnitudes are higher than in the baseline estimates presented in Table 1.21.

To conclude, there is a positive and statistically significant association between rural share of ethnic Ukrainians and collectivization rate in 1930. This relationship is not explained by agricultural productivity and specialization, wealth, climate, or preferences for collectivization. This

Table 1.22: Placebo test: ethnic Ukrainians and collectivization in 1927 and 1930. Region level estimates.

Dependent variable:	Collectivization 1927	Collectivization 1930
	(1)	(2)
Ukrainians 1927	-0.045**	0.244
	(0.020)	(0.212)
Baseline controls	✓	✓
Observations	38	38
R^2	0.570	0.414
Magnitude: Standardized beta coefficients		
Ukrainians 1927	-0.343	0.172

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

Table 1.23: Ethnic Ukrainians and collectivization; alternative collectivization data

Dependent variable: Collectivization 1930	v2	v3	v4
	(1)	(2)	(3)
Ukrainians 1927	0.158***	0.176***	0.150***
	(0.050)	(0.048)	(0.053)
Baseline controls	✓	✓	✓
Province FE	✓	✓	✓
Observations	287	339	229
R^2	0.435	0.397	0.459
Magnitude: Standardized beta coefficients			
Ukrainians 1927	0.201	0.214	0.199

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

Table 1.24: Ethnic Ukrainians and collectivization; controlling for collective farms per capita in 1925

Dependent variable: Collectivization 1930	(1)	(2)
Ukrainians 1927	0.158**	0.191
	(0.078)	(0.143)
Germans 1927		0.191
		(0.202)
Jews 1927		-0.351
		(0.533)
Other ethnicities 1927		-0.105
		(0.193)
Collectives pc 1925	✓	✓
Baseline controls	✓	✓
Province FE	✓	✓
Observations	225	225
R^2	0.333	0.342
Magnitude: Standardized beta coefficients		
Ukrainians 1927	0.152	0.184
Germans 1927		0.103
Jews 1927		-0.043
Other ethnicities 1927		-0.057

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.

Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

positive association is unique to ethnic Ukrainians: there is either no relationship between non-Ukrainian ethnic groups and collectivization rate in 1930 (ethnic Germans), or a weak negative association (ethnic Russians and Jews). In addition, relative to ethnic Russians, all other ethnic groups were allocated fewer favored industries.

I have to emphasize that for the above to be a proof of genocide Stalin had to *know* in 1929 that collectivization and the lack of favored industries would increase mortality, when comprehensive collectivization campaign and industrialization began being implemented.

Enforcement

Finally, this section examines whether the enforcement of the government policies varied with ethnic composition. To study this question, I estimate the following specification:

$$mortality_d = \alpha_p + \beta z_d + \theta ethnicity_d z_d + \delta ethnicity_d + X_d' \gamma + \epsilon_d \tag{1.6}$$

where z_d is a policy proxy (collectivization or Group A industry). If the enforcement of the policies varied with ethnic composition, then this interaction coefficient should be different from zero.

Table 1.25 reports the results. Columns (1) shows the impact of the interaction coefficient between collectivization and Ukrainians on 1933 mortality, Column (2) demonstrates the relationship between interaction of Group A workers per capita and rural share of ethnic Ukrainians and mortality, and Column (3) includes both interactions in the estimates. In all specifications the interaction coefficients are statistically zero. Thus, there is no evidence that enforcement of the government policies varied with ethnic composition.

Table 1.25: Enforcement of the government policies. District level estimates

Dependent variable: Mortality 1933	(1)	(2)	(3)
Ukrainians 1927	0.016	0.018	0.017
	(0.024)	(0.014)	(0.024)
Ukrainians × Collectivization	0.003		0.004
	(0.047)		(0.047)
Ukrainians × Group A workers pc		-0.097	-0.099
		(0.168)	(0.172)
Policy controls	✓	✓	✓
Baseline controls	✓	✓	✓
Province FE	✓	✓	✓
Observations	280	280	280
R^2	0.523	0.523	0.523
Magnitude: Standardized beta coefficients			
Ukrainians 1927	0.080	0.088	0.082
Ukrainians × Collectivization	0.016		0.021
Ukrainians × Group A workers pc		-0.065	-0.066

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 1.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

1.5 Conclusion

The 1933 Soviet famine is remembered as one of the worst 20th century famines. This famine was the first in the line of famines characteristic to command economies[35]. In addition, unlike other command economy famines, such as the 1946 Soviet famine, and the Great Chinese famine, it could also have had an ethnic component. The questions why so many lives were lost and whether the 1933 famine killed more Ukrainians due to their ethnicity creates a bitter divide among historians, politicians, and the citizens of contemporary Russia and Ukraine.

This paper makes progress in understanding what happened during the famine years. It documents that poor economic policies (collectivization and the lack of favored industries) and not bad weather were the primary reason of the famine. It argues that collectivization had a strong negative impact on mortality because it disrupted the rural economy and decreased agricultural productivity. Collectivization led to a drop in livestock, and, most importantly, and disorganized production.

[35]The 1921 Soviet famine occurred in not yet a command economy.

Collective farms did not create large economies of scale the Soviet ideologues expected, on the contrary, the more households there were in a collective, the higher mortality they experienced. Back-of-the-envelope calculations show that collectivization increased the total death toll by at least 31%. And the lack of favored industries reduced the amount of food available to population and further increased mortality.

In addition, this work documents that there indeed was a positive relationship between a higher share of ethnic Ukrainians and 1933 mortality in a district. Although this relationship is statistically weak, it is not explained by the factor most often offered in the literature: grain productivity. It is also not explained by differences in wealth levels, industry composition, access to urban centers and healthcare facilities, or negative weather shock. The paper demonstrates that one of the mechanisms driving mortality up in more Ukrainian districts is that Ukrainians were more exposed to poor government policies. Districts with a higher share of ethnic Ukrainian population were more collectivized and were allocated fewer favored industries.

Further understanding government economic policies is an important avenue for future research. This paper explores one side of the crisis – collectivization and its impact on production. Another equally important part of Soviet policies is the procurement of grain from the countryside. How exactly did procurement system operate, why some areas faced higher procurement quotas, and how this affected mortality is an open question.

Chapter 2

The the inflexible procurement policy and the 1933 Soviet famine

WITH ANDREI MARKEVICH[1], NANCY QIAN[2], AND KATIA ZHURAVSKAYA[3]

2.1 Introduction

In 1933 six to eight million people died of starvation in the Soviet Union[4]. Studying the Greate Chinese Famine of 1951–1951 Meng et al. (2015) demonstrated the importance of the inflexible procurement policy in generating disparities of food availability across regions and therefore contributing to the famine mortality. This article reproduces Meng et al. (2015) study in the context of the 1933 Soviet famine. Similar to the Chinese context, it documents that there was a *positive*

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[2]Kellogg School of Management, Northwestern University

[3]Paris School of Economics

[4]Conquest estimates population losses due to collectivization, arrests and deportations, and famine to be 14.5 million, 7 million deaths directly due to the famine (Conquest, 1986, Chapter 16, p. 306). Andreyev et al. (1990) measure excess mortality due to the famine to be 8.5 million. Davies and Wheatcroft (2009) argue that Andreyev et al. (1990) projections do not account for underregistration of infant mortality and of mortality in less-developed Soviet republics, and estimate excess mortality to be 5.7 million (Davies and Wheatcroft, 2009, Chapter 13, p 415). In 2008 Russian parliament issued a special decree stating that 7 million people perished in the Soviet Union during this famine, Duma (2008).

correlation between grain production and famine mortality and argues that this positive correlation must be explained by the inflexible procurement policy under which more grain was procured from provinces known to be more productive in the past.

The study proceeds as follows. First, we consider the total amount of produced grain and the rural retention, that is, the difference between produced grain and the amount procured by the government. We demonstrate that although rural retention decreased during the years leading to the famine, the average amount of food available to rural population far exceeded levels necessary to generate large-scale starvation. Thus, the *distribution* of food in the economy must have played an important role in generating the famine. We also demonstrate that in the famine year together with the rise in average mortality, the variation in mortality also increased dramatically. Thus, to understand the 1933 famine it is necessary to study the variation in access to food.

Next, since we have established that the distribution of food must have been an important determinant of the famine severity, we study the relationship between grain production and mortality. We find that, surprisingly, for the famine year, there is a strong *positive* correlation between per capita grain production and rural mortality rates. We acknowledge that grain produciton figures reported by the government might have been exagerated during the famine and therefore we construct grain production using inputs that were unlikely to have been altered: monthly temperature and precipitation, grain suitability, area, and population, and we find that there is still a strong positive correlation between constructed grain production per capita and rural mortality rates. Studies have indicated that economic policies and political factors were important contributors to the famine mortality. For example, Chapter 1 shows that collectivization of agriculture increased famine mortality and that ethnic Ukrainians were discriminated against. We demonstrate that even after accounting for these factors there is still a strong positive correlation between 1932 grain production and 1933 mortality.

We then turn to investigating the mechanism that could explain this peculiar positive correlation. We argue that since starvation is equivalent to food availability (more food equals less starvation), it must be the case that disproportionately *more* grain was procured from provinces that produced more. We show that provinces that are more productive in one year usually remain more productive in the next year, but that *production growth* is lower in more productive provinces. This means that when an aggregate shock to production occurs more productive provinces experience a higher absolute drop in production (while still remaining more productive). We argue that the government procurement policy was *inflexible*, that is, it did not easily adjusted to the changes in local production, and *progressive*, that is, it aimed at extracting more from areas known to produce more. Therefore, higher *production gap*, the difference between target production and the realized production, must lead to more overprocurement and higher mortality. We estimate the relationship between production gap and mortality assuming that target production equals to production two years ago and show that there is a strong positive relationship between production gap and mortality. We then do a crude quantification exercise and demonstrate that the inflexible procurement system explains 45% to 50% of excess rural deaths in 1933.

Finally, using available data on procurement, we demonstrate that indeed higher past production is associated with higher procurement, and that with the start of five-year plans in 1929 the increase in procurement occurred disproportionally in more productive areas. We also show that higher production gap is associated with lower rural grain retention and that higher retention is associated with lower mortality.

The article is organized as follows. Section 2.2 provides some background of the 1933 famine, Section 2.3 describes the data, 2.4 studies the average food availability, Section 2.5 investigates spatial correlation between famine severity and grain production, Section 2.6 estimates the mechanism, and Section 2.7 concludes.

2.2 Background

This section provides very basic stylized facts of the Russian and Soviet history and the 1933 famine. Allen (2003) presents a study of the evolution of Russian economy in the 20th century from an economics perspective. Lewin (1968) studies Russian and Soviet peasants, Conquest (1986) was the first Western historian to investigate the 1933 famine, and Davies and Wheatcroft (2009) provide an extensive research of this famine using recently declassified archival documents. Ó Gráda (2009) and Alfani and Ó Gráda (2017) place the 1933 Soviet famine in context of the history of world famines.

Before 1917 the Russian Empire was governed by the tzar. Tzarist policies limited economic development (see, for example Cheremukhin et al. (2017)). In 1917 a revolution occurred and, after a period of turmoil and a civil war, a Communist Party ceased control over the government. The country changed name from Russia to Soviet Union. After a brief period of experimentation and attempts to reorganize the economy in accordance with the communist ideals, a quasi-market New Economic Policy (NEP) was introduced in 1921. Under NEP small-scale manufacturers were allowed to operate independently. In the countryside, where most of the grain was produced by small individual peasants, peasants were obliged to pay taxes and were allowed to sell their produce on a free market. More details about the NEP period of the Soviet history can be found in Gregory (1994). Markevich and Harrison (2011) show that under NEP the Soviet economy rapidly recovered from the losses of the revolution and the civil war.

By the late 1920s Stalin consolidated power within the Communist Party, and in late 1928 the first five-year plan for the development of the economy was introduced. NEP was abandoned, large-scale investment and construction begun. In the countryside, trading of foodstuffs was banned, the government procured grain from peasants at below-market prices and then rationed it to the urban dwellers or exported it to pay for the imported machines. In late 1929 comprehensive collectivization campaign was launched: peasants were forced to give up their private land, livestock and implements and to join collective farms. By 1932 approximately 70% of rural households belonged to collective farms. Although in some instances collective farm members preserved some of their livestock and land plots, these private sources were insufficient for subsistence.

During 1929 and 1930 grain production and collections went as planned (Davies and Wheatcroft, 2009, Table 1), but in 1931 and 1932 production was much lower than planned. Stalin, unwilling to accept low harvest estimates insisted that procurement went as planned (actually, even more than planned was extracted). In 1933 a disaster struck: usually grain-surplus areas of Ukraine and southern Russia were hit by a severe famine. The peak of the famine occurred in the winter and spring of 1933 after the 1932 harvest. According to contemporary estimates six to eight million people perished as a result of this famine.

In 1933 as a reaction to the food crisis the government changed its policy. Although collectivization continued, collective farm members were allowed to have private plots and to keep some livestock, and, after paying taxes, to sell produce from their private plots on the free markets in the cities (so-called kolkhoz markets). Thus, the government guaranteed peasants subsistence by reintroducing small private sector.

2.3 Data

We construct a panel of 25 provinces spanning European provinces on Belarus, Russia, and Ukraine. For these provinces we collected yearly data on population, urban population, deaths, rural deaths, and grain production for the years from 1900 to 1970.

The main obstacle in constructing the data is that administrative division was constantly changing under the Soviet government and the available data all refer to different administrative boundaries. We digitized 1926, 1928, and 1934–1939 administrative maps and selected 1934 as our baseline map. This is the most conservative choice since the number of provinces gradually increased after 1934. The 25 European provinces in our main sample cover more than 80% of population (as of 1927) and grain production (as of 1928). We used the digitized administrative maps from other years to calculate data in 1934 administrative borders.

We combined published and archival data on population, deaths, and grain production and procurement. The source of each variable is presented in the Appendix Table B.1. Generally speaking, published data are available until the 1933 famine, but for the later years we rely mostly on archival figures as the government ceased publication of statistical information in response to the crisis. Grain production figures are only available for 1900–1914, 1928, and 1932–1940. Due to the lack of data in the years leading to the famine, and to avoid potential overreporting we estimate grain production function using 1900–1914 data and then construct grain production for 1925–1940 (see Section 2.5).

2.4 Rural food availability and spatial variation in famine mortality

This section demonstrates that the average grain production far exceed the amount of food necessary for survival and that there was a large variation in rural mortality during the famine.

First, we consider the total grain production and procurement in Belarus, Russia, and Ukraine as reported by the government and calculate rural food retention and its caloric value. Table 2.1 Column (1) reports grain production, Column (2) presents total population of Belarus, Russia, and Ukraine, Column (3) shows rural population, and Column (4) presents reported procurement rate, that is, the share of the harvest procured by the government, for all years for which data are available. Column (5) then calculates per capita production in kilograms per person per year, and Column (6) then converts these values into calories per person per day assuming one kilogram

Table 2.1: Average food availability

					Per capita production		Per capita rural retention	
Year	Grain mln t (1)	Population mln (2)	Rural population mln (3)	Proc rate (proc/grain) (4)	Kg/year (5)	Calories/day (6)	Kg/year (7)	Calories/day (8)
1925	70	129	109	0.12	540	4441	561	4608
1926	73	132	110	0.14	555	4561	568	4671
1927	71	135	111		528	4342		
1928	66	138	115	0.15	477	3921	488	4011
1929	69	141	117	0.23	487	3999	456	3747
1930	79	144	118	0.27	551	4527	491	4036
1931	61	147	118	0.37	414	3400	329	2705
1932	64	143	112	0.28	449	3689	414	3400
1933	84	139	106	0.26	605	4971	588	4833
1934	80	126	93		636	5228		
1935	83	132	97		624	5132		
1936	75	135	95		555	4558		
1937	112	138	93		812	6675		
1938	85	140	93		607	4986		
1939	91	142	93		645	5297		

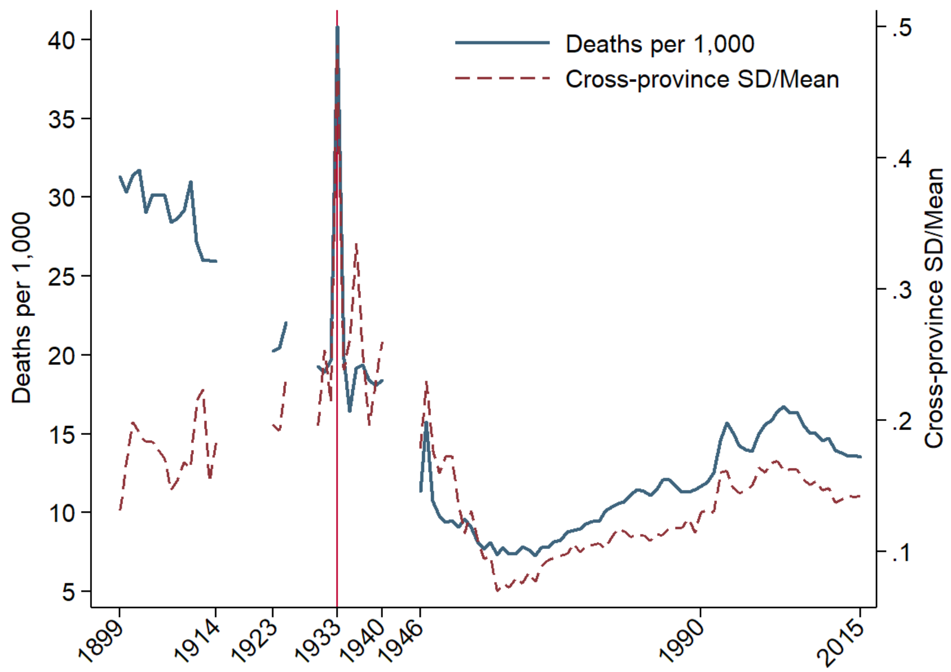
of grain yields 3,000 calories[5]. Columns (7) and (8) then repeat the exercise for rural population only by calculating rural per capita retention, which is the difference between production and procurement, and then converting it into caloric value.

Few things might be noticed from the figures presented in the table. First, the aggregate production did decrease in 1931 and 1932, two years before the peak of the famine. In addition, procurement increased in these years. However, average per capita grain availability in 1931 and 1932 was still far above the starvation level yielding at the minimum more than 3,000 calories per day per person. Similarly for rural population, although rural retention did decrease in 1931 and 1932, on average there appears to be enough food left in the countryside to avoid starvation. Thus, the *distribution* of food must be studied to understand the famine.

Next, we turn to study average mortality. Figure 2.1 presents yearly average mortality for 25 provinces in our sample. It demonstrates that the average mortality spikes in 1933, its value more than doubling. In addition, Figure 2.1 presents cross-province standard deviation of mortality

[5]The caloric yeild of grain depends on the type of grain. In the Soviet Union main grains produced were rye, wheat, and barley. Rye and barley yield approximately 3,000 calories per kilogram while wheat yields slightly more. We take the most conservative approach in calculating caloric yield.

Figure 2.1: Province-level mortality rates – Mean and Cross-Province Standard Deviation



Notes. The solid line plots mean mortality rates, that is, the average mortality rates across provinces in each year. The dashed line is the standardized variance in mortality rates, which is the standard deviation in mortality rates across provinces in year t divided by the mean mortality in year t.

normalized by the mean mortality. This is a measure of variability of mortality within a year. As Figure 2.1 demonstrates, cross-province variation in mortality also spikes in 1933. Thus, we need to explain not only the average rise in mortality, but also why the famine was much more severe in some provinces compared to other.

2.5 Spatial correlation between famine severity and productivity

This section investigates the empirical relationship between grain production and rural mortality across provinces. It documents statistically strong positive correlation between mortality and productivity for the famine year.

It is possible that, fearing demotion and political reprisals, Soviet officials overreported grain production. If misreporting occurred more in the southern areas subsequently struck by the famine, the estimated relationship between grain production and rural mortality might be confounded by misreporting.

To address this concern, we construct a time-varying measure of grain production using 1901–1914 data[6]. More specifically, we estimate grain production function by regressing log grain output in province p and year t on the following inputs: log total province area, grain suitability, log rural population, fall, winter, spring, and summer temperature and precipitation, their interactions and square terms. The production function regression has an adjusted R^2 of 0.99, that is, the inputs explain 99% of the variation of grain production within the sample[7]. The temperature and precipitation figures are constructed from the weather stations reports that were never known to have been manipulated by the Soviet officials. The grain suitability index is created by the Global Agro-Ecological Zones (GAEZ) model developed by the Food and Agricultural Organization[8]. The total land area is calculated from the digitized maps. The only production function input from the Soviet era is rural population, and the Soviet statisticians had little incentives to overreport population figures before the famine[9]. Thus, constructed grain production figures are unlikely to be biased by Soviet officials misreporting.

We then use the estimated production function to construct grain output during 1927–1939 and 1927–1970. Figure 2.2 plots reported and constructed grain figures along with 45° line. Constructed grain production figures are reasonably close to reported grain, the discrepancies might be explained by misreporting and measurement error. To be conservative, in the subsequent analysis

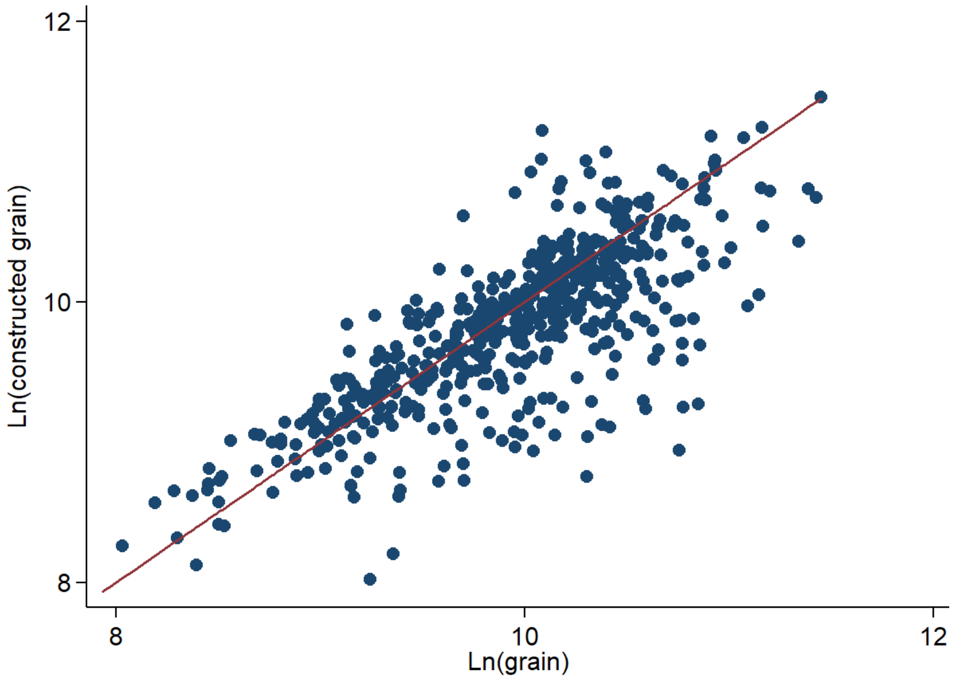
[6]Gridded weather data are only available starting 1900. Since we are using fall and winter temperature and precipitation in estimating grain production function, we are restricted to start with 1901 output. We omit years after 1914 because grain production might have been affected by World War I.

[7]Due to the large number of regressors and many interaction terms, it is difficult to interpret the each coefficient of production function. We therefore do not report the estimated production function. It is available upon request.

[8]We assume low inputs and rain-fed agriculture.

[9]Nevertheless, to address potential misreporting of population figures, we re-estimate production function using only land area, grain suitability, and weather inputs. The results using this production function are very close the the ones reported in the paper (available upon request).

Figure 2.2: Reported grain production and constructed grain production



Notes. Log reported and Log constructed grain production during 1928 – 1940. Constructed grain production is calculated using grain production function described in Section 2.5. The solid line represents the 45° line. The correlation between log reported and log constructed grain is 0.77.

we use constructed grain figures.

To study the relationship between per capita production and rural mortality we estimate the following specification:

$$m_{p,t+1} = \alpha Grain_{p,t} + \beta Grain_{p,t} I_t^{fam} + Z'_{p,t}\gamma + \nu_t + \theta_p + \delta_p t + \sigma_{t,r} + \epsilon_{p,t,r} \qquad (2.1)$$

where p stands for province, and t – year. $m_{p,t+1}$ is log number of rural deaths in province p and year $t+1$, $Grain_{p,t}$ is log grain production (constructed or reported) in province p and year t, I_t^{fam} is a famine year indicator that equals to one in 1932 and zero otherwise, $Z'_{p,t}$ are province characteristics (in the baseline specification, log population and log urban population), and ν_t, θ_p, $\sigma_{t,r}$, and $\delta_p t$ are respectively year, province, republic-year fixed effects and province-specific time trends, and $\epsilon_{p,t,r}$ is the error term. Year fixed effects account for changes in economic conditions that affect all provinces simultaneously, province fixed effects ensure that the resulting estimates are not explained by differences in unobserved province characteristics, and republic-year fixed effects are included to make sure that the results are not driven solely by Ukrainian provinces. Due to the vast size of the Soviet Union, different provinces might have different development trajectories, province-specific time trends account for that. To account for possible heteroscedasticity, robust standard errors are reported for all estimates. Thus, equation (2.1) estimates the correlation between grain production and next year mortality in non-famine year ($\widehat{\alpha}$), and the correlation between grain production and next year mortality in the famine year ($\widehat{\alpha + \beta}$).

Table 2.2 presents the estimates of the equation (2.1). Columns (1) and (2) use constructed grain, and Columns (3) and (4) use reported grain. Column (1) uses data for all available years (1927 – 1970) and demonstrates that there is a strong positive correlation between constructed grain production and mortality in the famine year. Column (2) restricts the sample to years close to the famine (1927 – 1939) and shows that the results are not driven by the post-1939 data, the estimates in Column (2) being very close to the baseline estimate in Column (1). Columns (3) and (4) demonstrate the the positive correlation between grain production and mortality during the famine also holds when reported grain figures are used.

Figure 2.3 plots conditional scatter plot and fitted values of the estimates of the coefficient of $Grain_{p,t} I_t^{fam}$ in specification (2.1) corresponding to the estimates presented in Table 2.2 Column (1). It demonstrates that the positive correlation between grain production and rural mortality in the famine year is not driven by outliers.

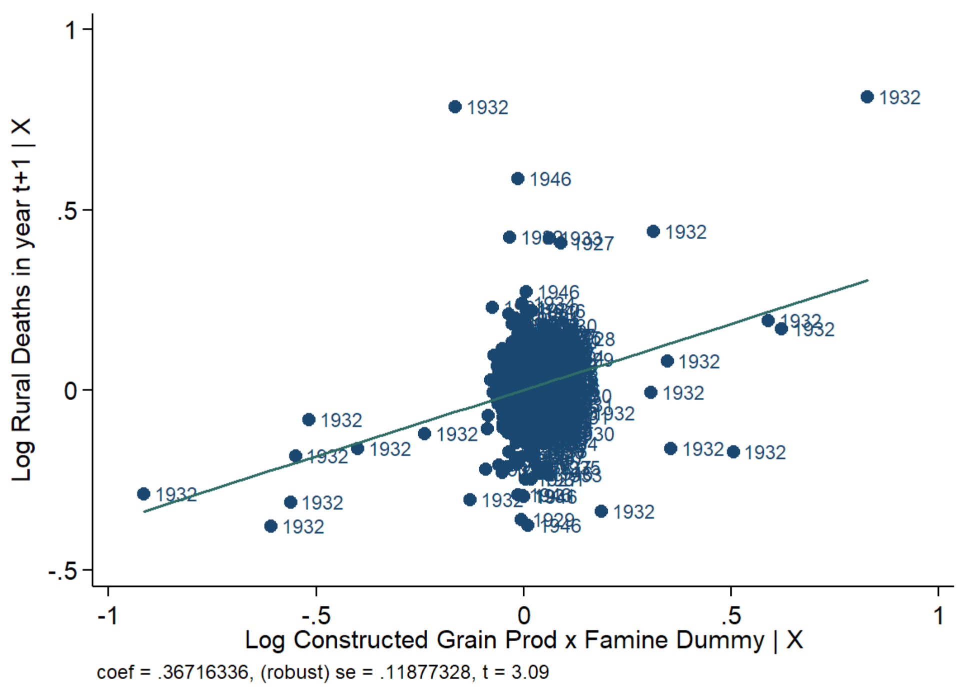
Next, it is possible that the correlation between grain production and rural mortality is negative for some years, positive for other years, and zero on average, and the positive correlation between grain production and rural mortality in the famine year occurred simply by chance. To check whether this is true, we study the correlation between grain production and mortality year by year

Table 2.2: The correlation between constructed (and reported) grain productivity and mortality rates across provinces

	Dependent variable: Ln rural deaths in year $t+1$			
	A. Constructed grain		B. Reported grain	
	1927 – 1970	1927 – 1939	1928 – 1970	1928 – 1939
	(1)	(2)	(3)	(4)
Ln grain × famine	0.367***	0.354***	0.247**	0.263**
	(0.119)	(0.128)	(0.105)	(0.118)
Ln grain	0.004	-0.010	0.017	-0.069
	(0.019)	(0.034)	(0.024)	(0.067)
Observations	746	284	452	204
R^2	0.986	0.978	0.988	0.977
Provinces	25	25	25	25

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%.
The famine dummy is equal to one for the year 1932, zero otherwize. All regressions control for log total population, log urban population, province and year fixed effects, and province-specific time trends. Robust standard errors are presented in parentheses. Section 2.3 provides details on data construction.

Figure 2.3: Mortality rates and constructed grain productivity during the famine – residual plot of *Ln constructed grain production × famine dummy variable*.



Notes: This figure plots the residuals and the regression line from regressing log mortality in year $t+1$ on the interaction of log constructed grain production in year t and the famine dummy variable, while controlling for log constructed grain production, log total population, log urban population, province and year fixed effects, and province-specific time trends (Table 2.2 Column (1), $\hat{\beta}$ from equation (2.1)). All of the explanatory variables are measured in year t. Constructed production is predicted by climate, geography, total land area, and total rural population as inputs.

by estimating the following specification:

$$m_{p,t+1} = \sum_{\tau} \beta_{\tau} Grain_{p,\tau} I[t = \tau] + Z'_{p,t}\gamma + \nu_t + \theta_p + \delta_p t + \sigma_{t,r} + \epsilon_{p,t,r} \qquad (2.2)$$

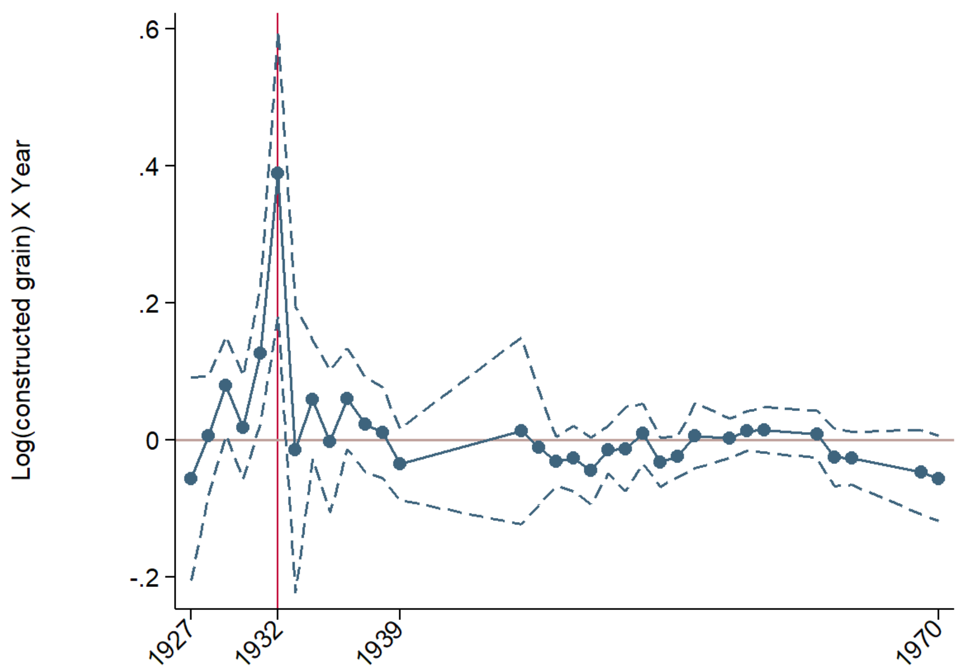
where $m_{p,t+1}$, $Grain_{p,\tau}$, $Z'_{p,t}$, ν_t, θ_p, $\delta_p t$, and $\sigma_{t,r}$ are as in specification (2.1), $I[t = \tau]$ is a year indicator that equal to one if year t equals to τ and zero otherwise. Since this specification estimates the correlation between grain production in year t and rural mortality in year $t+1$ separately for all years for which data are available, it omits the term estimating average correlation between grain and mortality, $\alpha Grain_{p,t}$.

Figure 2.4 plots the set of estimated β_τ coefficients with their 95% confidence intervals using constructed grain. It demonstrates that for non-famine years the correlation between grain production and next year rural mortality is close to zero, but for the famine year (that is, 1932 grain production and 1933 rural mortality) there is a very strong and highly statistically significant positive relationship between grain and mortality. Thus, the positive correlation between grain and mortality presented in Table 2.2 is not a result of some spurious positive correlation that occurred sporadically.

The 1933 famine occurred in the southern provinces on Russia and Ukraine, regions that historically were more productive. It is possible that the economic policies implemented by the government at the time (collectivization of agriculture) varied in their intensity, causing bias to our estimates of constructed grain production. Another potential concern is that historically more productive regions were different in some other characteristics and these characteristics could lead to higher mortality in 1933. For example, more productive regions could have had more ethnic Ukrainians, and if, as some historians argue, there was a strong bias against ethnic Ukrainians, higher mortality could have been explained by factors other than grain production.

To account for this, Table 2.3 presents estimates of specification (2.1) with additional controls accounting for economic policies, ethnic composition, and political zealousness. Column (1) adds

Figure 2.4: The correlation between constructed productivity and mortality rates over time – estimated coefficients of *Ln constructed grain production* $\times$ *year dummy variables* and 95% Confidence Intervals.



Notes: The solid line plots the coefficients of the interaction effects of log constructed grain production and dummy variables for each year, which are estimated by regressing log rural mortality in year $t + 1$ on the interaction variables, while controlling for log total population, log urban population, year fixed effects, province fixed effects, and province-specific time trends using equation (2.2). All of the explanatory variables are measured in year t. Constructed production is predicted by climate, geography, total land area, and total rural population as inputs.

Table 2.3: The correlation between constructed grain productivity and mortality rates across provinces – robustness to controls

	Dependent variable: Ln rural deaths in year $t+1$			
	(1)	(2)	(3)	(4)
Ln grain × famine	0.312***	0.235**	0.392***	0.223***
	(0.088)	(0.102)	(0.114)	(0.081)
Ln grain	0.004	0.010	0.004	0.008
	(0.018)	(0.018)	(0.019)	(0.018)
Collectivization 1930 × famine	✓			✓
Ukrainians 1926 × famine		✓		✓
Ln communists 1926 × famine			✓	✓
Observations	746	746	746	746
R^2	0.987	0.987	0.986	0.988
Provinces	25	25	25	25

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%.
The famine dummy is equal to one for the year 1932, zero otherwize. All regressions control for log total population, log urban population, province and year fixed effects, and province-specific time trends. Robust standard errors are presented in parentheses. Section 2.3 provides details on data construction.

1930 collectivization rate interacted with the famine indicator to province controls. Column (2) adds share of ethnic Ukrainians in rural population according to 1926 census interacted with the famine dummy. Estimates in Column (3) control for log number of Communist party members in 1926 interacted with the famine dummy. Finally, Column (4) adds collectivization rate, share of ethnic Ukrainians, and log number of Communists interacted with the famine indicator. In all specifications there is still a statistically strong positive correlation between log grain output interacted with the famine indicator and next year's rural mortality. The additional controls slightly decrease the coefficient on $Grain_{p,t}I_t^{fam}$, but do not explain it away. Thus, it is unlikely that the positive correlation between grain production and rural mortality in the famine year is explained by the bias introduced by differential exposure to the government economic policies or by other factors.

2.6 The inflexible grain procurement policy

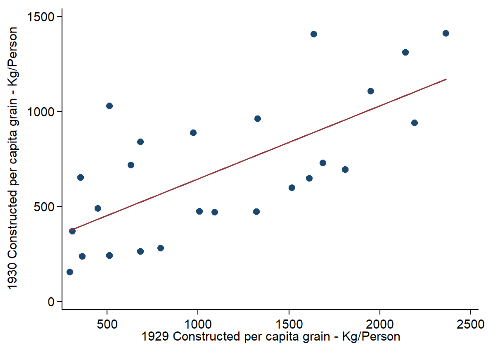
Famine is mechanically equivalent to the amount of food available to individuals. That is, less food must lead to more starvation and higher mortality. The opposite is also true, more starvation and higher mortality must mean that less food is available to population. Available food, in turn, is the difference between produced food and the food procured by the government. Therefore, if higher mortality is observed in the areas that produced more grain per capita, this positive relationship has to be explained by procurement.

Starting in the late 1920s the government procurement system was progressive: it aimed at extracting more grain from areas that produced more. With the introduction of five-year plans, each year in December-January the government set total production and procurement targets. These yearly targets were based on the five-year plan with some adjustments based on past production and procurement. During winter and spring production and procurement plans for provinces were set. In July, when harvesting of winter grain begins, production estimates were updated. However, harvesting usually takes several months, from early July to late September, and the actual harvest size was difficult to observe. Davies and Wheatcroft (2009) point out that it usually took approximately two years for the government statisticians to gather all information and construct accurate harvest estimates. Procurement started with the harvesting in July and occurred until January or February next year. It was difficult for the government to adjust procurement targets set in January of the previous year to the changes in local harvest estimates: in addition to delays due to imperfect statistical information, the atmosphere of suspicion and the hunt for 'saboteurs' further reduced the incentives to report the harvest truthfully.

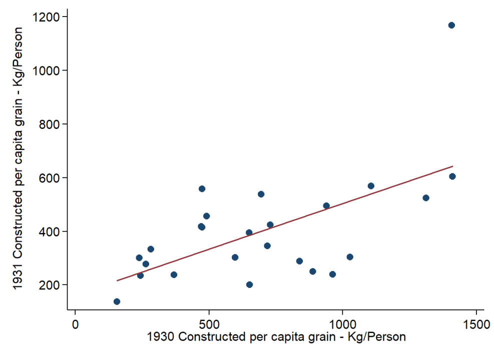
To better understand the spatial patterns of drop in production Figure 2.5 presents the correlation of grain production and production growth versus lagged grain production. First, it shows that provinces that produce more grain in one year usually still produce more in the next year. That is, Figures 2.5 (a-c) demonstrate that provinces that produced more in 1929 maintained higher production rank in 1930, provinces that produced more in 1930 still produced more in 1931, and there is a strong positive correlation in production rank between 1931 and 1932. However, Figures 2.5 (d-f) show that *production growth* is typically negatively correlated with the past production. That is, provinces that produced more in one year on average experienced lower production growth, or, equivalently, higher production drop in the next year (but not as high a drop as to change the productivity rank). Thus, we might expect that in a relatively bad year more productive provinces would still produce more grain, but, while remaining more productive, these provinces would also experience higher absolute drop in grain production. As a result, if the government determines procurement targets based on the past production, the gap between past production and current production might be higher for more productive provinces, leading to higher overprocurement and higher mortality.

Figure 2.5: The correlation between constructed productivity and productivity growth versus lagged constructed productivity.

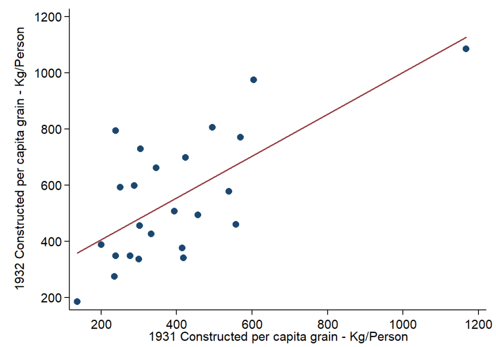
(a) 1930 versus 1929 productivity



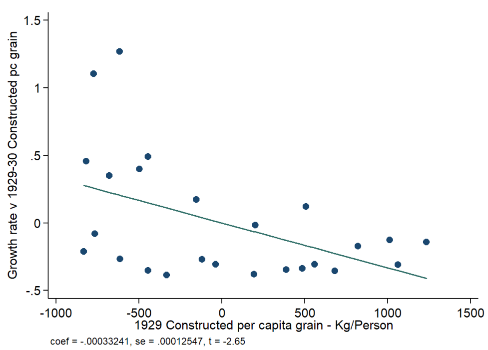
(b) 1931 versus 1930 productivity



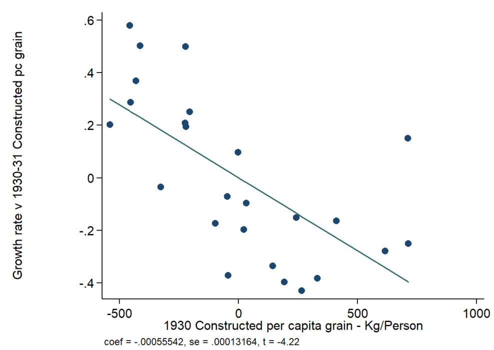
(c) 1932 versus 1931 productivity



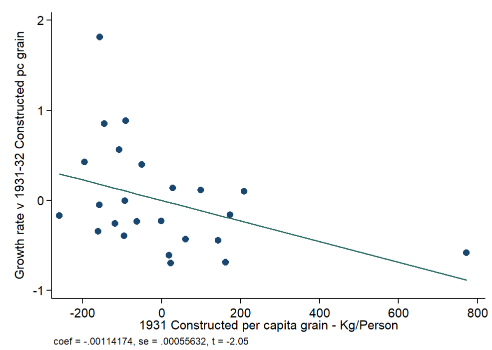
(d) 1930 productivity growth versus 1929 productivity



(e) 1931 productivity growth versus 1930 productivity



(f) 1932 productivity growth versus 1931 productivity



Notes: Constructed production is predicted by climate, geography, total land area, and total rural population as inputs. Constructed productivity = constructed province production/province population.

Meng et al. (2015) in Section 6.2 provide a stylized example of how the lack of accurate information about local conditions might lead to overprocurement from areas known to be more productive on average, and how this overprocurement can generate a positive correlation between grain production per capita and mortality. In their example higher gap between grain production expected by the government and the actual grain production leads to higher overprocurement (and therefore lower grain retention) and consequently to higher mortality. Therefore, to understand the mechanism we study the relationship between production gap (the difference between expected and realized production) and mortality. We estimate the following specification:

$$m_{p,t+1} = F(\hat{P}_{p,t} - P_{p,t}) + \Gamma(urbanization_{p,t}) + \epsilon_{p,t} \tag{2.3}$$

where as before p stands for province, t – year, $m_{p,t+1}$ – rural mortality in province p and year $t+1$. $P_{p,t}$ – constructed grain production per capita in province p and year t, and $\hat{P}_{p,t}$ – government projected grain production per capita in province p and year t. Given that it took approximately two years to create a precise harvest estimates we take a conservative approach and assume that the government projected production equals to actual production two years ago. The difference between projected and actual production $\hat{P}_{p,t} - P_{p,t}$ is *production gap*. Thus, we estimate a relationship between rural mortality in province p and year $t + 1$ and a function F of production gap and a function Γ of urbanization rate $urbanization_{p,t}$. We allow for a flexible functional form of the relationship between the production gap and mortality and estimate a step-function F defined over the intervals of production gaps. We divide production gaps into six groups[10]. For simplicity, we assume that the Γ function is linear.

First we estimate the relationship between mortality and production gap by regressing rural mortality in year $t + 1$ on six indicators of production gap intervals and urbanization. Table 2.4 Column (1) presents the estimated coefficients and their standard errors and Figure 2.6a plots

[10] We concentrate on the production gaps between -400 kg/person and up to 400 kg/person as most of our sample falls in this range.

Table 2.4: The correlation between the production gap and mortality rates

	Dependent variable:					
	Number of rural deaths per 1,000 in year $t+1$			Grain retention (kg/person) in year t		
	(1)	(2)	(3)	(4)	(5)	(6)
Government projected PC prod − realized PC prod is:						
Group 1: ≤ -100	20.636***	16.588***	14.853***	1101.661***	1290.354***	484.639*
	(3.954)	(1.037)	(1.464)	(218.753)	(247.102)	(244.729)
Group 2: $(-100, -50]$	20.730***	16.205***	14.921***	741.091***	894.009***	174.320
	(3.943)	(1.147)	(1.584)	(249.251)	(256.898)	(244.645)
Group 3: $(-50, 0]$	21.574***	16.136***	15.007***	729.376***	877.995***	133.334
	(4.008)	(1.176)	(1.445)	(229.815)	(241.233)	(230.465)
Group 4: $(0, 50]$	22.234***	16.441***	15.499***	584.485***	708.558***	96.526
	(5.474)	(1.314)	(1.550)	(210.562)	(228.467)	(220.654)
Group 5: $(50, 100]$	22.037***	16.225***	15.382***	652.156***	824.230***	125.716
	(4.269)	(1.293)	(1.530)	(232.322)	(248.905)	(254.884)
Group 6: > 100	24.130***	16.836***	16.716***	601.099**	706.660***	42.867
	(4.145)	(1.027)	(1.340)	(232.942)	(246.540)	(255.575)
Political controls		✓	✓		✓	✓
Year FE			✓			✓
Observations	263	263	263	101	101	101
R^2	0.834	0.948	0.951	0.910	0.920	0.950

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%.
The famine dummy is equal to one for the year 1932, zero otherwize. All regressions control for log total population, log urban population, province and year fixed effects, and province-specific time trends. Robust standard errors are presented in parentheses. Section 2.3 provides details on data construction.

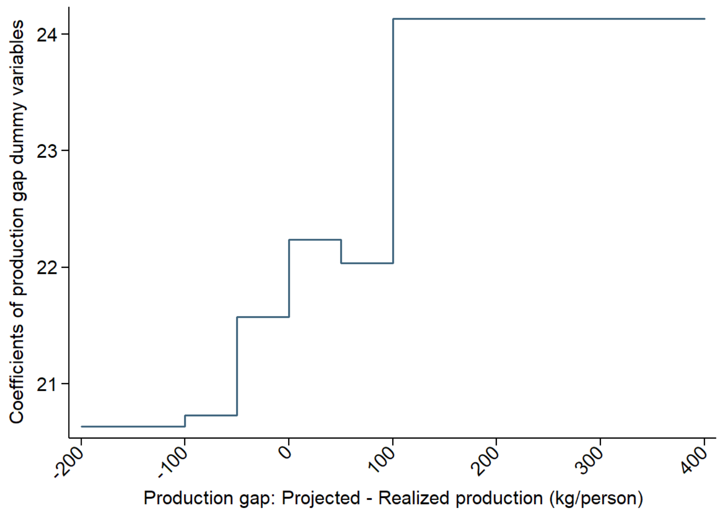
the coefficients against production gap intervals. Fist, for two lowest production gap intervals the estimated mortality is close to the "normal" levels of about 20 per 1,000. For higher values of production gap mortality increases consistent with our proposed mechanism that higher production gap led to higher mortality.

We verify that the relationship between production gap and mortality is not explained by political factors by controlling for collectivization rate, rural share of ethnic Ukrainians, and log number of Communist Party members. Table 2.4 Column (2) presents the estimates. They are roughly similar to the ones presented in Column (1). Finally, we also include year fixed effects to restrict the variation to within-year variation. Table 2.4 Column (3) presents the estimates. Rural mortality increases with production gap. Thus, the positive relationship between production gap and mortality is not explained by political factors and is driven by within-year variation in production.

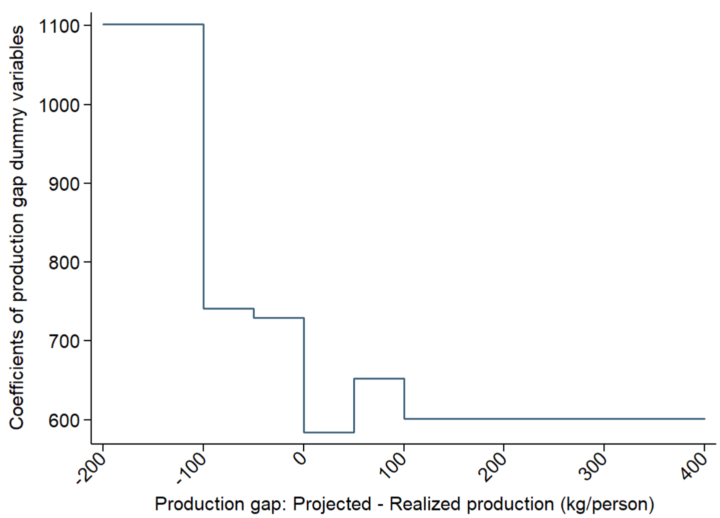
Finally, we provide a crude estimate of the total impact of inflexible procurement policy on

Figure 2.6: The effect of the production gap (government projected production minus realized production) on mortality and food retention, 1929 - 1933

(a) Mortality Rate (Deaths per 1,000)



(b) Per Capita Grain Retention (Kg/Person)



Notes: The coefficients of production gap dummy variables are estimated from regressing (a) mortality rates or (b) grain retention in year $t+1$ on the gap between government projected production and realized production in year t, while controlling for the urban population share; we are estimating the function $F(\cdot)$ in equation (2.3), where the dependent variable is (a) mortality rates or (b) grain retention in year $t{+}1$. The production gap is the difference between government projected production and realized production. The regression uses constructed production measures, which are predicted by climate, geography, total land area, and total rural population. The coefficients and standard errors are presented in Table 2.4 column (1) and column (4) respectively.

mortality. If the government was able to adjust procurement to realized production (that is, if procurement policy was flexible) then by definition production gap would have been zero. We therefore calculate *benchmark deaths* as a number of predicted deaths with zero production gap. Next, we calculate *predicted deaths* – a number of deaths predicted by our model with the actual observed production gaps. *Predicted excess deaths* is the difference between predicted deaths and benchmark deaths. *Reported excess deaths* is a difference between reported deaths in our sample and benchmark deaths. The ratio of predicted excess deaths and reported excess deaths is a share of excess deaths explained by the inflexible procurement policy. Our model explains from 50% (Column (1)) to 45% (Column (3)) of excess deaths. Thus, the inflexible procurement policy was a sizable contributor to the 1933 famine.

So far in our analysis of the mechanism we assumed that higher past production increased procurement and that the positive correlation between production and mortality in the famine year must be explained by procurement. Below we use available procurement data to verify both of these claims. Only 1925, 1927, and 1929–1932 figures are available, and only for Russian provinces therefore all subsequent estimates should be interpreted with caution.

First, we assumed that higher past production increased procurement. Table 2.5 presents the estimates of the relationship between per capita procurement in year t and per capita produciton in year $t-2$ or 3-year moving average production for the year $t-2$. Column (1) shows that there is a statistically strong positive relationship between production in year $t-2$ and procurement in year t. Column (3) demonstrates a similarly strong positive relationship between 3-year average production in year $t-2$ and procurement in year t. To ensure that this positive relationship is not driven by political factors, in Columns (2) and (4) we include political controls: collectivization rate, rural share of ethnic Ukrainians, and log number of Communist Party workers. The coefficients decrease compared to the estimates without political controls, but are still positive and highly statistically significant. The fact that coefficients decrease signifies the importance of political factors in determining procurement. Nevertheless, grain production is also an important factor.

Table 2.5: Procurement and past production

	Dependent variable: per capita procurement$_t$			
	(1)	(2)	(3)	(4)
Grain pc$_{t-2}$	0.221***	0.107***		
	(0.025)	(0.023)		
3 year moving average grain pc$_{t-2}$			0.286***	0.144***
			(0.042)	(0.034)
Political controls		✓		✓
Year FE	✓	✓	✓	✓
Observations	94	94	68	68
R^2	0.517	0.759	0.552	0.751

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%.
The famine dummy is equal to one for the year 1932, zero otherwize. All regressions control for log total population, log urban population, province and year fixed effects, and province-specific time trends. Robust standard errors are presented in parentheses. Section 2.3 provides details on data construction.

An increase of production by a hundred kilograms per person increased subsequent procurement by approximately ten to fourteen kilograms per person.

Next, to demonstrate the progressive nature of procurement system in the years leading to the famine we estimate the relationship between constructed production in year t and procurement in year t. We regress log procurement on log production interacted with year dummies and controlling for log population and log urban population as in specification (2.2). Figure 2.7 presents the coefficients of the interactions of log constructed production and year indicators with their 95% confidence intervals. It demonstrates that in the three years leading to the famine (1930, 1931, 1932) there was a higher increase in procurement in more productive provinces.

Next, similar to the relationship between production gap and mortality, we can estimate the relationship between production gap and reported grain retention[11]. As before, we regress per capita retention on six indicators of production gap intervals controlling for urbanization rate. Table 2.4 Column (4) reports the coefficients and their standard errors, and Figure 2.6b plots the coefficients against production gap intervals. The estimates demonstrate that higher production gap is associated with lower retention. To ensure that the negative relationship between production gap and rural retention is not explained by political factors we re-estimate it controlling for collectivization,

[11] Grain retention is the difference between constructed production and reported procurement.

Figure 2.7: The The correlation between constructed productivity and grain procurement rates - estimated coefficients of *Ln constructed grain production* $\times$ *year dummy* variables and their 95% Confidence Intervals.

Notes: The interaction coefficients are estimated by regressing the log of grain procurement on the interaction of log constructed grain with year dummy variables, while controlling for log urban population, log total population, and year fixed effects. The plotted coefficients are β_τ from equation (2.2) where the dependent variable is log procurement.

rural share of ethnic Ukrainians, and log number of Communist party members. Table 2.4 Column (5) reports the estimates. As in Column (4), lower production gap is associated with higher retention. Finally, to use only within-year variation we also include year fixed effects, Column (6) reports the estimates. The magnitude of the coefficients changes but the qualitative results remain the same: lower production gap is associated with higher retention. Thus, the relationship between production gap and retention is consistent with the inflexible procurement policy and is not driven by other political factors.

Finally, we can use a simple linear specification to directly estimate a relationship between production gap and retention, and then between rural retention and mortality. First, we regress production gap on reported retention controlling for urbanization and political factors, Table 2.6 Column (1) reports the estimate. As in the previous exercise, there is a strong negative relationship between production gap and rural retention. Next, we estimate a linear relationship between production gap and rural mortality controlling for urbanization and political factors. Table 2.6 Column (2) presents the estimates. Again, similar to the results presented in Table 2.4 and Figure 2.6a there is a strong positive relationship between production gap an rural mortality. Next, as a sanity check, we estimate the relationship between retention and mortality, again controlling for urbanization and political factors. Table 2.6 Column (3) presents the estimate. As expected, there is a negative relationship between rural retention and mortality. Finally, as a crude scaling exercise, to assess how much mortality occurred due to decrease in retention because of production gap we instrument for retention with production gap[12]. Table 2.6 Column (4) presents the 2SLS estimate, it's negative and statistically significant. These estimates are consistent with our hypothesis that higher production gap increased overprocurement, decreased rural food retention and therefore increased mortality.

[12]Table 2.6 Column (1) is the first stage of this estimate, and Table 2.6 Column (2) is a reduced form.

Table 2.6: Mortality, grain retention and the production gap

	Dependent variable:			
	Retention	Rural mortality in year $t + 1$		
	(1)	(2)	(3)	(4), 2SLS
Production gap (kg/person)	-0.601***	0.003***		
	(0.096)	(0.001)		
Retention (kg/person)			-0.004*	-0.005**
			(0.002)	(0.003)
Observations	79	276	79	79
R^2	0.810	0.482	0.451	0.447

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%.
The famine dummy is equal to one for the year 1932, zero otherwize. All regressions control for log total population, log urban population, province and year fixed effects, and province-specific time trends. Robust standard errors are presented in parentheses. Section 2.3 provides details on data construction.

2.7 Conclusion

The 1933 Soviet famine was one of the worst famines in Russian and Soviet history and the first famine in the series of famines that occurred in command economies. The memory of this famine still affects the attitudes and believes of people living in contemporary Belarus, Russia, and Ukraine. This article is one of the first attempts to provide a strong quantitative evidence explaining the famine. Relying on the study of the Great Chinese Famine of 1951–1961 by Meng et al. (2015), this paper demonstrates that the inflexible procurement system had a significant impact on mortality in the Soviet context as well.

Chapter 3

Demographic consequences of the 1933 Soviet famine

3.1 Introduction

An increasing share of economic activity concentrates in urban areas. Urbanization is associated with higher levels of economic development and improved living standards. It is therefore essential to understand the determinants of urbanization patterns and location of cities.

Two competing strands of literature developed in recent years. On the one hand, there is growing evidence that location fundamentals, like access to transportation networks or resource endowments, might have a long-term impact on the formation of urban settlements, even after the initial determinants become obsolete. For example, Bleakley and Lin (2012) argue that historical river portage sites in the U.S. attracted manufacturing and therefore affected the location of cities even after the portage itself ceased to be significant. On the other hand, starting with Davis and Weinstein (2002), there is substantial evidence that once formed, urban networks are extremely resilient to temporary adverse shocks to capital and population.

Using recently discovered archival data, this article studies the impact of the 1933 Soviet famine on population and urbanization patterns. I document that, although most of the famine victims lived in rural areas, the famine had a persistent negative impact on the urban population. In fact, rural population gradually recovered while urban settlements in more affected areas became permanently smaller. The paper argues that the shortage of labor during the crucial years of rapid industrialization hindered the development of cities in areas struck by the famine. Thus, the *timing* of the shock to population appears to be an important factor. While established urban networks recover from large temporary negative shocks, the lack of people during construction and rapid growth might have a permanent negative impact.

My empirical findings are consistent with the classical model presented in Krugman (1991). Since the primary factor of rural sector of the economy, land, is immobile, rural population should be distributed in accordance with location characteristics and, to equalize marginal product of rural labor, short-term shocks to population should have no persistent impact. Agglomerations, on the other hand, can have multiple equilibria because urban capital is relatively more mobile and because of the increasing returns to agglomeration. My results are also consistent with the Michaels et al. (2012) study of structural transformation from rural to urban economy. Studying urban and rural population of U.S. locations, the authors document that, for the intermediate values of population density, population growth (and therefore urbanization) is strongly positively correlated with the initial population density. Thus, a negative shock to population during structural transformation from agricultural to industrialized economy might generate a persistent negative impact.

My study proceeds as follows. First, I employ a panel of 81 provinces constituting present-day Belarus, Russia, and Ukraine and spanning years from 1897 to 2010 and use cross-sectional variation in the severity of the 1933 famine to study the impact of the famine on rural and urban population. I acknowledge that World War II created a major population shock, and any study of long-term demographic consequences must account for the war population losses. To address this, I construct disaggregated WWII losses estimates using archival data on post-war population, and in all estimates I control for WWII losses. I document that rural population in the provinces that experienced higher excess mortality in 1933 was strongly negatively affected but gradually recovered and by 1989 no significant negative effects could be found. In contrast, urban population was negatively affected, and the shock persists till 2010 when observations stop.

Chapter 1 and Chapter 2 present evidence that the 1933 famine was a consequence of ill-thought economic policies of the Soviet government. To address potential endogeneity concerns, I utilize instrumental variable strategy. I rely on the fact that the severity of the 1933 famine was strongly correlated with the 1932 harvest and use 1932 weather (deviations from the mean of spring temperature and summer precipitation) to instrument for the famine severity. Since short-term deviations in weather conditions are unlikely to have a permanent impact on population and economic development, the exclusion restriction is probably satisfied. The instrumental variable estimates are very close to the difference-in-difference estimates. Therefore, it is unlikely that the change in urban population occurred due to Stalin's design to decrease urban population in the famine areas. I also show that the effect on urban population cannot be explained by the existing infrastructure, the severity of Stalin's political repressions, or variation in natural resources endowments.

Next, I demonstrate that consistent with the effect of the famine on rural and urban population, the famine had a short-term negative impact on agriculture and a persistent adverse effect on manufacture. Grain production, sown area, and cattle were negatively affected in the short run, but not in the long run. In contrast, industrial output permanently decreased in the areas with more severe 1933 famine.

To check that the impact on urban population can be observed on a more disaggregated level, I use a panel of more than 500 urban settlements located in Belarus, Russia, and Ukraine. I document that settlements located in areas with relatively higher 1933 mortality were permanently negatively affected, even after accounting for province fixed effects. Moreover, I demonstrate that the effect is driven by urban settlements that were relatively smaller before the famine, consistent with the importance of agglomeration effects.

I argue that the results cannot be explained by the Soviet-specific factors like passport system and restrictions on migration. First, restrictions on migration were relatively more severe on rural population, and the recovery of rural population contradicts severe restrictions on migration. Second, the effects persist 20 years after the collapse of the Soviet Union. Third, Buckley (1995) argues that Soviet passport system had only marginal impact on population mobility. Thus, the findings are in line with economic literature and are unlikely to be explained by factors specific to the Soviet economic system.

This paper contributes to the literature studying the impact of short-term population shocks on long-term economic outcomes. Historians, urban scholars, and economists have long observed remarkable persistence of cities to temporary adverse shocks to population and capital. Grübler (1998) points out that since antiquity very few urban settlements have actually vanished (Grübler, 1998, p. 188). Vale and Campanella (2005) present a collection of essays describing large-scale disasters and subsequent recovery of cities. Davis and Weinstein (2002) document that the cities of Hiroshima and Nagasaki recovered their population to pre-war trend levels after the devastating WWII bombing in just twenty years. In the follow-up work, Davis and Weinstein (2008) construct a detailed dataset of Japanese cities bombed during WWII and again demonstrate that there were no long-term changes in population, share of aggregate manufacturing, or even industrial composition. Brakman et al. (2004) study bombing of German cities during WWII and find no significant long-term impact on West-German cities, although the authors cannot reject the hypothesis that growth of East-German cities follows a random walk. In a subsequent work, Bosker et al. (2007) argue that there is some evidence for multiple equilibria when geographic fundamentals are explicitly taken into account. Studying German cities, the authors find that distance to the Eastern border was an important factor affecting long-term development of West-German cities and the speed of post-WWII recovery. Nevertheless, it might be argued that the evidence presented does not indicate the existence of multiple equilibria, but that the unique equilibrium changed due to changes in economic potential of the cities located close to the Eastern Border. Studying the division and reunification of Germany, Redding and Sturm (2008) use a standard new economic geography model and argue that the relative decline of West-German cities located near the Eastern border can be explained by the change in market access due to the partition of Germany. Miguel and Roland (2011) study U.S. bombing of Vietnam and find no long-term negative effects on local poverty rates, consumption levels, infrastructure, literacy or population density through 2002. Turning to temporary *positive* population shocks, Braun et al. (2017) investigate the inflow of refugees from East Germany to West Germany after WWII and find a persistent effect on the spatial distribution of population within but not between interconnected local labor markets. The authors conclude that the persistence likely depends on the level of observation. In contrast, Feigenbaum et al. (2017) investigating the impact of Sherman's military march through Southern U.S. states during the American Civil War, document persistent (until 1920 when the observations stop) negative impact on the economy and argue that underdevelopment of local credit markets hindered the recovery process. Finally, in the Soviet context, in a controversial work Acemoglu et al. (2011) argue that the Holocaust had a persistent detrimental impact on urban population in Russia because at the time of the Holocaust Jews constituted the majority of Soviet middle class, and therefore the Holocaust was a shock to social structure and human capital. Mikhailova (2018) documents persistent but economically small impact of evacuation of Soviet industry during WWII on the subsequent cities growth.

On the other hand, there is a small but growing body of evidence that factors that are irrelevant or even detrimental in the present day might affect economic development because these factors were beneficial in the past. For example, Nunn and Puga (2012) show that more rugged territories in Africa have higher incomes per capita, and they argue that the effect is because in the past rugged terrain created protection against slave trade. As noted, Bleakley and Lin (2012) demonstrate the importance of portage sites for the development of the cities in the U.S. Finally, Michaels and Rauch (2018) study the location of ancient Roman cities on the territory of contemporary England and France, and demonstrate that once an urban network is formed, only a complete collapse can change it. The authors document that Roman cities were likely to be located close to Roman roads. In England, where cities stopped functioning after the collapse of Roman Empire, the new medieval towns were located closer to rivers taking advantage of more important river waterways, while in France medieval towns were more likely to be located in old Roman cites, suboptimally far from the rivers. I contribute to this literature by showing that in addition to location characteristics, a short-term population shock during the time of rapid construction and growth can have a persistent impact.

The rest of the paper is organized as follows. Section 3.2 gives a short description of Soviet industrialization and the 1933 famine. Section 3.3 characterizes the data I use. Section 3.4 discusses empirical approach and offers instrumental variable strategy. Section 3.5 presents the main results, some robustness checks, and investigates possible mechanisms. Section 3.6 concludes. Additional robustness checks and tables are presented in the Appendix.

3.2 Background

This section presents a very brief stylized description of the transformation of the Soviet economy from agricultural to industrial, and the 1933 Soviet famine. Gregory (1994) studies the Soviet economy before rapid industrialization. A detailed account of the transformation of Soviet economy is presented in Davies (1989), Davies (1996), Davies et al. (2014). Allen (2003) and Cheremukhin et al. (2017) study economic policies behind the rapid Soviet industrialization.

In 1917 a Revolution occurred in Russia, and, after a period of civil conflict and turmoil, Communist Party ceased control over the country. Although initially the Communist government introduced drastic reforms, abolishing money and private property in agriculture and industry, it quickly reversed its course allowing small-scale industry and peasants to operate in a quasi-market economy (the so-called New Economic Policy). However, by the late 1920's Stalin consolidated power within the Communist Party and in the late 1928 begun the industrialization of the country launching his first five-year plan for the economic development.

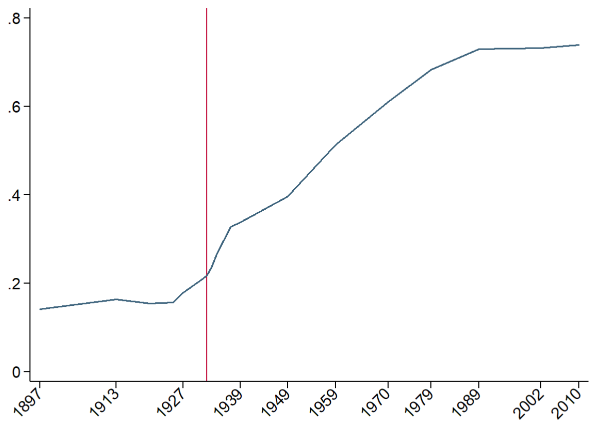
Radical reforms were introduced. All industry and trade were nationalized, the government introduced price controls and rationing of consumer goods. A massive investment in industry and large-scale construction was launched. As a result, migration from rural to urban settlements begun to rise. In agriculture, in 1929 Stalin introduced collectivization – forced transfer of private peasant property to collective farms managed by the government appointees according to the government plans. Collective farms and the remaining private peasants were allocated grain procurement quotas at the below-market prices. The government then used procured grain to feed rapidly growing cities and to export to pay for the imported machines. The combination of drop in production due to inefficient collective farms and the inflexible procurement policy by 1933 created the worst famine in Russian history[1], killing six to eight million people[2], most in the countryside. The famine was never acknowledged by the Soviet government, and industrialization of the economy continued even more rapidly after 1933.

Figure 3.1 displays share or urban population of Belarus, Russia, and Ukraine in constant administrative borders from 1897 to 2010. It shows that the urbanization rate changed little from 1897 to 1927. However, rapid growth begun in the late 1920's. In five years, from 1927 to 1932, urbanization increased by 4%, from 18% to 22%. Starting in 1932, the growth of the urban population was even more rapid, the share of urban population reached 34% by 1939. Thus, in seven

[1] Meng et al. (2015) studies the Great Chinese Famine and demonstrates the importance of inflexible procurement policy in contributing to the famine severity. Chapter 1 and Chapter 2 show the detrimental impact of collectivization and the inflexible procurement policy in the Soviet context.

[2] Conquest estimates population losses due to collectivization, arrests and deportations, and famine to be 14.5 million, 7 million deaths directly due to the famine (Conquest, 1986, Chapter 16, p. 306). Andreyev et al. (1990) measure excess mortality due to the famine to be 8.5 million. Davies and Wheatcroft argue that Andreyev et al. (1990) projections do not account for underregistration of infant mortality and of mortality in less-developed Soviet republics, and estimate excess mortality to be 5.7 million (Davies and Wheatcroft, 2009, Chapter 13, p 415). In 2008 Russian parliament issued a special decree stating that 7 million people perished in the Soviet Union during this famine, Duma (2008). In Ukraine a team of researchers from the Institute for Demography and Social Studies headed by Ella Libanova estimates direct losses for Ukraine alone to be 3.4 million, Libanova (2008). In a more recent work, Mesle et al. (2013) argue that Ukraine was "missing" 4.6 million people by the 1939 census, including 2.6 million due to excess mortality. A team of researchers associated with the Harvard Ukrainian Research Institute estimate direct population losses in Ukraine to be 4.5 million, including 3.9 million excess deaths and 0.6 million lost births (Rudnytskyi et al., 2015).

Figure 3.1: Urbanization in Belarus, Russia, and Ukraine



Constant administrative borders. Territories acquaired during and after 1939 are not included. Red vertical line marks the year of 1932. *Sources:* 1897, 1926, 1927, 1939, 1959, 1970, 1979, 1989, 2002, 2010 – censuses; 1913 – MVD (1914); 1920 – Tsentral'noye statisticheskoye upravleniye pri Sovete Ministrov SSSR (1975); 1925 – Trudy TsSU (1924); 1931 – Tsentral'nyy Ispolnitel'nyy Komitet Soyuza SSR (1931); 1932 – Tsentral'nyy Ispolnitel'nyy Komitet Soyuza SSR (1932); 1933, 1934, 1935 – RSAE 1562/329/49; 1937 – Zhiromskaia et al. (1996).

years, from 1932 to 1939, the population of urban settlements grew by more than 50%. Urbanization continued to rise after 1939, but in the history of Russia/Soviet Union such high growth rates of urban population were never observed again.

3.3 Data

I combine archival and published sources to construct unique province- and city-level panel datasets on the population and economic development of Belarus, Russia, and Ukraine from the late nineteenth to the early twenty first century. I concentrate the analysis on the territories belonging to Russia/Soviet Union from 1897 onward and therefore exclude from the analysis the Western provinces of Belarus and Ukraine, the Kaliningrad enclave acquired by the Soviet Union as a result of World War II, and the island of Sakhalin since large part of it was under the Japanese control from 1905 to 1945. This section describes the main variables used, Table 3.1 reports summary statistics, and Appendix Table C.1 provides the exact source of each variable and lists years for

Table 3.1: Summary statistics of the main variables used

	N	Mean	SD	Min	Max
Excess mortality 1933, deaths per 1,000	81	15.685	20.555	-4.186	88.831
WW2 losses	81	0.281	0.104	-0.018	0.501
Nazi occupation indicator	81	0.556	0.500	0.000	1.000
Grain suitability	81	59.774	22.927	4.023	96.833
Grain volatility (sd/mean 1900 – 1913)	81	0.271	0.111	0.098	0.618
1932 railroad stations per 1000 km^2	81	0.053	0.053	0.000	0.220
Capital province indicator	81	0.049	0.218	0.000	1.000
Distance to Moscow, km	81	1,158.322	1,151.178	14.816	6,407.451
Number of individuals sentenced under Article 58	81	24,248.173	23,139.345	968.000	122,002.000
Number of individuals executed under Article 58	81	1,006.568	2,177.044	16.000	12,261.000
2006 oil & gas production, mln tons	81	5.673	36.300	0.000	325.493
2006 coal production, mln tons	80	4.265	20.517	0.000	175.000
Population, thousands	972	1,802.145	1,496.750	44.000	18,598.621
Urban population, thousands	972	911.023	1,373.568	10.000	17,187.211
Rural population, thousands	972	891.122	527.803	33.000	2,764.000
Grain, mln tons	3413	11.921	11.513	0.010	102.570
Sown area, mln hectares	4957	0.999	0.867	0.000	5.808
Cattle, thousands	1500	745.761	488.385	69.000	2,415.000
Ln industrial output	1560	22.726	1.696	13.036	28.106

Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used.

which data are available.

Province-level panel

Outcome variables. The main outcome variable is province population. I use all available Russian/Soviet/Post-Soviet censuses[3], 1913 data from the published statistical yearbooks, and post-WWII 1949 and 1950 province-level population from the Russian State Archive of the Economy in Moscow.

Since Russian/Soviet administrative borders were constantly changing from 1913 to 1959, selecting the right administrative borders and calculating data using these borders creates a considerable obstacle. I construct province population panel in constant 1989 administrative borders. For a few territories only aggregated post-WWII data are available. For these territories I respectively aggregate 1989 provinces[4]. I use Kessler and Markevich (2015) district (*uezd*) administrative map to calculate 1897 and 1913 population in 1989 administrative borders, and rely on Tsentral'noye

[3]The first Russian census was held in 1897. Soviet Union executed censuses in 1926, 1939, 1959, 1970, 1979, and 1989. Russia held censuses in 2002 and 2010. Ukraine had a census in 2001. Belarus had censuses in 1999 and 2009.

[4]To be precise, I unite Astrakhan province and Kalmyk ASSR; Kamchatcka, Magadan and Khabarovsk provinces.

statisticheskoye upravleniye pri Sovete Ministrov SSSR (1975) to obtain 1926–1970 population in 1989 administrative borders.

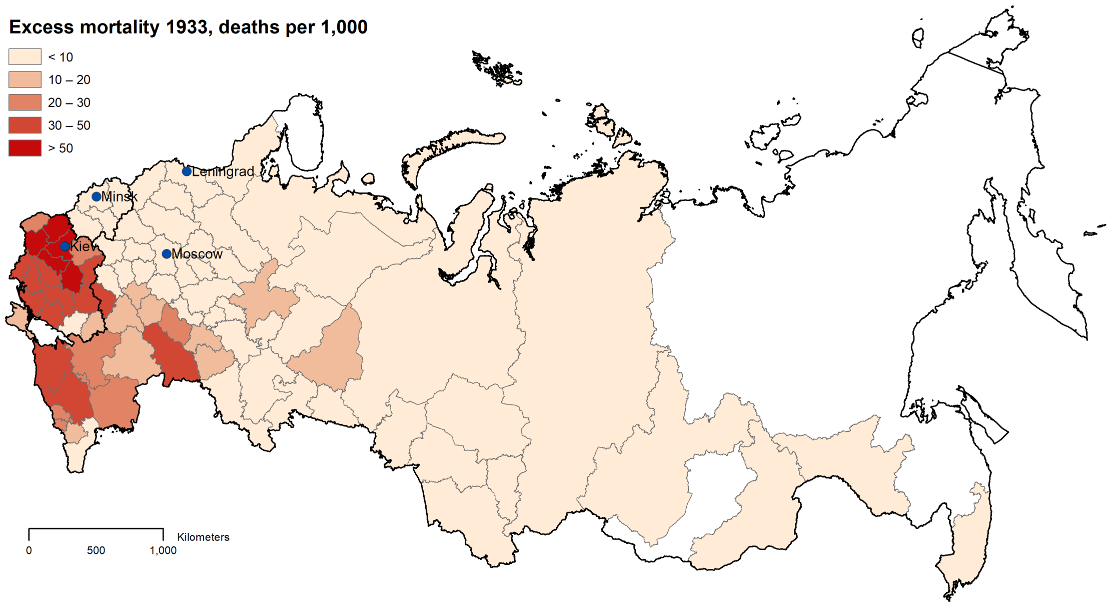
The 1939 census has long been deemed unreliable due to the centralized additions (*pripiski*): it was believed that in some territories population figures were inflated by the authorities. In recent years Russian demographers have discovered these additions in the archives and published them (Bogoyavlenskiy, 2014). I use these data and the 1939 administrative map I constructed to correct the 1939 population figures.

Presumably to hide the enormous population losses, the first post-WWII census occurred in 1959, fifteen years after the war. Nevertheless, Soviet officials maintained post-WWII population estimates for planning and statistical purposes. Although the quality of these population estimates is probably lower than the quality of the census data, due to the Soviet population registration system (*propiska*) the data reflects the actual population fairly accurately. The Red Army soldiers were gradually discharged during 1945–1948. Therefore, I use 1949 and 1950 archival data in my analysis.

After the collapse of the Soviet Union the independent states of Belarus, Russia, and Ukraine conducted censuses in different years (see footnote 3). Since Russia is the largest among these states I use years of Russian censuses (2002 and 2010) for the province population panel and employ Belorussian and Ukrainian statistical publications to get the corresponding population figures. Overall, I construct a panel of 81 provinces and 12 time periods (1897, 1913, 1926, 1939, 1949, 1950, 1959, 1970, 1979, 1989, 2002, 2010).

Additional outcome variables characterize the economic development of Russia/Soviet Union. I collected data on the state of agricultural and industrial sectors: grain production, sown area, number of cattle, and industrial output. Pre-1917 and post-WWII data on the state of agriculture are available from official statistical publications, and 1928 and 1932–1940 figures are coming from the archives. Industrial output data is harder to obtain. 1897, 1959 (Russia only), and 2002 province-level figures are available from Kessler and Markevich (2015), but Soviet statistical

Figure 3.2: Excess mortality 1933. Province-level data



Excess mortality 1933 is the difference between 1933 mortality and the average of 1928 and 1937–1939 mortality rates. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used.

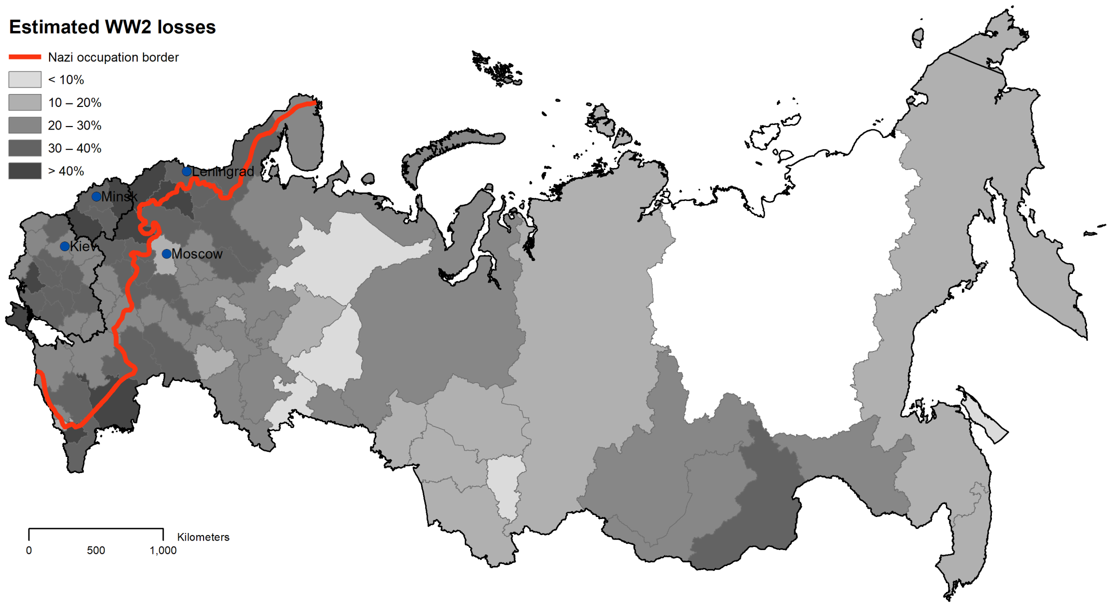
publications did not reveal the levels of industrial output, showing instead *growth* relative to the previous year. Using data on growth I extrapolate 1959 level to 1940 and 1945–1975. However, industrial output figures should be interpreted with caution since they likely contain a very large measurement error.

Explanatory variables. I use cross-sectional data on the severity of famine conditions in 1933. The main explanatory variable is 1933 excess mortality. I have district[5]-level 1933 population and mortality in Belarus, Russia, and Ukraine from Chapter 2. I calculate excess mortality as a difference between 1933 mortality and 1928 and 1937–1939 average mortality. Figure 3.2 plots 1933 excess mortality on the map in 1989 administrative borders.

Additional data. To account for WWII population losses for each province I project 1939 population to 1949 using average 1937–1939 birth and death rates, and then use the difference between the actual 1949 population and the projected 1949 population as a measure of war losses.

[5]Districts were the smallest administrative units. In 1933 there were more than 2000 districts in Belarus, Russia, and Ukraine.

Figure 3.3: Estimated WWII losses. Province-level data



Estimated WWII losses is the difference between the actual 1949 population and the projected 1949 population. Solid red line represents Nazi occupation border. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used.

More specifically,

$$\text{WW2 losses} = 1 - \frac{\text{actual population 1949}}{\text{projected population 1949}}$$

Thus, for example, if the projected population in a province is 2 million, and observed population is 1.5 million, then the loss attributed to WWII is 25%. I also mark provinces occupied by the Nazi using archival data and verifying it with the available maps of Nazi invasion to the Soviet Union. Figure 3.3 plots estimated WWII losses and Nazi occupation border on the map.

Finally, I rely on FAO GAEZ data and 1989 administrative map to calculate grain suitability by province using the mean value for a respective polygon. I construct a series of monthly temperature and precipitation using land surface weather data from Matsuura and Willmott (2014). I use 2006 province-level oil & gas and coal output to account for natural resources endowment. I also obtained historical railroad stations locations and georeferenced data on Soviet political repressions from Zhukov and Talibova (2018). Using these data, I calculate number of railroad stations per km^2

in 1932, and number of people sentenced or executed under the Article 58 ("Counterrevolution") of the Soviet Penal Code.

Urban settlement panel

The settlement-level panel encompasses data on population of every settlement that had "town" status by 1989[6] located in Belarus, Russia, or Ukraine excluding territories acquired as a result of WWII. Importantly, according to Soviet classification, a settlement has urban-type status if *occupation* of most of its inhabitants is non-agricultural. Thus, a five hundred miner settlement would be classified as urban-type, while a settlement of several thousand could still be called a village if the majority of its inhabitants are occupied in agriculture. Thus, data on urban-type settlements truly reflects the transition from agricultural to industrialized economy.

Figure 3.4 plots towns on the map. For most of the settlements in the sample population data is only available for census years. Therefore, the settlement-level panel has information on 525 urban settlements and 11 time periods (1897, 1926, 1939, 1946, 1947, 1950, 1959, 1970, 1979, 1989, 2002). As with province-level data I correct 1939 figures for centralized additions. 1946, 1947, and 1950 population figures come from the archives. I calculate 1933 mortality in the 50 kilometers radius of each town using district-level 1933 mortality data (Figure 3.5 shows district-level 1933 mortality on the map). Unfortunately, only province-level mortality figures are available for non-famine years. It is therefore impossible to calculate disaggregated excess mortality. Instead, I use province-year fixed effects in all subsequent city-level estimates. Since towns mostly grew due to migration, I estimate WWII losses by simply comparing 1939 and 1947[7] population. That is, for each town I calculate the following:

$$\text{WW2 losses} = 1 - \frac{\text{population 1947}}{\text{population 1939}}$$

[6]There are three main settlement types: (1) village or rural settlement, (2) urban-type settlement that doesn't yet has town status (*poselok gorodskogo tipa*), (3) and town or city (*gorod*). The panel comprising all settlements that ever had urban-type status is under construction.

[7]The results are very similar if 1950 data are used instead of 1947; available upon request.

Figure 3.4: Urban settlements

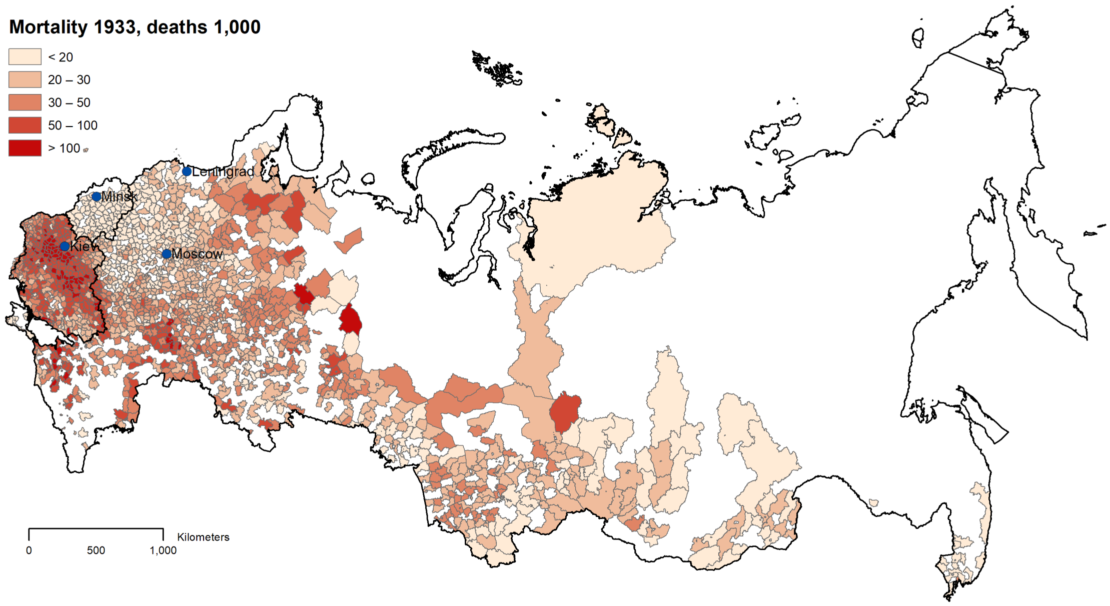
Urban-type settlements that reached the status of town by 1989. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used.

I also mark towns occupied by the Nazi using M.L.Dudarenko et al. (1985) and calculate grain suitability in the vicinity of each town as a mean suitability in the 50 kilometers radius around the town.

Birth and death rates yearly data

To test whether 1933 famine led to persistent long-term changes in birth and death rates I use yearly mortality and natality data from Chapter 2. As explained before, the administrative division was changing constantly from 1917 to 1959. As a result, only very aggregated data are available from 1923 to 1937. Therefore, the yearly mortality panel consists of only 25 large administrative units (but has almost a hundred years of data). Chapter 2 provide more details on construction of this panel.

Figure 3.5: 1933 mortality, district-level data



District-level 1933 mortality data are used to construct 1933 mortality estimates in the 50 kilometers radius around urban settlements. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used.

3.4 Empirical strategy

I use cross-province variation in the severity of 1933 famine to estimate the effect of loss of human life due to excess mortality on subsequent population and on economic outcomes. The main specification is as follows:

$$y_{i,t} = \beta ExcessMortality1933_i \times PostFamine_t + X'_{i,t}\gamma + \alpha_i + \delta_t + \epsilon_{i,t} \tag{3.1}$$

where i stands for province, and t – year. The outcome of interest $y_{i,t}$ is either population itself (Ln population, Ln rural population, Ln urban population), or an economic development indicator (Ln grain production, Ln sown area, Ln cattle, Ln industrial output). $PostFamine_t$ is an indicator denoting time after the 1933 famine, $PostFamine_t$ equals to 1 after 1933 and 0 otherwise.

The interaction between excess mortality 1933 and post-famine indicator is the main variable of interest. The coefficient on this interaction β is a difference-in-differences estimator of the effect of the 1933 famine on population and economic development. Year fixed effects δ_t control for macroeconomic shocks, and province fixed effects α_i account for unobserved heterogeneity among provinces. To account for the fact that the famine was more severe in more grain-productive areas, province-level controls $X'_{i,t}$ include grain suitability interacted with post-famine indicator, and grain volatility (measured as standard deviation of grain production divided by the mean grain production during 1900 – 1913) interacted with post-famine indicator. Although it is unclear why WWII losses should be correlated with the 1933 famine severity, the war losses were so large[8] that it is important to account for them in all long-term economic development studies. Therefore, I include the WWII losses estimates and Nazi occupation indicator interacted with post-war dummy in province controls. Since capital cities (Moscow, Leningrad, Kiev, and Minsk) likely received preferential treatment (higher investment and better supplies to recover from the famine) I include a capital province indicator interacted with post-famine dummy in province controls. Finally, to account for existing infrastructure that likely affected subsequent economic development, province controls include number of railroad stations in 1932 normalized by province area interacted with post-famine indicator.

The identifying assumption is that provinces with similar characteristics would have had similar changes in economic development if not for the famine. I test this assumption by replacing the interaction of 1933 excess mortality and post-famine dummy with a set of interaction of 1933 excess mortality and year indicators and by showing that before the famine there are no significant differences in economic outcomes:

$$y_{i,t} = \sum_{\tau} \beta_t ExcessMortality1933_i \times I[t = \tau] + X'_{i,t}\gamma + \alpha_i + \delta_t + \epsilon_{i,t} \tag{3.2}$$

As Chapter 1 and Chapter 2 demonstrate, the variation in famine severity is not random and to a large extent is driven by the poor government's economic policies. If the famine was engineered by

[8]Harrison estimates Soviet population losses to be almost 30 million (Harrison, 1996, Chapter 7, p. 161).

the government[9] then it is possible that the subsequent economic development is also a result of a specific government policy and the correlation between economic outcomes and famine is spurious. In addition, although Wheatcroft (2013) argues that 1933 mortality data are of fairly good quality, civil acts registration systems tend to deteriorate with the severity of the crisis. Thus, it is possible that measurement error is correlated with the severity of the famine attenuating estimates. To eliminate potential endogeneity and measurement error concerns I offer an instrumental variable strategy.

The idea of the instrument is to use the fact that there is a correlation between harvest and mortality. Chapter 2 demonstrate that there is a strong positive relationship between the 1932 harvest and 1933 mortality and that this pattern is unique for the famine year[10]. The actual 1932 harvest was affected by the economic policies implemented at the time and therefore is likely endogenous. Nevertheless, weather affects harvest. Therefore, I use presumably exogenous variation in 1932 weather to instrument for the famine severity.

Table 3.2 presents the relationship between 1932 weather and the famine severity. It reports the estimates from regressing 1933 excess mortality on the deviations from 1900–1970 means of 1932 fall, winter, spring and summer temperature and precipitation controlling for all province characteristics listed in specification (3.1).[11] Table 3.2 demonstrates that the two strongest predictors of the famine severity are demeaned 1932 spring temperature and demeaned 1932 summer precipitation. Figure 3.6 demonstrates that 1932 weather is a good predictor of 1933 excess mortality; it presents the conditional scatter plots and fitted lines between demeaned 1932 spring temperature and 1933 excess mortality, and between demeaned 1932 summer precipitation and 1933 excess mortality conditional on all province characteristics listed in specification (3.1).

[9]Note that there is a difference between implementing ill-thought economic policies that led to famine and deliberately killing people by starvation. The question of intent is beyond the scope of this research.

[10]For the purpose of this work the sign of the relationship is not important, the important fact is that there is a strong correlation between 1932 harvest and 1933 mortality.

[11]More specifically, all regressions control for grain suitability, grain volatility, capital province indicator, WW2 losses, Nazi occupation indicator, Ln distance to Moscow, 1932 number of RR stations per km^2, republic FE, and region FE.

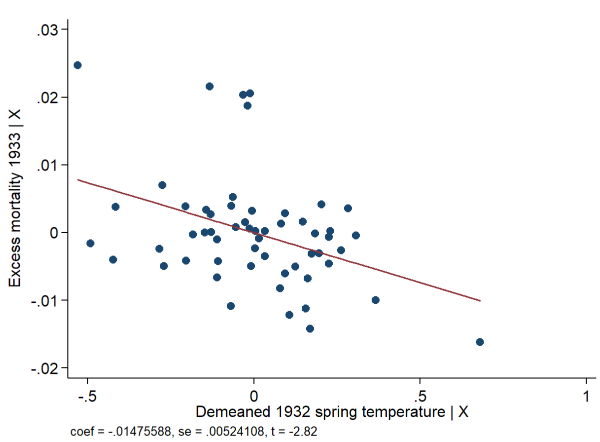
Table 3.2: The correlation between demeaned 1932 weather and excess mortality 1933

	Dependent variable: Excess mortality 1933													
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Fall														
temp	-0.009		-0.010										-0.001	
	(0.006)		(0.006)										(0.008)	
precip		0.000	0.000										0.001*	
		(0.000)	(0.000)										(0.000)	
Winter														
temp				-0.000		-0.000							0.000	
				(0.000)		(0.000)							(0.001)	
precip					0.000	0.000							0.000	
					(0.000)	(0.000)							(0.000)	
Spring														
temp							-0.015**		-0.017**				-0.018**	-0.016***
							(0.007)		(0.007)				(0.008)	(0.006)
precip								0.000	0.000*				0.000	
								(0.000)	(0.000)				(0.000)	
Summer														
temp										-0.005		-0.001	-0.001	
										(0.005)		(0.004)	(0.006)	
precip											0.001***	0.001***	0.001***	0.001***
											(0.000)	(0.000)	(0.000)	(0.000)
N	77	77	77	77	77	77	77	77	77	77	77	77	77	77
R^2	0.588	0.585	0.603	0.581	0.573	0.582	0.603	0.584	0.621	0.579	0.689	0.690	0.742	0.723

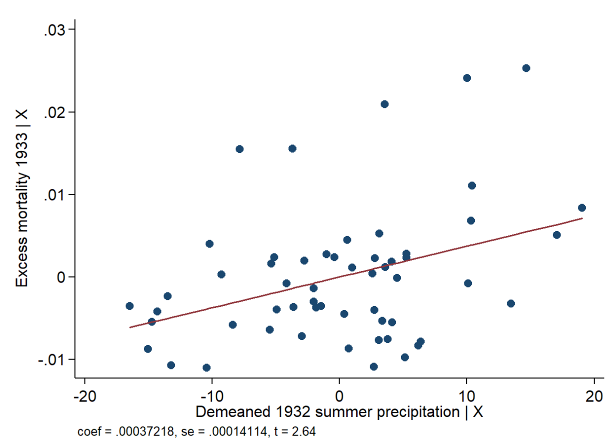
*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used. Table 3.1 shows summary statistics of the main variables.
All regressions control for grain suitability, grain volatility, capital province indicator, WW2 losses, Nazi occupation indicator, Ln distance to Moscow, 1932 number of RR stations per km^2, republic FE, and region FE.

Figure 3.6: Conditional scatter plots and fitted lines

(a) Demeaned spring 1932 temperature and 1933 excess mortality



(b) Demeaned summer 1932 precipitation and 1933 excess mortality

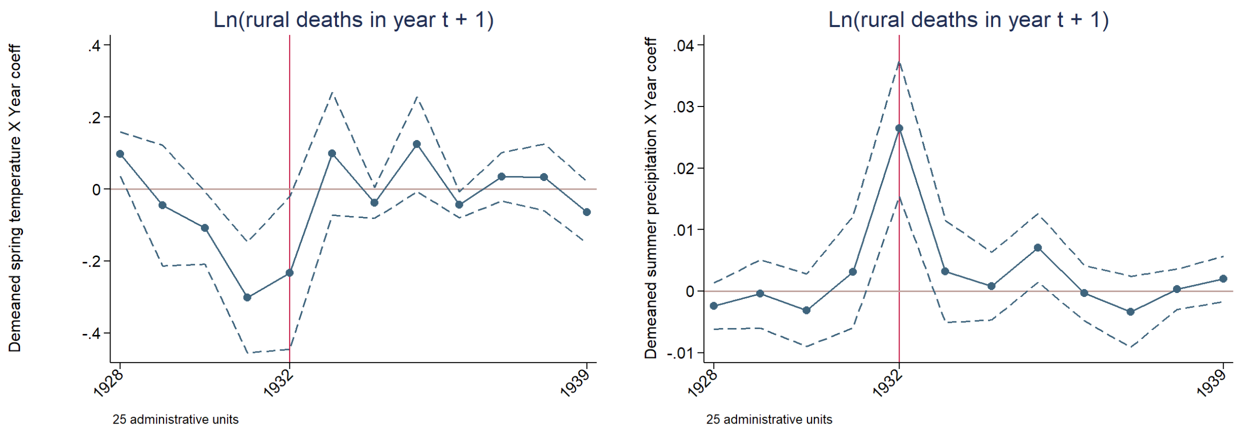


Conditional scatter plots and fitted lines between 1932 weather and 1933 excess mortality (two estimates from one regression) conditional on grain suitability, grain volatility, capital province indicator, WW2 losses, Nazi occupation indicator, Ln distance to Moscow, 1932 number of RR stations per km^2, republic FE, and region FE.

Figure 3.7: The correlation between climatic conditions and number of rural deaths over time – coefficients of *demeaned weather* × *year indicator variables* and their 95% confidence intervals

(a) Coefficients of *Demeaned spring temperature* × *Year indicator variables*

(b) Coefficients of *Demeaned summer precipitation* × *Year indicator variables*



The interaction coefficients are estimated by regressing Ln number of rural deaths in year $t+1$ on the interaction of the specified variable (demeaned spring temperature in year t, demeaned summer precipitation in year t) with year t dummy variables. The coefficients from both figures are estimated from one regression that controls for Ln population, Ln urban population, year and administrative unit fixed effects. The estimated coefficients and their standard errors are shown in Table 3.3.

To confirm that the correlation between 1932 weather and 1933 famine severity is not an accident I examine the relationship between weather and death rates from 1928 to 1939 using yearly mortality data panel. I regress log number or rural deaths in year $t+1$ on the interactions of demeaned spring temperature and demeaned summer precipitation in year t with year t dummy variables controlling for log population, log urban population, year and administrative unit fixed effects. The coefficients with robust standard errors are reported in Table 3.3. Figure 3.7 plots the interaction coefficients and their 95% confidence intervals. It demonstrates that while during non-famine years weather has little impact on mortality, the 1932 weather is strongly correlated with the 1933 death rates[12].

I instrument *ExcessMortality1933*$_i$ × *PostFamine*$_t$ with *Demeaned 1932 spring temperature*$_i$

[12] Demeaned 1931 spring temperature also appears to be strongly correlated with subsequent mortality. This is consistent with the fact that both 1931 and 1932 harvests were important determinants of 1933 famine severity. Later in robustness checks I replace demeaned 1932 spring temperature with demeaned 1931 spring temperature and show that the results are very similar to the baseline estimates.

Table 3.3: The correlation between climatic conditions and number of rural deaths over time

	Dependent variable: *Ln* rural deaths in year $t+1$
	(1)
Demeaned spring temperature × 1928	0.097***
	(0.030)
Demeaned spring temperature × 1929	-0.046
	(0.081)
Demeaned spring temperature × 1930	-0.108**
	(0.049)
Demeaned spring temperature × 1931	-0.301***
	(0.074)
Demeaned spring temperature × 1932	-0.233**
	(0.103)
Demeaned spring temperature × 1933	0.098
	(0.083)
Demeaned spring temperature × 1934	-0.038*
	(0.021)
Demeaned spring temperature × 1935	0.125*
	(0.064)
Demeaned spring temperature × 1936	-0.044**
	(0.018)
Demeaned spring temperature × 1937	0.034
	(0.033)
Demeaned spring temperature × 1938	0.033
	(0.045)
Demeaned spring temperature × 1939	-0.064
	(0.041)
Demeaned summer precipitation × 1928	-0.002
	(0.002)
Demeaned summer precipitation × 1929	-0.000
	(0.003)
Demeaned summer precipitation × 1930	-0.003
	(0.003)
Demeaned summer precipitation × 1931	0.003
	(0.004)
Demeaned summer precipitation × 1932	0.026***
	(0.005)
Demeaned summer precipitation × 1933	0.003
	(0.004)
Demeaned summer precipitation × 1934	0.001
	(0.003)
Demeaned summer precipitation × 1935	0.007**
	(0.003)
Demeaned summer precipitation × 1936	-0.000
	(0.002)
Demeaned summer precipitation × 1937	-0.003
	(0.003)
Demeaned summer precipitation × 1938	0.000
	(0.002)
Demeaned summer precipitation × 1939	0.002
	(0.002)
Ln population	1.394***
	(0.311)
Ln urban population	-0.293*
	(0.151)
Year FE, Administrative unit FE	✓
Observations	268
R^2	0.782

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used. Table 3.1 shows summary statistics of the main variables. Robust standard errors.

$\times$ *PostFamine*$_t$ and *Demeaned 1932 summer precipitation*$_i$ $\times$ *PostFamine*$_t$. This instrument is excludable because short-term weather changes should not directly affect economic development years and decades later.

I follow Bertrand et al. (2004) and, because there are just 81 provinces in my sample, cluster province-level estimates at the province level separately before and after the famine; because there are more than 500 cities and towns I cluster estimates that use the town sample at the town level.

3.5 Results

3.5.1 Rural and urban population

Table 3.4 presents the estimates of the impact of the 1933 famine on total, rural, and urban population of Belarus, Russia, and Ukraine. The results suggest a strong and persistent negative impact of 1933 famine on total population and urban population, and no persistent effect on rural population. Panel A presents the results of the panel data estimation, and Panel B reports the corresponding first stages of the IV estimates.

Columns (1) – (3) of Table 3.4 show the impact of the 1933 famine on total population. Column (1) reports difference-in-differences estimates as in specification (3.1). In Column (2) I instrument for the main explanatory variable, *1933 excess mortality* $\times$ *Post-famine*, with 1932 weather conditions, *demeaned 1932 spring temperature* $\times$ *Post-famine* and *demeaned 1932 summer precipitation* $\times$ *Post-famine*. The corresponding first stage of the two-stage least squares specification is presented in Panel B of the table, just below the second-stage results. The instruments are strong predictors of the famine severity with F-test above 22. In Column (3) I estimate the effect of the famine separately for 1939 (the only pre-WWII year for which good quality population data are available) and for the remaining periods. In all three specifications there is a strong negative and highly statistically significant effect of 1933 excess mortality on population. The instrumental

Table 3.4: The effect of 1933 famine on population

Panel A: Panel data estimation

	Dependent variable:								
	Ln population			Ln rural population			Ln urban population		
Model:	OLS (1)	IV (2)	OLS (3)	OLS (4)	IV (5)	OLS (6)	OLS (7)	IV (8)	OLS (9)
Excess mortality 1933 × Post-famine	-8.687*** (1.863)	-8.588*** (3.215)		-1.819 (1.941)	-2.186 (3.371)		-10.069*** (2.770)	-10.206** (4.179)	
Excess mortality 1933 × 1939			-9.615*** (2.375)			-5.443** (2.701)			-10.383*** (3.671)
Excess mortality 1933 × Post-1949			-8.560*** (1.914)			-1.325 (1.983)			-10.027*** (2.762)
Ln rural population							✓	✓	✓
Observations	972	924	972	972	924	972	972	924	972
R^2	0.638	0.868	0.639	0.634	0.837	0.636	0.925	0.947	0.925
Provinces	81	77	81	81	77	81	81	77	81

Panel B: First stages of the corresponding 2SLS panel regressions

	Dependent variable: Excess mortality 1933 × Post-famine		
Demeaned spring 1932 temp × Post-famine	-0.012*** (0.004)	-0.012*** (0.004)	-0.012*** (0.004)
Demeaned summer 1932 precip × Post-famine	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
F	22.782	22.782	22.711

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used. Table 3.1 shows summary statistics of the main variables.

All regressions control for province and year FE, grain suitability × Post-famine, grain volatility × Post-famine, capital province indicator × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, Ln distance to Moscow × Post-famine, 1932 number of RR stations per km^2 × Post-famine, republic-year FE, and region-year FE.

Standard errors clustered at the province level separately before and after the famine.

variable estimate is very close to the difference-in-differences estimate, suggesting that the impact of the famine on population is not driven by some omitted factor and that measurement error is small enough to allow for fairly precise estimates. Moreover, estimates reported in Column (3) demonstrate that the immediate impact of the famine on population is little, if at all, mitigated over time: both the interaction of 1933 excess mortality with 1939 year indicator and of 1933 excess mortality with post-1949 indicator are very close in magnitude.

Next, Columns (4) – (6) of Table 3.4 show the impact of the famine on rural population. Similar to the previous estimates, Column (4) reports difference-in-differences estimate of the impact of 1933 excess mortality on rural population using specification (3.1); Column (5) reports instrumental variable estimates (Panel B presents the first state estimates which are identical to the Column (2) first stage because only second stage dependent variable changed relative to Column (2)); and Column (6) reports separately the short-term impact of the famine on 1939 rural population, and a long-term impact on the Post-1949 rural population. The famine appears to have only temporarily affected rural population. There is a strong short-term negative effect, the coefficient of the interaction of 1933 excess mortality and 1939 year indicator is large, negative, and statistically significant. However, there appears to be no long-term impact – the difference in difference estimate, the instrumental variable estimate, and the coefficient on the interaction of 1933 excess mortality with Post-1949 dummy are, although negative, small in magnitude and not statistically significant. Thus, the 1933 famine negatively affected rural population in the short run, but there is not strong long-term impact.

Finally, Columns (7) – (9) of Table 3.4 study the impact of the 1933 famine on urban population. To account for province size, I include rural population in province controls, that is, in effect I study the impact of the famine on urbanization[13]. As before, Column (7) reports difference-in-differences estimate of specification (3.1). Column (8) presents instrumental variable estimates

[13]The estimates without controlling for rural population are very similar to the reported estimates and are available upon request.

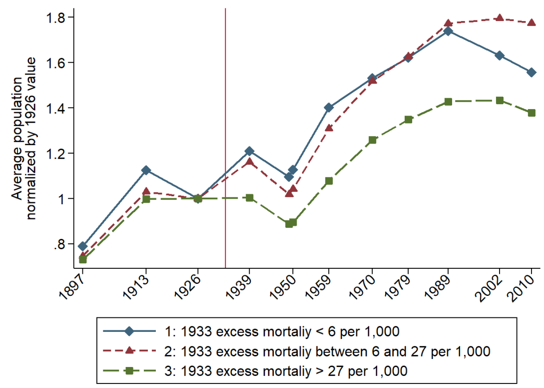
with Panel B presenting the corresponding first stage. Compared with Columns (2) and (5), first stage changes slightly because rural population is added to the controls. Nevertheless, the instruments are strong predictors of the main explanatory variable, *1933 excess mortality* $\times$ *Post-famine*, with F-statistic still above 22. And, as in the previous estimates, Column (9) reports short- and long-term impact of the famine on urban population by estimating coefficients on the interaction of 1933 excess mortality separately with 1939 year indicator and with Post-1949 indicator. In all specifications the impact of the famine on urban population is negative and highly statistically significant. The instrumental variables estimate of the impact of the famine on urban population is very close in magnitude to the difference-in-differences estimate, and the negative impact of the famine does not appear to be alleviated with time with both 1939 and Post-1949 coefficients negative, highly statistically significant, and very close in magnitude. Given that there appears to be a permanent negative impact of the famine on total population and no permanent impact on rural population, mechanically it has to be the case that urban population was permanently affected.

To better understand the changes in population during the 20th century, Figure 3.8 reports the average province population normalized by the 1926 value by quartiles of 1933 excess mortality. That is, for each province and each year t I first calculate normalized population by dividing population in year t by the province's 1926 population, then break provinces into groups according to the severity of the 1933 famine, and then for each group and each year calculate the average normalized population. The first group includes 41 provinces with the 1933 excess mortality below the median, that is, below 6 people per 1,000. The second group consists of 21 provinces with the 1933 excess mortality above the median but below 75th percentile, that is, between 6 and 27 per 1,000. The third group includes 20 provinces with 1933 excess mortality above 75th percentile, that is, above 27 per 1,000. Figure 3.8a reports total population, Figure 3.8b shows rural population, and Figure 3.8c presents urban population.

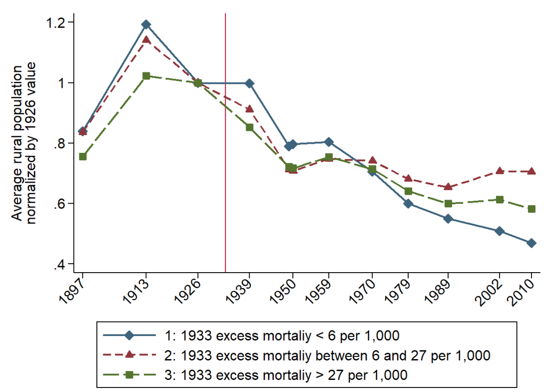
Several important takeaways can be made from Figure 3.8. First, before the famine, provinces that in 1933 were hit more appear to be developing similarly to provinces that were hit relatively

Figure 3.8: Average population by quartiles of 1933 excess mortality

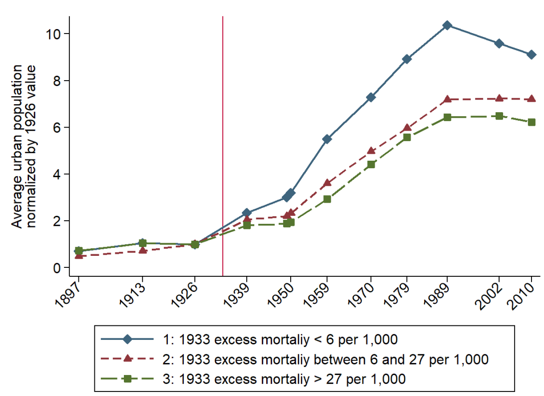
(a) Total population



(b) Rural population



(c) Urban population



These figures represent average population normalized by the 1926 value separately for 41 provinces where 1933 excess mortality was below median, 21 provinces in the third quartile of 1933 excess mortality, and 20 provinces in the fourth quartile of 1933 excess mortality. The vertical line indicates the 1933 famine.

less, especially when comparing total and urban population of provinces in the second and third groups. Next, Figure 3.8a shows that during the time from 1926 to 1939 total population of the provinces less affected by the famine (groups one and two) grew on average, while total population of the most affected provinces (group three) did not increase on average. During 1939 – 1949 all provinces lost large shares of population, but the differences that originated during 1926–1939 between less affected provinces (groups one and two) and more affected provinces (group three) persisted, and these differences remained until 2010 when the data end.

A similar pattern can be observed for the urban population, Figure 3.8c with the difference that during 1926–1939 urban population grew in all three groups, only it grew less in provinces that had higher 1933 excess mortality. The differences that first occurred during 1926–1939 have then persisted during the war and until 2010 when the observations stop.

Rural population, however, does not follow this pattern, Figure 3.8b. From 1926 to 1939 rural population did not increase (group one) or significantly decreased (groups two and three) in accordance with the famine severity. By 1949 however, groups two and three were indistinguishable, and by 1979 groups more affected by the famine (groups two and three) had higher rural population than the group least affected by the famine (group one). Thus, there appear to be no persistent differences in rural population due to the famine.

I proceed by testing the main identifying assumption of the difference-in-differences estimates, that is, that there are no different pre-trends in province population before the famine. I estimate the coefficients of 11 interaction terms of the 1933 excess mortality with year indicators of each year for which data are available, including two before the famine (1897 and 1913) and omitting 1926 as a reference year, as in specification (3.2). In estimating these interaction terms I include all province controls as reported in Table 3.4.

Figure 3.9 plots the estimated interaction coefficients with their 95% confidence intervals[14]. Figure 3.9a presents the interaction coefficients from estimating specification (3.2) with log total

[14]Table 3.5 presents the estimated coefficients and standard errors.

population as a dependent variable, Figure 3.9b depicts the coefficients from estimating specification (3.2) with log rural population as a dependent variable, and Figure 3.9c – with log urban population as a dependent variable. The results indicate the absence of pre-trends as there are no significant effects before the famine. If anything, total and rural population appear to increase from 1913 to 1926 in the provinces subsequently hit more by the famine, although this increase is far from being statistically significant. Changes in urban population are uncorrelated with the severity of the 1933 famine before the famine, the point estimates of the interaction coefficients on 1933 excess mortality with 1897 and 1913 year indicators are very close to zero and are statistically indistinguishable from zero. Thus, there are no pre-trends in population correlated with the severity of the 1933 famine and therefore the identifying assumption of the difference-in-differences estimates is likely satisfied.

Figures 3.9a, 3.9b, 3.9c also illustrate how the impact of the famine evolved over time and the magnitude of the effect. To show the magnitude, Figures 3.9a, 3.9b, 3.9c present standardized beta coefficients. That is, they illustrate by what fraction of a standard deviation the dependent variable would have changed on average in each year if 1933 excess mortality changed by a standard deviation. Figures 3.9a and 3.9c show that the famine had a very large and persistent negative impact on total and urban population: an increase of 1933 excess mortality by a standard deviation, or by approximately 21 people per 1,000, lowered total and urban population by approximately 0.3 of a standard deviation, and this decrease persisted over time. Figure 3.9b shows that there was a very strong immediate negative impact of the famine on rural population: an increase in 1933 excess mortality by a standard deviation lowered rural population by 0.34 of a standard deviation in 1939. But this negative impact was alleviated over time, and by 1989 the impact of the famine on rural population is statistically indistinguishable from zero.

Finally, this section presents a couple of robustness checks. I offer an alternative instrumental variable strategy and demonstrate that the effect of the famine is not driven by the differences in natural resources endowments or by Stalin's political repressions.

Table 3.5: The correlation between 1933 excess mortality and population over time – province-level estimated coefficients of *1933 excess mortality* × *Year indicator variables*

	Dependent variable:					
	Ln population		Ln rural population		Ln urban population	
	estimates (1)	beta coeff (2)	estimates (3)	beta coeff (4)	estimates (5)	beta coeff (6)
Excess mortality 1933 × 1897	-1.430	-0.047	-1.826	-0.067	-0.109	-0.003
	(1.299)		(1.356)		(2.881)	
Excess mortality 1933 × 1913	-1.365	-0.044	-1.771	-0.065	0.330	0.010
	(1.297)		(1.359)		(2.916)	
Excess mortality 1933 × 1939	-10.837***	-0.352	-9.215***	-0.340	-7.369**	-0.217
	(1.904)		(2.027)		(2.907)	
Excess mortality 1933 × 1949	-9.948***	-0.324	-7.024***	-0.259	-8.092***	-0.238
	(1.851)		(1.919)		(2.780)	
Excess mortality 1933 × 1950	-10.088***	-0.328	-7.149***	-0.264	-8.261***	-0.243
	(1.832)		(1.915)		(2.783)	
Excess mortality 1933 × 1959	-9.925***	-0.323	-6.018***	-0.222	-10.314***	-0.303
	(1.630)		(1.690)		(2.610)	
Excess mortality 1933 × 1970	-9.298***	-0.302	-4.807***	-0.177	-9.878***	-0.291
	(1.584)		(1.625)		(2.485)	
Excess mortality 1933 × 1979	-8.899***	-0.289	-3.333**	-0.123	-10.052***	-0.296
	(1.639)		(1.683)		(2.490)	
Excess mortality 1933 × 1989	-8.949***	-0.291	-2.846	-0.105	-10.008***	-0.294
	(1.738)		(1.806)		(2.522)	
Excess mortality 1933 × 2002	-8.681***	-0.282	-2.203	-0.081	-10.099***	-0.297
	(1.871)		(2.109)		(2.593)	
Excess mortality 1933 × 2010	-8.684***	-0.282	-2.303	-0.085	-9.888***	-0.291
	(2.006)		(2.341)		(2.674)	
Ln rural population					✓	
Observations	972		972		972	
R^2	0.635		0.629		0.923	

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used. Table 3.1 shows summary statistics of the main variables.

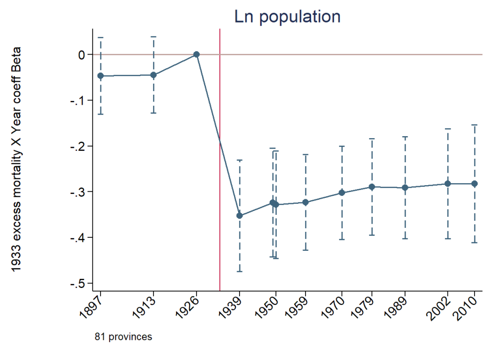
All regressions control for province and year FE, grain suitability × Post-famine, grain volatility × Post-famine, capital province indicator × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, Ln distance to Moscow × Post-famine, 1932 number of RR stations per km^2 × Post-famine, republic-year FE, and region-year FE.

For each interaction coefficient estimate standardized beta-coefficient is calculated by multiplying the estimate by standard deviation of 1933 excess mortality and dividing by standard deviation of the dependent variable in the corresponding year.

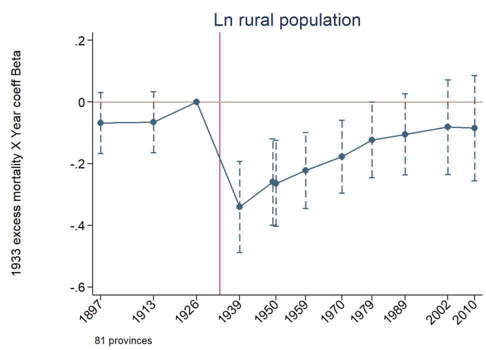
Standard errors clustered at the province level separately before and after the famine.

Figure 3.9: The correlation between 1933 excess mortality and population over time – province-level estimated coefficients of *1933 excess mortality* × *Year indicator variables* and their 95% confidence intervals

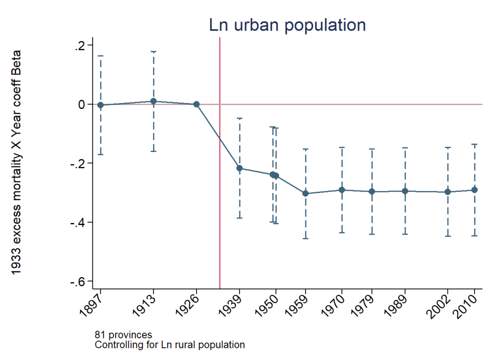
(a) Total population



(b) Rural population



(c) Urban population



The figure presents coefficients along with their 95% confidence intervals of the interaction effects of *1933 excess mortality* × *Year indicator variables* for each year for which data are available omitting 1926 as a reference year. These coefficients are estimated by regressing *Ln population*/*Ln rural population*/*Ln urban population* on the interaction variables, while controlling for province and year FE, grain suitability × Post-famine, grain volatility × Post-famine, capital province indicator × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, Ln distance to Moscow × Post-famine, 1932 number of RR stations per km^2 × Post-famine, republic-year FE, and region-year FE from equation (3.2). The vertical line indicates the 1933 famine. The estimated coefficients and standard errors are presented in Table 3.5.

Table 3.6: The effect of 1933 famine on population. Using 1931 spring temperature instead of 1932 spring temperature in the instrumental variable estimates

Panel A: Panel data estimation			
	Dependent variable:		
	Ln population	Ln rural population	Ln urban population
Model:	IV	IV	IV
	(1)	(2)	(3)
Excess mortality 1933 × Post-famine	-9.790***	-1.285	-10.206**
	(3.305)	(3.663)	(4.179)
WW2 losses × Post-war	✓	✓	✓
Ln rural population			✓
Observations	924	924	924
R^2	0.868	0.837	0.947
Provinces	77	77	77
Panel B: First stages of the corresponding 2SLS panel regressions			
	Dependent variable: Excess mortality 1933 × Post-famine		
Demeaned spring 1931 temperature × Post-famine	-0.011***	-0.011***	-0.011***
	(0.003)	(0.003)	(0.003)
Demeaned summer 1932 precipitation × Post-famine	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
F	20.169	20.169	20.266

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used. Table 3.1 shows summary statistics of the main variables.
All regressions control for province and year FE, grain suitability × Post-famine, grain volatility × Post-famine, capital province indicator × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, Ln distance to Moscow × Post-famine, 1932 number of RR stations per km^2 × Post-famine, republic-year FE, and region-year FE.
Standard errors clustered at the province level separately before and after the famine.

First, as mentioned earlier, 1931 spring temperature also appears to be correlated with the subsequent mortality. Therefore, I present alternative instrumental variable estimates using deviations from the mean of 1931 spring temperature and 1932 summer precipitation interacted with post-famine indicator as an instrument for *1933 excess mortality* × *Post-famine*. Table 3.6 presents the estimates of the impact of the famine on total, rural, and urban population. As before, the corresponding first stage is shown in Panel B of the table. This instrumental variable strategy is slightly weaker that the one employing the 1932 weather only, with F-test just above 20. Nevertheless, the estimates of the impact of the famine severity on population are very close to the baseline estimates presented in Table 3.4, Columns (2), (5), and (8). This is not surprising since historians emphasize the importance of both 1931 and 1932 harvests in determining the severity of the 1933 famine.

Table 3.7: The effect of 1933 famine on population. Controlling for natural resources endowment

Panel A: Panel data estimation

	Dependent variable:								
	Ln population			Ln rural population			Ln urban population		
Model:	OLS (1)	IV (2)	OLS (3)	OLS (4)	IV (5)	OLS (6)	OLS (7)	IV (8)	OLS (9)
Excess mortality 1933 × Post-famine	-7.202*** (1.690)	-8.521*** (3.051)		-1.489 (1.963)	-2.622 (3.226)		-8.201*** (2.358)	-9.290** (3.922)	
Excess mortality 1933 × 1939			-8.381*** (2.265)			-5.129* (2.720)			-8.850*** (3.283)
Excess mortality 1933 × Post-1949			-7.036*** (1.742)			-0.978 (2.009)			-8.111*** (2.352)
Natural resources	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ln rural population							✓	✓	✓
Observations	960	912	960	960	912	960	960	912	960
R^2	0.660	0.876	0.660	0.637	0.839	0.639	0.930	0.951	0.930
Provinces	80	76	80	80	76	80	80	76	80

Panel B: First stages of the corresponding 2SLS panel regressions

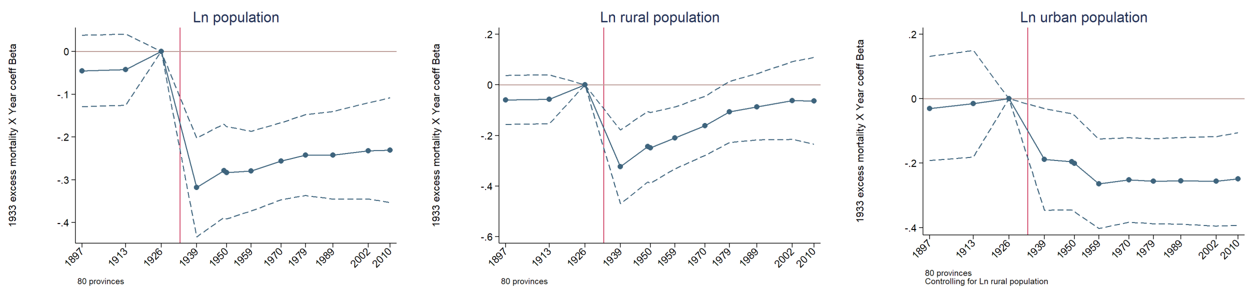
	Dependent variable: Excess mortality 1933 × Post-famine		
Demeaned spring 1932 temp × Post-famine	-0.014*** (0.004)	-0.014*** (0.004)	-0.013*** (0.004)
Demeaned summer 1932 precip × Post-famine	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
F	22.662	22.662	22.554

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used. Table 3.1 shows summary statistics of the main variables.
All regressions control for province and year FE, grain suitability × Post-famine, grain volatility × Post-famine, capital province indicator × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, Ln distance to Moscow × Post-famine, 1932 number of RR stations per km^2 × Post-famine, republic-year FE, and region-year FE.
Natural resources are oil production 2006 × Post-famine, and coal production 2006 × Post-famine.
Standard errors clustered at the province level separately before and after the famine.

Next, the 1933 famine was especially severe in grain-producing areas. It is possible that grain-producing areas were poor with other natural resources and the lack of natural resources and not the famine hindered urbanization after 1933. I proxy natural resources endowment with 2006 oil and coal output and re-estimate specifications (3.1) and (3.2) controlling for 2006 oil output interacted with post-famine indicator and 2006 coal output interacted with post-famine indicator. Table 3.7 and Figure 3.10 present the estimates. The results are very close to the baseline estimates: there is a short-term negative impact on rural population and long-term persistent negative impact on urban population. Thus, it is unlikely that the effect of the famine is driven by the differences in natural resources endowments.

Figure 3.10: The correlation between 1933 excess mortality and population over time with added controls for natural resources endowments – province-level estimated coefficients of *1933 excess mortality* × *Year indicator variables* and their 95% confidence intervals

(a) Population (b) Rural population (c) Urban population



The figure presents coefficients along with their 95% confidence intervals of the interaction effects of *1933 excess mortality* × *Year indicator variables* for each year for which data are available omitting 1926 as a reference year. These coefficients are estimated by regressing *Ln population*/*Ln rural population*/*Ln urban population* on the interaction variables, while controlling for province and year FE, grain suitability × Post-famine, grain volatility × Post-famine, capital province indicator × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, Ln distance to Moscow × Post-famine, 1932 number of RR stations per km^2 × Post-famine, republic-year FE, and region-year FE from equation (3.2). The vertical line indicates the 1933 famine. The estimated coefficients and standard errors are presented in Table 3.5.

Finally, I demonstrate that the results are not explained by Stalin's political repressions. I use georeferenced data on political sentences and executions from Zhukov and Talibova (2018) and estimate specifications (3.1) and (3.2) controlling for log number of individuals executed under the Article 58 of the Soviet penal code[15] interacted with post-famine indicator, and log number of individuals sent to Gulag under the Article 58 interacted with post-famine indicator. Table 3.8 and Figure 3.11 present the estimates. Qualitatively and quantitatively, these estimates are very close to the baseline estimates presented in Table 3.4 and Figure 3.9. Thus, the impact of the 1933 famine on urbanization is not driven by Stalin's political repressions.

3.5.2 Rural and urban economy

I complement the above analysis by considering the impact of the 1933 famine on Soviet economy. Table 3.9 reports the estimates of the impact of 1933 excess mortality on rural and urban sectors

[15] Under the Article 58 individuals suspected with counter-revolutionary activity could be arrested or executed.

Table 3.8: The effect of 1933 famine on population. Controlling for political repressions

Panel A: Panel data estimation									
	Dependent variable:								
	Ln population			Ln rural population			Ln urban population		
Model:	OLS (1)	IV (2)	OLS (3)	OLS (4)	IV (5)	OLS (6)	OLS (7)	IV (8)	OLS (9)
Excess mortality 1933 × Post-famine	-8.470*** (2.000)	-9.082*** (3.076)		-1.760 (2.071)	-2.493 (3.156)		-9.688*** (2.763)	-10.112** (3.937)	
Excess mortality 1933 × 1939			-9.376*** (2.467)			-5.374* (2.764)			-9.989*** (3.640)
Excess mortality 1933 × Post-1949			-8.347*** (2.051)			-1.270 (2.117)			-9.648*** (2.759)
Political repressions	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ln rural population							✓	✓	✓
Observations	972	924	972	972	924	972	972	924	972
R^2	0.644	0.871	0.644	0.640	0.840	0.642	0.925	0.948	0.925
Provinces	81	77	81	81	77	81	81	77	81
Panel B: First stages of the corresponding 2SLS panel regressions									
	Dependent variable: Excess mortality 1933 × Post-famine								
Demeaned spring 1932 temp × Post-famine		-0.010*** (0.004)			-0.010*** (0.004)			-0.010*** (0.004)	
Demeaned summer 1932 precip × Post-famine		0.001*** (0.000)			0.001*** (0.000)			0.001*** (0.000)	
F		26.641			26.641			26.397	

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used. Table 3.1 shows summary statistics of the main variables.

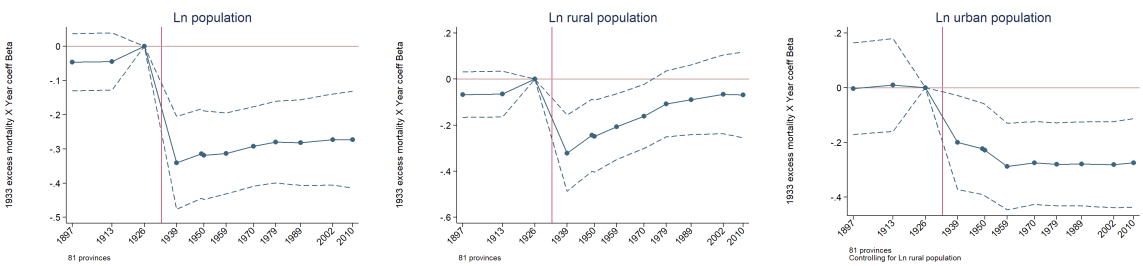
All regressions control for province and year FE, grain suitability × Post-famine, grain volatility × Post-famine, capital province indicator × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, Ln distance to Moscow × Post-famine, 1932 number of RR stations per km^2 × Post-famine, republic-year FE, and region-year FE.

Political repressions are Ln number of convicted and Ln number of executed individuals under Article 58 × Post-famine.

Standard errors clustered at the province level separately before and after the famine.

Figure 3.11: The correlation between 1933 excess mortality and population over time with added controls for political repressions – province-level estimated coefficients of *1933 excess mortality* × *Year indicator variables* and their 95% confidence intervals

(a) Population (b) Rural population (c) Urban population



The figure presents coefficients along with their 95% confidence intervals of the interaction effects of *1933 excess mortality* × *Year indicator variables* for each year for which data are available omitting 1926 as a reference year. These coefficients are estimated by regressing *Ln population*/*Ln rural population*/*Ln urban population* on the interaction variables, while controlling for province and year FE, grain suitability × Post-famine, grain volatility × Post-famine, capital province indicator × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, Ln distance to Moscow × Post-famine, 1932 number of RR stations per km^2 × Post-famine, republic-year FE, and region-year FE from equation (3.2). The vertical line indicates the 1933 famine. The estimated coefficients and standard errors are presented in Table 3.5.

of the economy: log grain, log sown area, log cattle, and log industrial output. The results are consistent with the impact of the famine on population. In the rural sector there is a short-term decline without persistent negative effect, but the urban sector is permanently affected.

For each of the considered economic outcomes (log grain, log sown area, log cattle, log industrial output), Table 3.9 first shows the total impact of the famine by reporting the difference-in-differences estimate as in specification (3.1). Next, Table 3.9 separates short- and long-term impacts of the famine by estimating the coefficients of the interaction of 1933 excess mortality with 1934–1940 years indicator and with Post-1949 indicator.

Columns (1) – (6) of Table 3.9 describe the agricultural sector. Columns (2), (4), and (6) demonstrate that there is a large negative and statistically significant short-term impact of the famine on agriculture. The coefficients on the interaction of 1933 excess mortality with [1934,1940] indicator are negative and statistically significant, that is, the famine led to grain production, sown area, and cattle to temporarily drop. However, Columns (1)–(6) demonstrate that there is no persistent long-term impact on agriculture as both the coefficient on the interaction of 1933 excess

Table 3.9: The effect of 1933 famine on economic development

	Dependent variable:							
	Ln grain		Ln sown area		Ln cattle		Ln industrial output	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Excess mortality 1933 × Post-famine	-1.128 (1.625)		-1.098 (2.119)		-2.897 (1.917)		-11.874* (6.903)	
Excess mortality 1933 × [1934,1940]		-9.031*** (2.620)		-8.230** (3.235)		-4.720* (2.836)		-18.454* (9.766)
Excess mortality 1933 × Post-1949		1.736 (1.881)		1.063 (2.315)		-2.760 (1.950)		-11.606* (6.910)
Observations	3413	3413	4957	4957	1500	1500	1560	1560
R^2	0.594	0.609	0.563	0.572	0.881	0.881	0.975	0.975
Provinces	77	77	77	77	60	60	53	53

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used. Table 3.1 shows summary statistics of the main variables.
All regressions control for province and year FE, grain suitability × Post-famine, grain volatility × Post-famine, capital province indicator × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, Ln distance to Moscow × Post-famine, 1932 number of RR stations per km^2 × Post-famine, republic-year FE, and region-year FE.
Standard errors clustered at the province level separately before and after the famine.

mortality with post-famine indicator and with post-1949 indicator are statistically indistinguishable from zero.

The pattern is different for the urban sector of the economy. Columns (7) and (8) of Table 3.9 demonstrate that the famine had a persistent negative impact on industrial output: the coefficients on the interaction of 1933 excess mortality with post-famine indicator, with [1934,1940] indicator, and with post-1949 indicator are all negative and statistically significant. Thus, consistent with the impact of the famine on urban population, industrial output also appears to be permanently affected.

3.5.3 Urban settlements

To test whether the impact of the famine on urban population can also be observed within provinces, I estimate specification (3.1) on a sample of urban settlements using 1933 mortality interacted with post-famine indicator as a main explanatory variable. As mentioned in Section 3.3, no disaggregated at a lower than province-level mortality data are available for non-famine years yet, and instead of calculating 1933 excess mortality with province-level 1928 and 1937–1939 mortality data I include province-year fixed effects in the estimates. In addition, I control for WWII losses interacted with post-war indicator, Nazi occupation dummy interacted with post-war indicator, and average grain suitability within 50 kilometers from a settlement interacted with post-famine indicator.

It is important to emphasize that the results reported in this section should be interpreted with caution, because only settlements that achieved “town” status by 1989 are in the sample. Thus, I observe only “surviving” towns; if the smallest urban settlements were the ones that were hit the most, with the implication that some stopped growing, never achieved “town” status or even turned into villages, the resulting estimates would be biased towards zero as these smaller settlements would not be in the sample.

Table 3.10 presents the estimates. The famine had a strong negative impact on the population of urban settlements. Thus, the within-province estimates are consistent with province-level results presented earlier.

Column (1) in Table 3.10 presents the difference-in-differences estimates on a sample of all urban settlements. The coefficient on the interaction of 1933 excess mortality with post-famine indicator is negative and highly statistically significant. Thus, higher 1933 mortality in the close proximity to a settlement appear to have a strong negative impact. Columns (2) – (4) of Table 3.10 present the difference-in-differences estimates separately for Belarus, Russia, and Ukraine. Since there was virtually no famine in Belarus in 1933 it is not surprising that there is no relationship between 1933 mortality and the subsequent population of Belorussian towns, the coefficient on the interaction of 1933 mortality with post-famine indicator is statistically zero and is very imprecisely estimated. Population of Russian and Ukrainian settlements, on the other hand, appears to be strongly affected by the 1933 famine. The coefficients on the interaction of 1933 mortality with post-famine indicator are negative, highly statistically significant, and are very close to the baseline

Table 3.10: The effect of 1933 famine on population of urban settlements

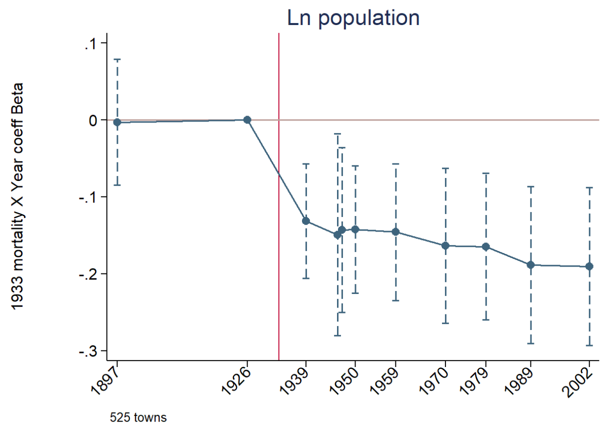
Panel A: Panel data estimation					
	Dependent variable: Ln population				
Model:	OLS				IV
Sample:	All	Belarus	Russia	Ukraine	All
	(1)	(2)	(3)	(4)	(5)
Mortality 1933 × Post-famine	-7.158***	1.531	-9.380**	-7.648**	-9.245
	(2.681)	(23.235)	(3.693)	(3.306)	(8.142)
Observations	4802	630	2181	1991	4161
R^2	0.809	0.625	0.875	0.764	0.395
Settlements	525	98	205	222	426
Panel B: First stages of the corresponding 2SLS panel regressions					
	Dependent variable: Mortality 1933 × Post-famine				
Demeaned spring 1932 temp × Post-famine					-0.010***
					(0.002)
Demeaned summer 1932 precip × Post-famine					0.000**
					(0.000)
F					19.751

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used. Table 3.1 shows summary statistics of the main variables.
All regressions control for town and year FE, grain suitability × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, and province-year FE.
Standard errors clustered at the settlement level.

estimates presented in Column (1). Finally, Column (5) presents instrumental variable estimates using the same strategy as in the province-level estimates. The first stage presented in Panel B of Table 3.10 shows that 1932 weather is a good predictor of 1933 mortality within provinces with F-test above 19. The second-stage point estimate is very close to the baseline OLS estimate presented in Column (1) but is much less precisely estimated and therefore is not statistically significant. This is not surprising given that province fixed effects are included in the estimates and that there is relatively little variation in weather conditions within provinces. Thus, as in province-level analysis, IV estimates suggest that the negative relationship between 1933 mortality and the subsequent size of urban settlements is causal and is not driven by some omitted factor.

Next, I test the main identifying assumption of the difference-in-differences estimates, that there are no differential trends within provinces in the settlements population before the famine. I estimate coefficients on ten interactions of 1933 mortality in the vicinity of a settlement with

Figure 3.12: The correlation between 1933 mortality and population over time – town-level estimated coefficients of *1933 mortality* × *Year indicator variables* and their 95% confidence intervals



The figure presents coefficients along with their 95% confidence intervals of the interaction effects of *1933 mortality* × *Year indicator variables* for each year for which data are available omitting 1926 as a reference year. These coefficients are estimated by regressing *Ln population* on the interaction variables, while controlling for town and year FE, grain suitability × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, and province-year FE from equation (3.2). The vertical line indicates the 1933 famine. The estimated coefficients and standard errors are presented in Table 3.11.

year indicators for each year for which data are available, omitting 1926 as a reference year, as in specification (3.2). I include all the controls and fixed effects as reported in Table 3.10.

Figure 3.12 shows the interaction coefficients with their 95% confidence intervals[16]. Since data on settlement population is only available for census years, only 1897 and 1926 figures are available before the 1933 famine. Thus, only one pre-famine interaction coefficient could be estimated, 1897. Nevertheless, the results are consistent with the province-level estimates. Before the famine, there is no correlation between 1933 mortality and settlements' population. After the famine, there is a very strong negative relationship, the coefficients on the interaction of 1933 mortality and post-famine year indicators are all negative, highly statistically significant, and their magnitude does not decrease over time.

To illustrate the magnitude of the impact of the 1933 famine on the population of urban settlements, Figure 3.12 plots standardized beta-coefficients. That is, it shows by what fraction of

[16]Table 3.11 presents the estimated coefficients and standard errors.

Table 3.11: The correlation between 1933 mortality and population over time – town-level estimated coefficients of *1933 mortality* × *Year indicator variables* and their 95% confidence intervals

	Dependent variable: Ln population	
	estimates (1)	beta coeff (2)
Mortality 1933 × 1897	-0.129	-0.003
	(1.869)	
Mortality 1933 × 1939	-5.978***	-0.131
	(1.697)	
Mortality 1933 × 1946	-6.790**	-0.149
	(2.987)	
Mortality 1933 × 1947	-6.513***	-0.143
	(2.446)	
Mortality 1933 × 1950	-6.479***	-0.142
	(1.893)	
Mortality 1933 × 1959	-6.636***	-0.146
	(2.024)	
Mortality 1933 × 1970	-7.450***	-0.164
	(2.297)	
Mortality 1933 × 1979	-7.492***	-0.165
	(2.173)	
Mortality 1933 × 1989	-8.588***	-0.189
	(2.329)	
Mortality 1933 × 2002	-8.678***	-0.191
	(2.337)	
Observations	4802	
R^2	0.810	
Cities	525	

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used. Table 3.1 shows summary statistics of the main variables.

All regressions control for town and year FE, grain suitability × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, and province-year FE.

For each interaction coefficient estimate standardized beta-coefficient is calculated by multiplying the estimate by standard deviation of 1933 mortality and dividing by standard deviation of the dependent variable in the corresponding year.

Standard errors clustered at the town level.

a standard deviation the settlements' population would have changed on average in each year if 1933 mortality in the vicinity of a settlement changed by a standard deviation, or by 27 per 1,000. Figure 3.12 shows that the increase in 1933 mortality by one standard deviation lowered the population of urban settlements by 0.13 to 0.19 of a standard deviation, a very large decrease. Thus, within-province settlement-level estimates are consistent with the province-level findings that the 1933 famine had a persistent negative impact on urban population.

3.5.4 Mechanism: migration v. differential natural increase

After large famines birth rates usually increase, correcting for the population losses and delayed births, and death rates usually decrease, since weaker individuals have higher chances to have already perished during the famine. It is therefore possible that the recovery of the rural population in famine-struck areas is explained simply by differential rates of natural population increase. However, this section presents evidence against the natural increase explanation. It demonstrates that the natural increase rates went back to normal quickly after the famine, much earlier than necessary for the recovery of rural population.

Table 3.12 presents the evidence against the natural increase explanation. It demonstrates that indeed immediately after the 1933 famine the natural increase rate of population was higher in the famine-struck areas. However, after World War II no differences in birth or death rates could be observed. Thus, a relative rise of birth rate and a relative fall of death rate cannot explain the recovery of rural population. Using specification (3.1) on a sample of 25 administrative units for which yearly birth and death rates data are available, Columns (1) – (3) demonstrate that there was an immediate drop in mortality rates, but no long-term drop, and no long-term impact on natural population increase. Column (4) – (5) show similar results for the natural increase rates of rural population. To illustrate the relationship between the famine and birth and death rates over time, Figure 3.13 shows the estimates of the correlation between 1933 excess mortality and birth, death,

Table 3.12: The correlation between 1933 excess mortality and the population growth rates

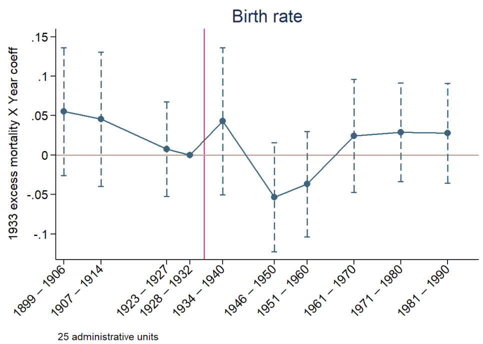
	Dependent variable:					
	Total, 1899 – 1990			Rural, 1928 – 1990		
	Birth rate	Death rate	Natural increase	Birth rate	Death rate	Natural increase
	(1)	(2)	(3)	(4)	(5)	(6)
Excess mortality 1933	0.002	-0.063***	0.061	0.076	0.041	0.032
× [1934,1940]	(0.043)	(0.019)	(0.036)	(0.060)	(0.031)	(0.068)
Excess mortality 1933	-0.048	-0.022	-0.027	0.027	0.080**	-0.054
× [1946,1990]	(0.039)	(0.013)	(0.033)	(0.028)	(0.032)	(0.043)
Observations	1470	1491	1470	1130	1151	1130
R^2	0.964	0.969	0.895	0.950	0.904	0.930
Administrative units	25	25	25	25	25	25

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used. Table 3.1 shows summary statistics of the main variables.
All regressions control for province and year FE, grain suitability × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, urbanization rate, and republic-year FE.
Natural increase is birth rate minus death rate.
Robust standard errors.

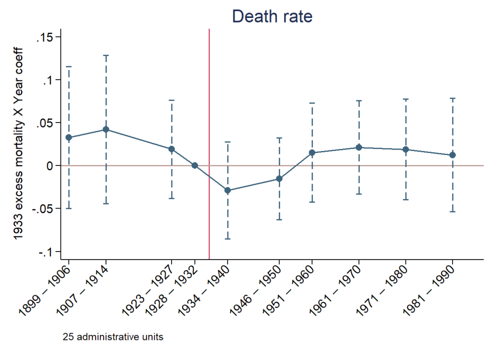
and natural increase rates over time. It confirms the findings presented in Table 3.12: changes in natural population increase rates are insufficient to explain the recovery or rural population.

Figure 3.13: The correlation between 1933 excess mortality and mortality, natality, and natural increase rates over time – 25 administrative units-level estimated coefficients of *1933 excess mortality* × *Year indicator variables* and their 95% confidence intervals

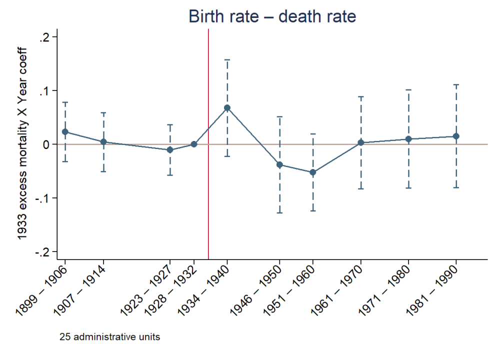
(a) Natality



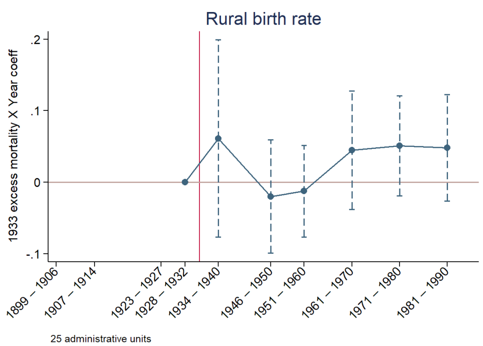
(b) Mortality



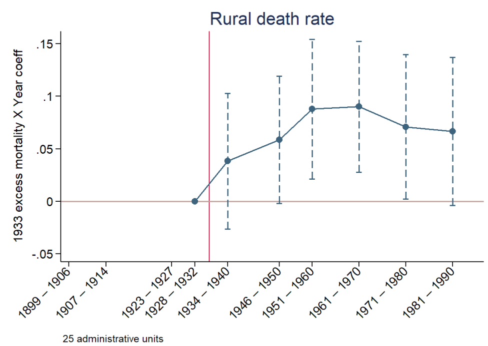
(c) Natural increase



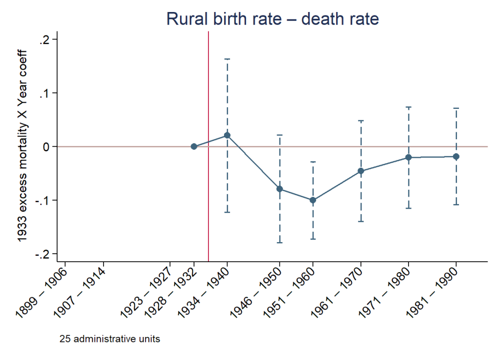
(d) Rural natality



(e) Rural mortality



(f) Rural natural increase



Natality is a ratio of live births to population, mortality is a ratio of deaths to population, natural increase is a difference between natality and mortality. The figure presents coefficients along with their 95% confidence intervals of the interaction effects of *1933 excess mortality* × *Year indicator variables* for each period for which data are available omitting 1928–1932 as a reference period. These coefficients are estimated by regressing *Mortality*/*Natality*/*Natural increase* on the interaction variables, while controlling for province and year FE, grain suitability × Post-famine, grain volatility × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, and republic-year FE from equation (3.2). The vertical line indicates the 1933 famine.

Since the differential rates of natural population increase cannot explain the recovery of rural population in areas struck by the famine, the recovery has to be explained by differential migration. Unfortunately, the data on migration within Soviet Union are not yet available, therefore I cannot directly distinguish between (1) a larger inflow of rural population from areas not affected by the famine to the areas that experienced severe losses and (2) a smaller outmigration to urban settlements from areas struck by the famine and therefore experiencing relatively larger labor shortages. Nevertheless, below I present some indirect evidence consistent with the smaller outmigration to urban settlements explanation.

In general, urban settlements grew mostly due to migration. One might expect that smaller settlements attracted mostly people from the surrounding rural areas, while larger cities could invite migrants from larger areas. Therefore, if outmigration to the urban areas was smaller in the territories struck by the famine, it is possible that the impact of the famine might vary with the initial size of the settlement: local shortage of rural labor might disproportionally affect growth of smaller urban settlements. To test this, I divide the sample into four groups: settlements that in 1926 had fewer than 20 thousand inhabitants, settlements that had between 20 and 30 thousand people, between 30 and 40, and more than 40 thousand. I then estimate the coefficient on the interaction of 1933 mortality and post-famine indicator using specification (3.1) separately for each subsample. Table 3.13 reports the estimates. It shows that indeed the effect of the famine on urban settlements' population is driven by smaller settlements. Column (1) presents the coefficient on the interaction of 1933 mortality and post-famine indicator estimated on a subsample of settlements that had fewer than 20 thousand people in 1926. This coefficient is negative, highly statistically significant, and its magnitude is slightly larger than the baseline estimate obtained with the whole sample and presented in Table 3.10 Column (1). Next, Table 3.13 Column (2) shows the coefficient on the interaction of 1933 mortality and post-famine indicator estimated on a sample of settlements that had between 20 and 30 thousand people in 1926. The coefficient is still negative, but the point estimate is closer to zero than in the previous column and is not statistically significant. Similarly,

Table 3.13: The differential effect of 1933 famine on population of cities and towns by 1926 town size

	Dependent variable: Ln population			
Sample:	1926 pop $\leq 20K$	$20K <$ 1926 pop $\leq 30K$	$30K <$ 1926 pop $\leq 40K$	1926 pop $> 40K$
	(1)	(2)	(3)	(4)
Mortality 1933	-8.695**	-3.214	17.937*	1.860
× Post-famine	(3.615)	(22.864)	(10.514)	(8.017)
Observations	2649	467	302	1384
R^2	0.818	0.969	0.972	0.893
Towns	295	45	28	157

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Section 3.3 provides details on data construction and Table C.1 lists the exact source of every variable used. Table 3.1 shows summary statistics of the main variables.
All regressions control for town and year FE, grain suitability × Post-famine, WW2 losses × Post-war, Nazi occupation indicator × Post-war, and province-year FE.
Standard errors clustered at the town level.

Columns (3) and (4) present coefficient on the interaction of 1933 famine and post-famine indicator on the sample of settlements that had between 30 and 40 thousand people, and more than 40 thousand people correspondingly. In both cases the famine appears to have created no negative impact on the population of these settlements[17]. Thus, the negative impact of the famine on urban population appears to be driven by relatively smaller settlements.

3.6 Conclusion

Urbanization is almost equivalent to economic development and prosperity. Understanding the formation of urban networks therefore is one of the major questions in economic literature. Krugman (1991) theoretically predicted the possibility of multiple equilibria in urban network formation. To this day, however, no strong empirical evidence supporting the existence of multiple equilibria was found. To the contrary, numerous studies demonstrated the resilience of formed urban networks to large temporary shocks to population and capital. This article presents preliminary evidence supporting the existence of multiple urbanization equilibria by demonstrating that local shortages of

[17]In Column (3) the coefficient is actually large and positive. Given the small sample size, I would not put much weight on this estimate.

labor during rapid construction might prevent urban settlements from growing and that this effect from temporary negative shock to population can be persistent when the shock occurs during the construction of urban network.

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Appendix A

(Chapter 1)

A.1 Collectivization and mortality: instrumental variable strategy

Collectivization was not an exogenous event. Although I try to control for all the factors that could have been simultaneously affecting collectivization and famine mortality, there is always a possibility for an omitted variable. For example, poor peasants probably had more incentives to join collective farms. Land and implements confiscated from their better off neighbors could have made joining a collective farm look like a good deal. Even though I include proxies for wealth and inequality in my OLS estimates (population density, literacy rate, value of agricultural equipment, share of households hiring workers), it is still possible that poorer or more unequal districts had a higher collectivization rate and suffered more from the 1933 famine not because of collectivization, but simply because they were poor or had higher inequality.

On the other hand, it is possible that the Soviet government spent more effort to collectivize wealthier districts faster. Wealthier and better equipped peasants were potentially easier to transform into well-functioning collectives. If this is true, my OLS estimates of the effect of collectivization are biased downward as better off districts probably had more resources to survive the crop failure, despite collectivization and grain procurement.

I use the differential impact of Stalin's "Dizzy with success" article to instrument for collectivization[1]. As already mentioned in Section 3.2, full scale collectivization drive started in the late 1929 and by the end of the winter of 1930 resistance to collectivization grew so strong that, according to some sources, Soviet Union was on the verge of full scale peasant revolt. Stalin had to back off. On March 2, 1930 he published his famous "Dizzy with success" article in the central Soviet newspaper "Pravda." In this article Stalin blamed local authorities for excesses during collectivization drive and argued that joining a collective farm should be voluntary[2]. A mass exodus of peasants from collective farms started after the publication.

Describing the mass exodus from collective farms after the Stalin's publication, Davies (1980) noticed that "in the Southern Ukraine and the North Caucasus, the spring sowing begins towards the end of March, so peasants could not withdraw from the kolkhozy in March and April as easily as they could in more northerly regions" (Davies, 1980, p. 286). To leave collective farms peasants needed to get land allotment from the kolkhoz. Kolkhoz chairmen dragged their feet allocating land back to peasants. As spring sowing season approached, many peasants were effectively locked in collective farms because they could not obtain land in time. Thus, in areas where spring started *earlier* the impact of Stalin's article was *smaller*, effectively increasing collectivization rate.

To capture the unexpectedly early spring, I use *normalized air temperature in March 1930*[3], – the difference between air temperature in March 1930 and average March temperature during 1900-1929, to instrument for collectivization. I argue that, all else being equal, warmer than usual spring of 1930 left less time for peasants to leave collective farms and therefore increased district

[1]I am grateful to Sergei Izmalkov in talk with whom the idea of this instrument popped up.

[2]"It is a fact that by February 20 of this year 50 percent of the peasant farms throughout the USSR had been collectivized. That means that by February 20, 1930, we had overfulfilled the five-year plan of collectivization by more than 100 per cent. [...] some of our comrades have become dizzy with success and for the moment have lost clearness of mind and sobriety of vision", Stalin (March 2, 1930)

[3]Normalized April 1930 also works, but the first stage is slightly less strong. Estimates available upon request.

collectivization rate. Using the normalization is important. Areas where spring *usually* starts earlier are better suited for agriculture. According to the discussion in Section 3.2, it is likely that the government tried to collectivize faster areas better suited for agriculture, and tried to procure more grain from these areas. The exclusion restriction is more likely to hold for areas where 1930 spring was *warmer than usual*.

There are many threats to validity of this instrument. If an unexpectedly warm spring increased subsequent harvest, peasants in warmer than usual districts might have accumulated more reserves to survive crop failure in the following years. However, warmer weather in March alone is not a sufficient predictor of a good harvest. It is crucially important that the weather is not too hot in the spring, that there is enough (but not too much) precipitation, and that there are no frosts in late spring and early summer. And most importantly, this would bias my IV estimates *downward*. I also control for 1925 wheat and rye production per capita, and additional controls include wheat and rye and potato suitability.

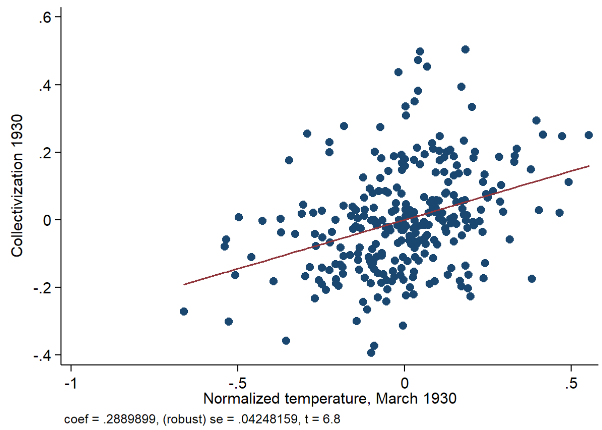
Another potential violation of exclusion restriction is that if indeed an unexpectedly warm spring of 1930 resulted in a better harvest, the government could have observed this better harvest and might have used this information in grain collections in the subsequent years. This would bias IV estimates upward. But as I've already mentioned, Soviet statistics were accurate during the 1920s, and, given the ongoing procurement crisis, by the 1930 peasants had much more incentives to hide their grain from the government. Thus, soviet officials should not have put too much weight on information from this one year when allocating procurement quotas in 1931 and 1932.

One more potential threat to the exclusion restriction is the following. Peasants leaving the collectives were allocated worse land. If it was most productive peasants who left and if they ended up with the relatively worse land, then, relative to these peasants staying in the collectives, their exit might have reduced grain production. On the other hand, if, as I argue in Section 1.4.2, collectives were disorganized and unproductive, then exit of the most productive peasants, even with the worst land, might have resulted in increase in district's grain production. As above, the direction of the bias would depend on whether we believe the production increased or decreased, and on whether the relative change in grain production affected the government's decision when allocating procurement quotas in 1931 and 1932.

Finally, what if weather shocks are negatively serially correlated? That is, what if unexpectedly warm spring of 1930 meant relatively colder spring in 1931 and 1932? According to Davies and Wheatcroft (2009), there was a severe negative weather shock in 1931 and 1932, with cold and late spring and drought in the summer. If normalized temperature of March 1930 is strongly negatively correlated with normalized temperature in 1931 or 1932, then the IV estimate might be capturing the effect of the negative weather shock, not collectivization. Luckily, this hypothesis is directly testable. Correlation between normalized 1930 spring temperature and normalized 1931 spring temperature equals 0.46, and correlation between normalized 1930 spring temperature and normalized 1932 spring temperature equals 0.11. Thus, it is unlikely that the IV estimates are capturing the effect of the subsequent drought.

Table A.1 presents IV estimates of the effect of collectivization on 1933 mortality. The instrument is a very strong predictor of collectivization rate with F-statistic higher than 20 in all specifications. Figure A.1 shows scatter plot of the first stage, demonstrating that the positive relationship between normalized March 1930 temperature and collectivization rate is not driven by outliers or by a particular subsample. The magnitude of the effect of collectivization on mortality is much higher in the IV estimates, one standard deviation increase in collectivization rate increases 1933 mortality by 0.38 to 0.49 of standard deviation, or by 22 people per 1000. The fact that IV estimates are much higher than OLS estimates is consistent with the fact that the Soviet government tried to collectivize better off districts first.

Figure A.1: Normalized 1930 March temperature and collectivization. District level estimates



Conditional scatter plot and fitted values between normalized temperature in March 1930 and collectivization in 1930 conditional on baseline controls: wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

Table A.1: Effect of collectivization on 1933 mortality.
Instrumental variable estimates

Second stage: dependent variable is Mortality 1933	(1)	(2)	(3)
Collectivization 1930	0.130***	0.085***	0.128***
	(0.032)	(0.024)	(0.040)
Wheat and rye pc 1925	✓	✓	✓
Baseline controls		✓	✓
Additional controls			✓
Province FE	✓	✓	✓
Observations	280	280	215
R^2	0.216	0.478	0.402
First stage: dependent variable is Collectivization 1930			
Normalized temperature, March 1930	0.237***	0.289***	0.268***
	(0.042)	(0.043)	(0.051)
R^2	0.416	0.473	0.535
F	32.558	46.277	27.560
Magnitude: Standardized beta coefficients			
Collectivization 1930	0.758	0.499	0.725

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 3.3 provides details on data construction and Table A.2 lists the exact source of every variable used. Table 1.1 shows summary statistics of the main variables.
Baseline controls are livestock per capita 1925, rural literacy rate 1927, wheat and rye per capita 1925, agricultural equipment per capita 1925, urbanization 1927, rural population density 1927, Ln(distance to the province center 1933), Ln(distance to a railroad 1933), Polissia region indicator.
Additional controls are number of soviets per capita 1925, collective farms per capita 1925, share of households hiring in workers 1925, share of households hiring out workers 1925, grain suitability, potato suitability.

A.2 Data sources

Table A.2: Data sources (Chapter 1)

Variable	Source
Mortality 1933 Natality 1933	RSAE 1562/329/18 pp 1-16
Collectivization 1930 Number of households per collective farm 1930	Gosplan SSSR. Upravleniye narodnokhozyaystvennogo ucheta (1931)
Rural share of Ukrainians 1927 Rural literacy rate 1927 Rural population density 1927, 100s per km^2 Urbanization 1927	USSR Census, December 1926. Tsentral'noye Statisticheskoye Upravleniye SSSR. Otdel perepisi (1929)
Livestock per capita 1925 Cows per capita 1925 Horses per capita 1925 Arable land per capita 1925, ha Household plot per capita 1925, ha Grain, sown area per capita 1925, ha Wheat and rye, sown area per capita 1925, ha Potato, sown area per capita 1925, ha Grain, harvest per capita 1925, centners Wheat and rye, harvest per capita 1925, centners Rural soviets per 1000 peasants, 1925 Agricultural cooperatives per 1000 peasants, 1925 Collective farms per 1000 peasants, 1925 Share of households hiring in workers 1925 Share of households hiring out workers 1925	Total quantities are from Materialy do opysu okruh USRR, Tsentralne Statystychne Upravlinnya USRR (1926), rural population is from 1927 census, Tsentral'noye Statisticheskoye Upravleniye SSSR. Otdel perepisi (1929)

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Table A.2 – *Continued from previous page*

Variable	Source
Value of agricultural equipment per capita 1925, rub	Quantities of plows, bukkers, harrows, seeders, winnows, reapers, and threshers are from Materialy do opysu okruh USRR, Tsentralne Statystychne Upravlinnya USRR (1926). 1914 prices are from (Ministerstvo zemledeliya. Otdel sel'skoy ekonomii i sel'skokhozyaystvennoy statistiki. Ministre de l'agriculture. Division d'Economie rurale et de Statistique agricole, 1917, pp 636-647). Rural population is from 1927 census, Tsentral'noye Statisticheskoye Upravleniye SSSR. Otdel perepisi (1929)
Cows per capita 1930 Share of industrial workers, 1930 Industrial output per capita, 1930, rub	Derzhavna Planova Komisiya USRR. Ekonomychno–statystychnyy sektor (1930a)
Distance to railroad 1933, km Railroad length 1933, km Density of railroad network 1933, length/area Distance to 1933 province center, km	Harvard Ukrainian Research Institute has kindly shared scanned 1933 Ukrainian map with me.
Normalized temperature, March 1930	Terrestrial Air Temperature and Precipitation: 1900–2014 Gridded Monthly Time Series, Version 4.01, Matsuura and Willmott (2014). Normalized temperature is the difference between temperature in March 1930 and the average March temperature during 1900-1929.
Mortality 1927 Natality 1927 Cows per household 1927 Rye, sown area per household 1927, ha	Tsentralna Statystychna Uprava USRR (1929)
Wheat and rye suitability Potato suitability	GAEZ portal, `gaez.iiasa.ac.at`. Wheat and rye suitability is an average of suitability values of all major grain crops grown in Ukraine: barley, buckwheat, corn, oat, rye, and wheat. Used values for low input level and rain-fed water supply.

Appendix B

(Chapter 2)

B.1 Data sources

Table B.1: Data sources (Chapter 2)

Variable	Source
Total and rural deaths	1900 – 1914: MVD (1901–1914); 1923–1924: Trudy TsSU (1924); 1925: Tsentral'noye Statisticheskoye Upravleniye SSSR (1928); 1927 – 1939: Russian State Archive of the Economy (RSAE) 1562/329/256; 1946–2010: demoscope.ru

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Table B.1 – *Continued from previous page*

Variable	Source
Population and urban population	1900 – 1914: MVD (1901–1914); 1923 – 1925: Trudy TsSU (1924); 1926: interpolated between 1925 and 1927; 1927: Tsentral'noye Statisticheskoye Upravleniye SSSR. Otdel perepisi (1929); 1928–1930: RSAE 4372/30/107; 1931: Tsentral'nyy Ispolnitel'nyy Komitet Soyuza SSR (1931); 1932: interpolated between 1931 and 1933; 1933–1935: RSAE 1562/329/49; 1936: interpolated between 1935 and 1937; 1937: Zhiromskaia et al. (1996); 1938: interpolated between 1937 and 1939; 1939: census with corrections for the centralized additions from Bogoyavlenskiy (2014); 1946: RSAE 1562/20/626; 1947: RSAE 1562/20/684; 1948: RSAE 1562/329/3802; 1949–1950: RSAE 1562/329/4464,4465; 1951–1958 interpolated between 1950 and 1959; 1959: census; 1960–1969: Narodnoe Khoziastvo RSFSR, BSSR, USSR; 1970: census
Grain production	1900 – 1914: MVD (1901–1914); 1928, 1932–1940: RSAE 1562/329/1409
Grain procurement	1924–1926: Publishing house Narkomtorg USSR and the RSFSR (Izdatel'stvo Narkomtorga SSSR i RSFSR); 1929–1933: SNABTEHIZDAT (1932)
Collectivization 1930	Gosplan SSSR. Upravleniye narodnokhozyaystvennogo ucheta (1931)
Rural share of ethnic Ukrainians 1926	Tsentral'noye Statisticheskoye Upravleniye SSSR. Otdel perepisi (1929)
Number of Communist Party members 1926	Russian State Archive of Socio-Political History 17/7/150

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Table B.1 – *Continued from previous page*

Variable	Source
Grain suitability	GAEZ portal, gaez.iiasa.ac.at. Grain suitability is an average of suitability values of all major grain crops grown in Belarus, Russia, and Ukraine: barley, buckwheat, corn, oat, rye, and wheat. Used values for low input level and rain-fed water supply. Mean values for province polygons are used.
Fall, Winter, Spring, Summer temperature and precipitation	Terrestrial Air Temperature and Precipitation: 1900–2014 Gridded Monthly Time Series, Version 4.01, Matsuura and Willmott (2014). Normalized temperature is the difference between temperature in March 1930 and the average March temperature during 1900-1929.

Appendix C

(Chapter 3)

C.1 Data sources

Table C.1: Data sources (Chapter 3)

Variable	Source
Excess mortality 1933	1933 mortality is from RSAE 1562/329/18, 1928 and 1937–1939 deaths are from RSAE 1562/329/256. 1928 population is from 1927 census, Tsentral'noye Statisticheskoye Upravleniye SSSR. Otdel perepisi (1929). 1937 population is from Zhiromskaia et al. (1996), 1939 population is from 1939 census, Bogoyavlenskiy (2014), 1938 population interpolated between 1937 and 1939.
WW2 losses	Projected 1949 population is calculated from 1939 population corrected for centralized additions (census, Bogoyavlenskiy (2014)) using 1937–1939 birth and death rates from RSAE 1562/329/256; Actual 1949 population is from RSAE 1562/329/4464
Nazi occupation indicator	RSAE 1562/329/2263
Population, Rural population, Urban population	1897, 1926, 1939, 1959, 1970, 1979, 1989, 2002, 2010 population is from the corresponding censuses. 1913 population is from MVD (1914)

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Table C.1 – *Continued from previous page*

Variable	Source
Grain suitability	GAEZ portal, gaez.iiasa.ac.at. Grain suitability is an average of suitability values of all major grain crops grown in Belarus, Russia, and Ukraine: barley, buckwheat, corn, oat, rye, and wheat. Used values for low input level and rain-fed water supply. Mean values for province polygons are used.
Grain volatility	Standard deviation divided by mean grain production during 1900–1913
1932 railroad stations per 1,000 km^2	Location of railroad stations is from Zhukov and Talibova (2018)
Fall, Winter, Spring, Summer temperature and precipitation	Terrestrial Air Temperature and Precipitation: 1900–2014 Gridded Monthly Time Series, Version 4.01, Matsuura and Willmott (2014). Normalized temperature is the difference between temperature in March 1930 and the average March temperature during 1900-1929.
Number of individuals sentenced under Article 58, Number of individuals executed under Article 58	Zhukov and Talibova (2018)