The Political Economy of Famine: the Ukrainian Famine of 1933

Natalya Naumenko*

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Abstract

The famine of 1932–1933 in Ukraine killed as many as 2.6 million people out of a population of approximately 30 million. Three main explanations have been offered: negative weather shock, poor economic policies, and genocide. This paper 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).
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*Department of Economics, Northwestern University, nata.naumenko@u.northwestern.edu. This research is supported by the Balzan Foundation and by Economic History Center at Northwestern University.

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 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

[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).

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 predicts 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

[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.

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, 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

[5] I describe these policies and the historical context in detail in Section 2, and the way that I measure these policies in Section 4.2.

[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.

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.

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 text is organized as follows. Section 2 gives background information and chronicles the events that led to the 1933 famine, Section 3 describes the data, Section 4 presents the results, and Section 5 concludes. The Appendix presents additional robustness checks.

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.

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). 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 in-

[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)

structions 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. 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.

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.

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 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

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

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 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.

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 E1 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 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

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

[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).

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 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 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 3.1 below). I omit districts for which I don't know the exact boundaries. Figure 4 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.

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*

[13]See comment in RSAE 1562/329/18, pp 77-80

[14]Estimates using the second version of mortality rates are available upon request.

[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 3.1 below.

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 E1).

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 3a, 3b, 3c, 3d 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 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.

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: 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

[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.

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.

4 Results

This section presents the empirical results. First, Section 4.1 investigates to what extent drop in production in 1931 and 1932 can be attributed to the weather. Next, Section 4.2 studies famine-specific policies in detail and demonstrates their contribution to 1933 mortality. Then Section 4.3 investigates the relationship between ethnic composition and mortality. Finally, Sections 4.3.1 and 4.3.2 analyze how exposure to and enforcement of the government policies varied with ethnic composition. The Appendix presents additional robustness checks.

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 5 plots demeaned temperature and precipitation during 1920 – 1940 for the months of April, May, June, and July. Figure 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 5b shows that May 1931 was slightly warmer than the average. According to figure 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 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 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

[17] Volgra region, as well as Ukraine, were considered “grain surplus” areas of the Soviet Union.

[18] 77 to 86 degrees Fahrenheit.

0.999, that is, the input 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 6 plots reported harvest and predicted harvest with its 95% confidence interval (to preserve space, the exact reported and estimated harvest figures are presented in the Appendix Table A1). 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 administrative 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-

[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.

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 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 2 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

[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 2), 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.

calculate individual peasants' yields I assume that sown area was divided in proportion with collectivization rate[22,23]. Figure 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. 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 2 Column (5) presents corrected harvest for the years of 1931 – 1933, and Figure 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 2 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.

[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 4.2.1, Table 7 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.

Since grain 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 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.

4.2 Policies

This section studies famine-specific policies. Motivated by the historical accounts summarized in Section 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 3 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 3 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

[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 3 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.

producing means of production. To account for these differences, in all subsequent estimates I control for urbanization and population density.

Finally, similar to the previous estimates, I compare districts with distance to a railroad below and above the median. Table 3 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 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 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 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.

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

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

$$mortality_d = \alpha_p + \beta z_d + X_d'\gamma + \epsilon_d \tag{1}$$

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 4 Panel A reports the estimates of the impact of government policies on mortality using model (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 10 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) with baseline controls dropping each of the eight Ukrainian provinces one by one. Figure 11 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 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 B1 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) using three alternative 1930 collectivization data versions (Table B2), and alternative 1933 mortality data from HURI (Table B3). The alternative estimates are very similar to the baseline estimates in Table 4 Column (1) both in magnitude and statistical significance.

In addition, Appendix Section B 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 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 4 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). 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 4 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 4 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) but without province fixed effects since regions don't fit into provinces. Table 4 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:

$$mortality_{i,t} = \beta z_i I_t^{fam} + X_i' I_t^{fam} \gamma + \alpha_i + \tau_t + \epsilon_{i,d} \tag{2}$$

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 4 Panel C presents the estimates. The coefficients are extremely close the the corresponding coefficients obtained on a cross-section of regions and reported in 4 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 12 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 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.

4.2.1 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 5 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).

First, consider Table 5 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

[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.

[28] This assumption is in favor of collective farms. If individual peasants had lower sown area per capita their

5 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 5 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 5 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) 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 5 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 5 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.

yields must have been even higher.

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

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

Table 6 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 8 demonstrates that it is the size of collective farms that drove mortality up in 1933. It presents estimates of specification (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.

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

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 collectivization rate in 1930. Table 7 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 9 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

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

[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.

[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.

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 10 reports the results. Because of the large number of controls and fixed effects, predicted 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 4 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 B4, 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 4 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 because these industries had a higher priority for the government and were better supplied.

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:

$$mortality_d = \alpha_p + \delta ethnicity_d + Z_d'\beta + X_d'\gamma + \epsilon_d \tag{3}$$

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

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 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 9 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 11 presents estimates of the effect of ethnicity on mortality using model (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 though barely statistically significant. Figure 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 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 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 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 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 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 16b shows that dropping these four districts from the sample results in a relationship statistically indistinguishable from zero between the share of ethnic Germans in the district and 1933 mortality.

Finally, Table 11 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 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. To preserve space, all tables are presented in the Appendix C and here I just briefly discuss them.

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 C1 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 networks. 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 C2 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 C3 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.

Finally, Table C4 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 11, 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:

$$mortality_{i,t} = \delta ukrainians_i I_t^{fam} + X_i' I_t^{fam} \gamma + Z_i' I_t^{fam} \beta + \alpha_i + \tau_t + \epsilon_{i,d} \qquad (4)$$

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 11 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.

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

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.

4.3.1 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:

$$z_d = \alpha_p + \beta ethnicity_d + X_d'\gamma + \epsilon_d \quad (5)$$

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 12 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 17 reports conditional scatter plot and fitted values of the relationship between ethnic Ukrainians and collectivization rate conditional on baseline controls (as in Table 12, 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.

estimates in Table 11.

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 D1 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 12, 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 D3 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 12.

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 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.

4.3.2 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:

$$mortality_d = \alpha_p + \beta z_d + \theta ethnicity_d z_d + \delta ethnicity_d + X_d'\gamma + \epsilon_d \tag{6}$$

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 13 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.

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. Collective farms did not create large economies of scale the So-

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

viet 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.

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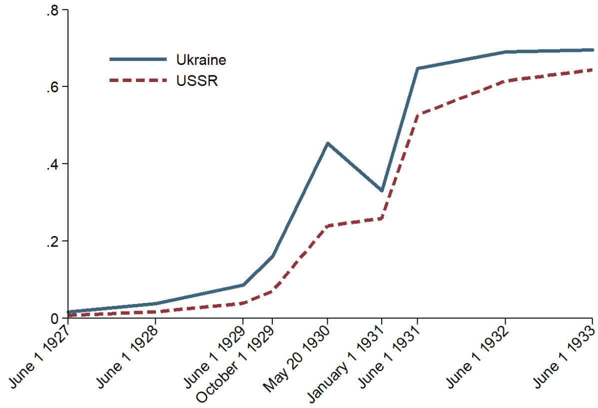
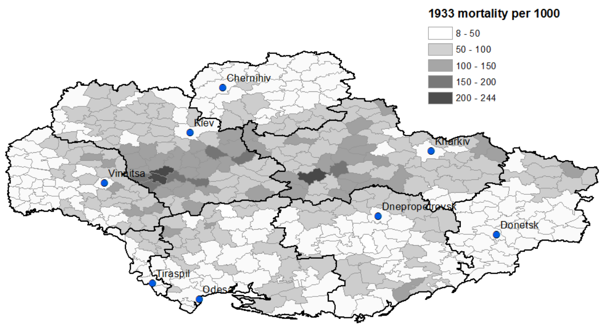
Figures

Figure 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)

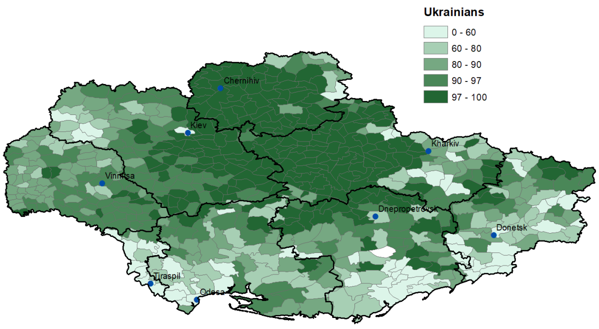
Figure 2: Mortality 1933



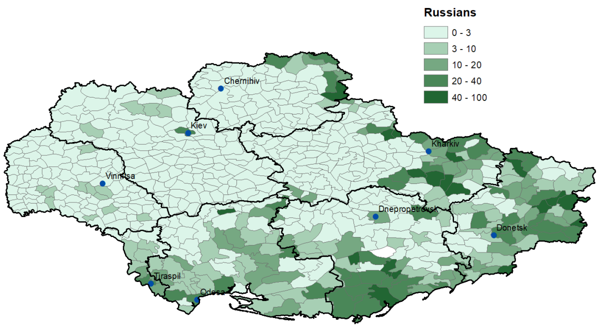
Mortality 1933 is a number of deaths per average 1933 population multiplied by 1000. *Source:* RSAE 1562/329/18. Thick lines are 1933 province borders.

Figure 3: Ethnic composition

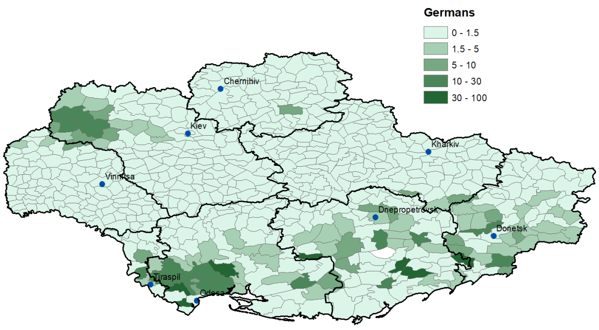
(a) Ukrainians



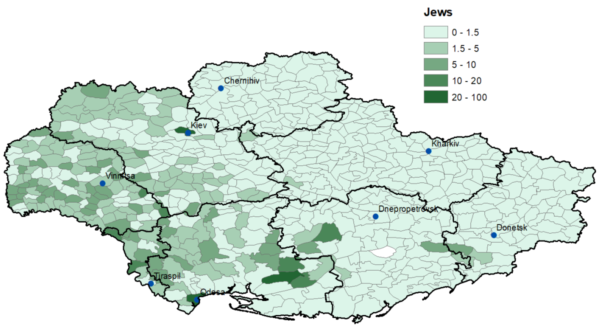
(b) Russians



(c) Germans

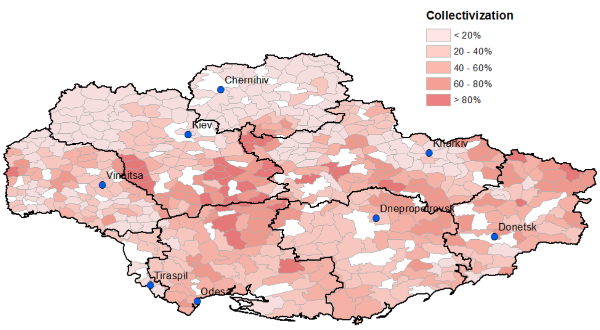


(d) Jews



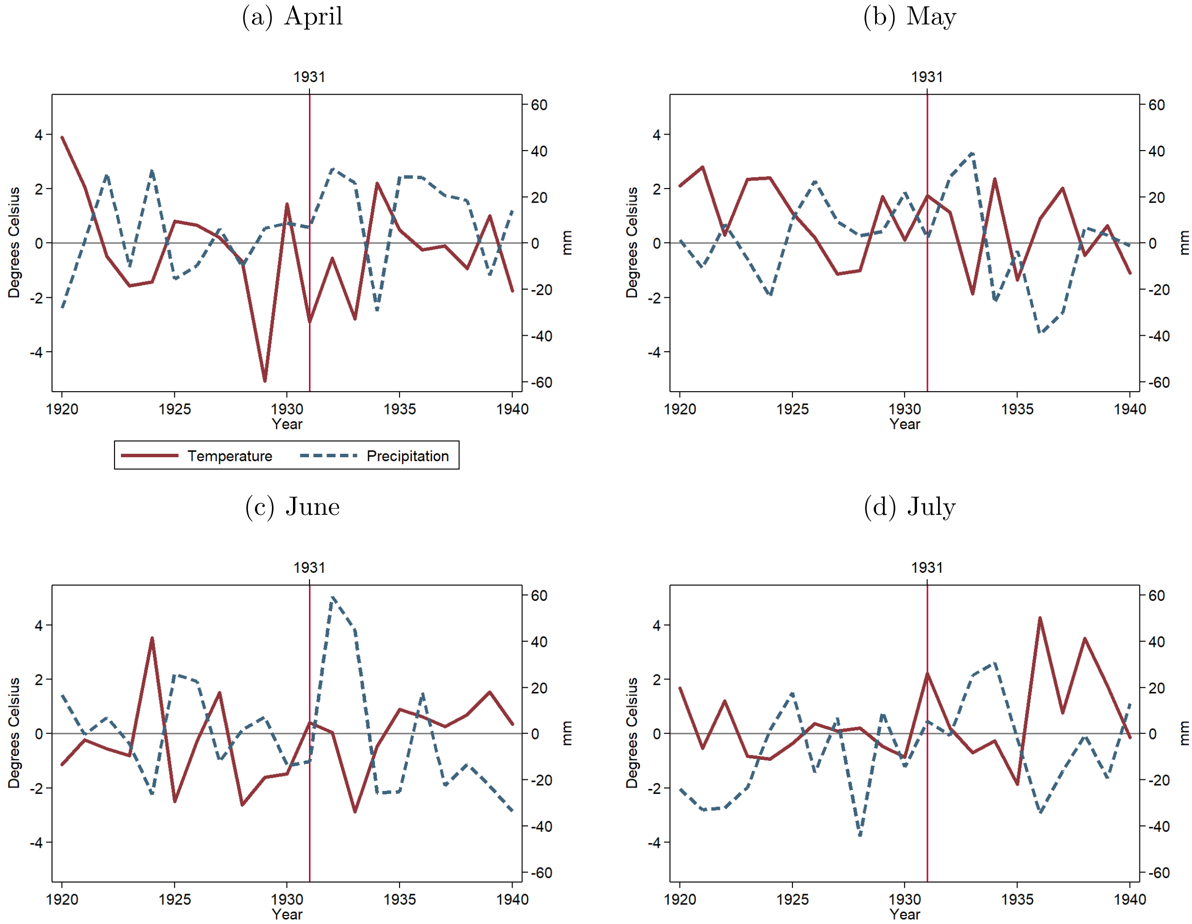
Source: Tsentral'noye Statisticheskoye Upravleniye SSSR. Otdel perepisi (1929).

Figure 4: Collectivization 1930



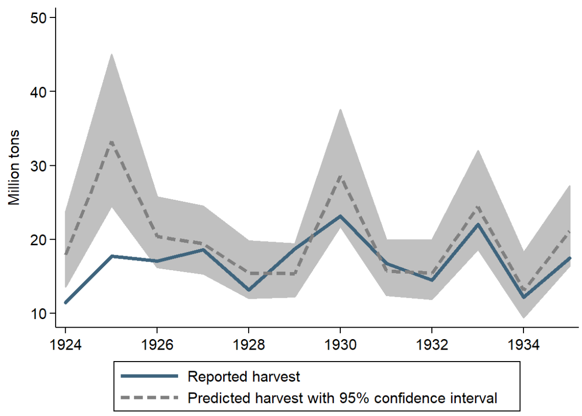
Collectivization rate is share of rural households in collective farms. *Source:* Gosplan SSSR. Upravleniye narodnokhozyaystvennogo ucheta (1931).

Figure 5: Demeaned temperature and precipitation in Ukraine (Section 4.1).



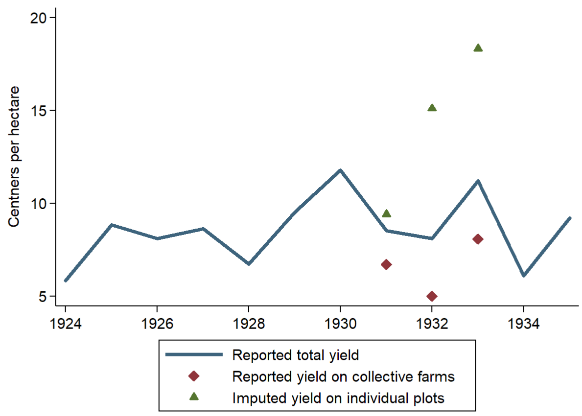
Source: Terrestrial Air Temperature and Precipitation: 1900–2014 Gridded Monthly Time Series, Version 4.01, Matsuura and Willmott (2014). Demeaned temperature (precipitation) is the difference between the reported temperature (precipitation) and the average temperature (precipitation) during 1900-1970.

Figure 6: Reported and predicted harvest in Ukraine (Section 4.1, Table A1).



Sources: Reported harvest: see notes to Table 2. Predicted harvest: calculated by the author. See section 4.1 for details.

Figure 7: Yield

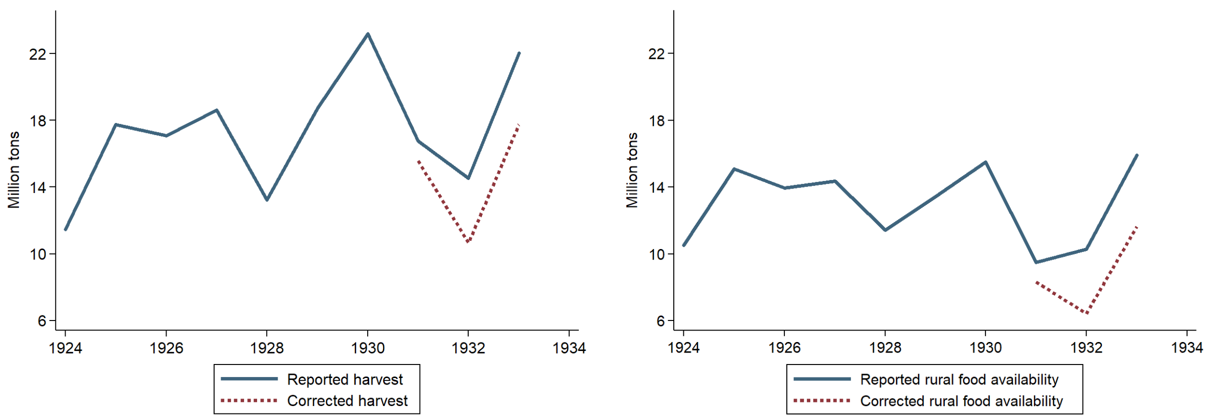


Sources: see notes to Table 2. See section 4.1 for details.

Figure 8: Harvest and rural food availability (Section 4.1).

(a) Harvest

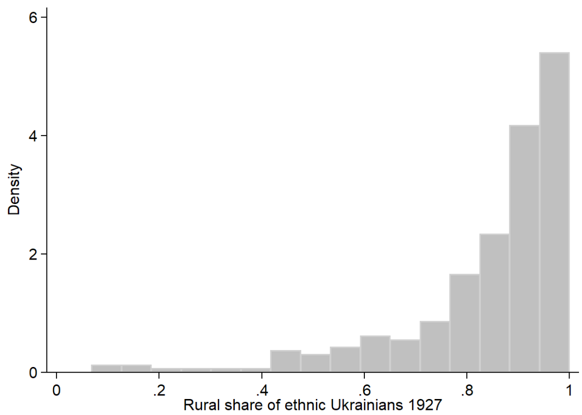
(b) Rural food availability



Sources: see notes to Table 2. See section 4.1 for details.

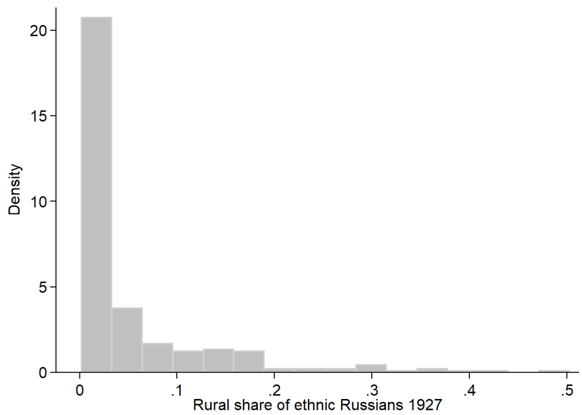
Figure 9: Histograms of rural shares of ethnic Ukrainians, Russians, Germans, and Jews (Section 4.3).

(a) Ukrainians



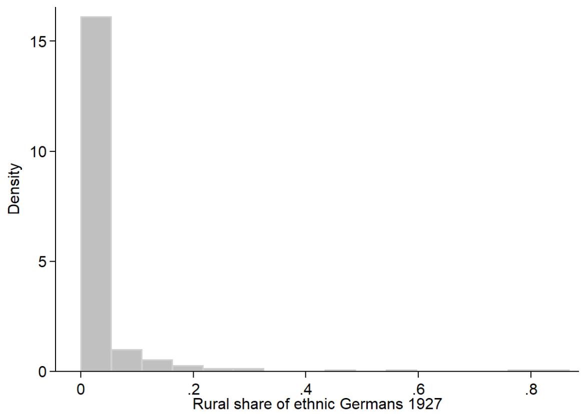
mean = .844, sd = .172

(b) Russians



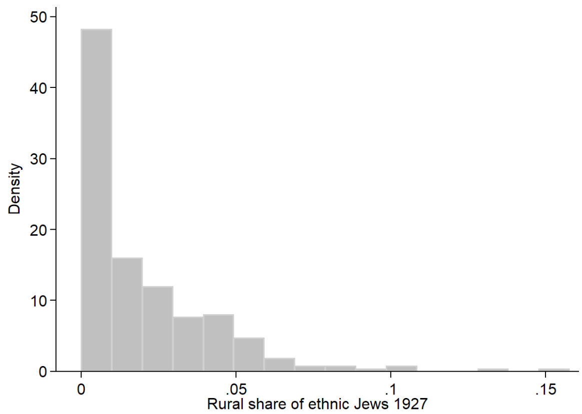
mean = .051, sd = .081

(c) Germans



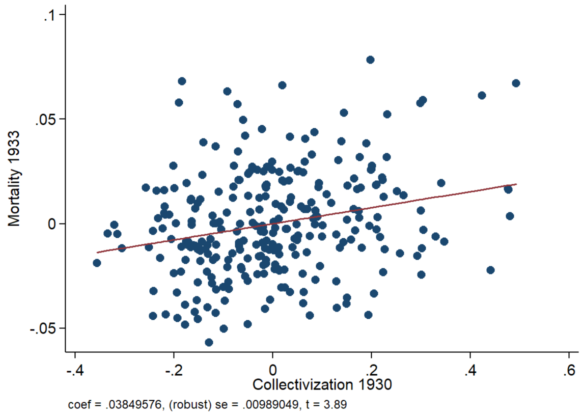
mean = .032, sd = .093

(d) Jews



mean = .019, sd = .023

Figure 10: Collectivization and mortality. District level estimates (Section 4.2, Table 4 Panel A Column (1)).



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.

Figure 11: Collectivization and mortality. District level estimates (specification (1)) dropping provinces one by one (Section 4.2).

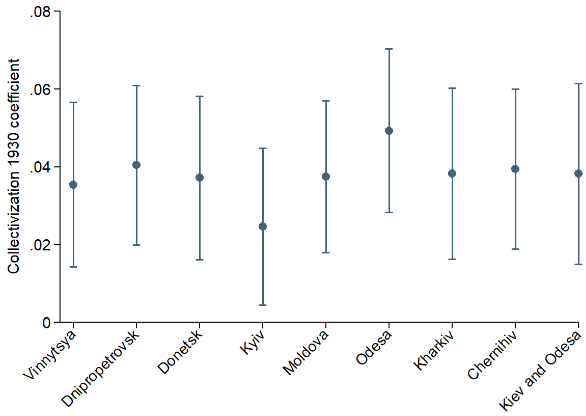
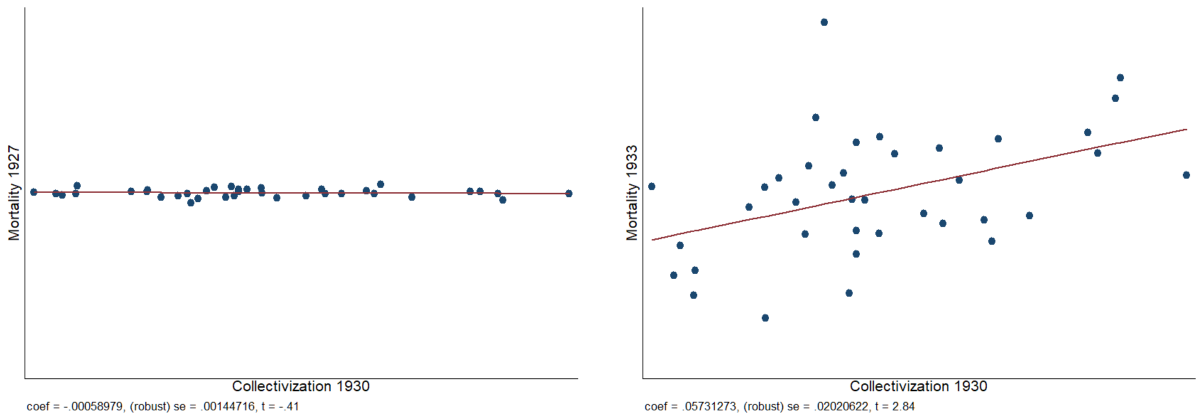


Figure displays impact of collectivization 1930 on mortality 1933 with 95% confidence intervals estimated using specification (1) on a sample without one of the provinces. See section 4.2 for details.

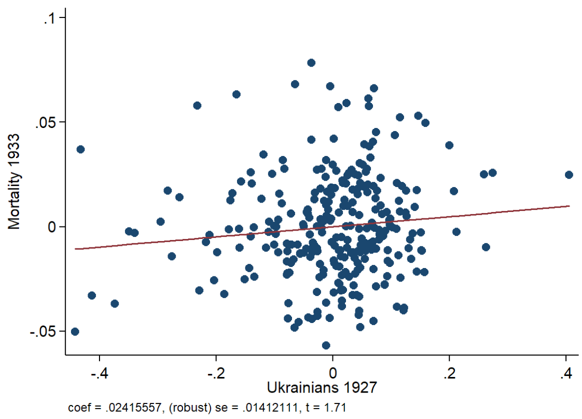
Figure 12: Collectivization in 1930 and mortality in 1927 and in 1933. Okrug level data (Section 4.2).

(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.

Figure 13: Ethnic Ukrainians and 1933 mortality (Section 4.3, Table 11 Panel A Column (1))



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.

Figure 14: Estimates of the impact of rural share of ethnic Ukrainians in 1927 on mortality in 1933 dropping provinces one by one (Section 4.3.

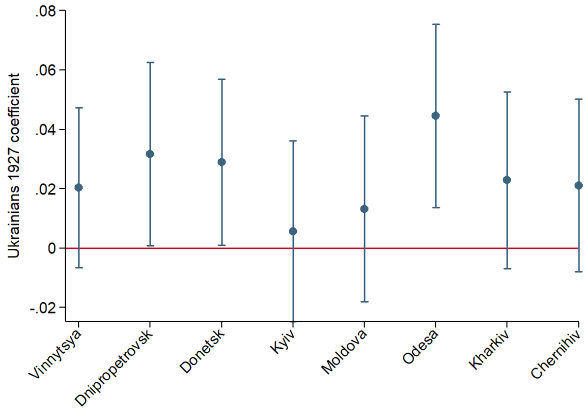
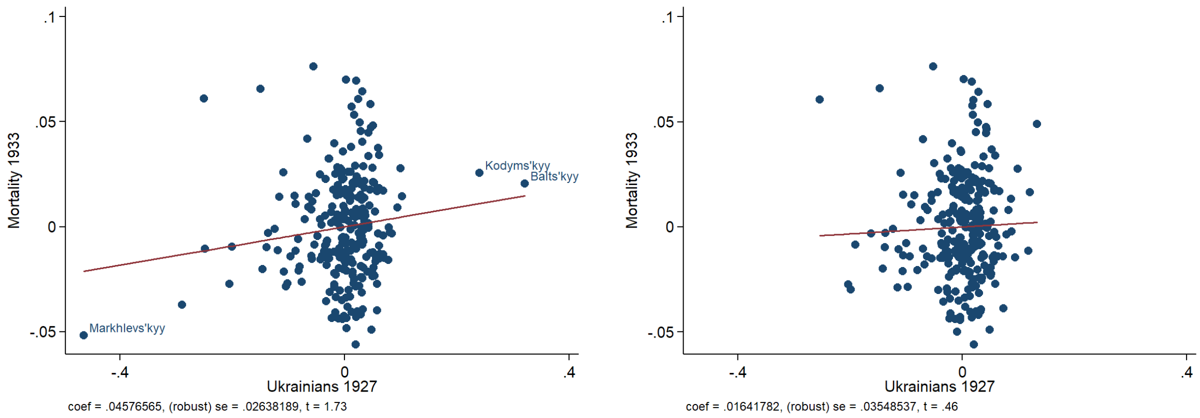


Figure displays impact of rural share of ethnic Ukrainians on mortality 1933 with 95% confidence intervals estimated using specification (3) on a sample without one of the provinces. District controls are all baseline controls: wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator.

Figure 15: Ethnic Ukrainians and 1933 mortality (Section 4.3, Table 11, Column (4)).

(a) Full sample

(b) Without three observations

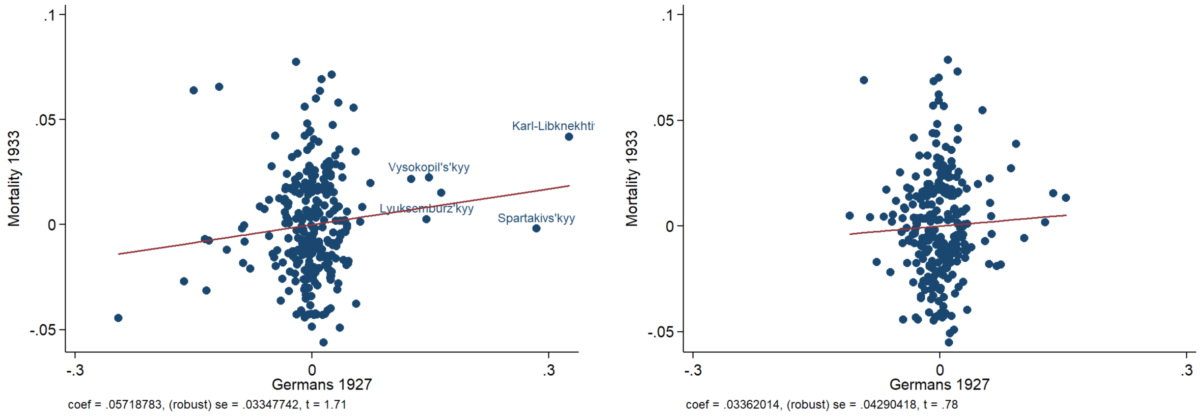


Conditional scatter plot and fitted values between rural share of ethnic Ukrainians in 1927 and mortality rate in 1933. Conditional on baseline controls: wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator (See also Table 11, Column (4)).

Figure 16: Ethnic Germans and 1933 mortality (Section 4.3, Table 11, Column (4)).

(a) Full sample

(b) Without four observations

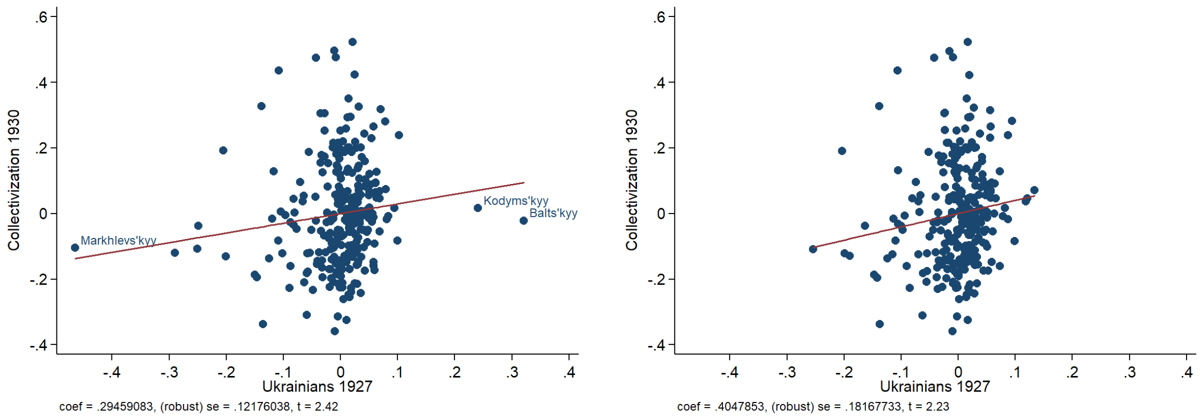


Conditional scatter plot and fitted values between rural share of ethnic Germans in 1927 and mortality rate in 1933. Conditional on baseline controls: wheat and rye production per capita 1925, sown area of potatoes per capita 1925, livestock per capita 1925, value agricultural equipment per capita 1925, rural literacy rate 1927, urbanization 1927, rural population density 1927, Polissia region indicator (See also Table 11, Column (4)).

Figure 17: Ukrainians and 1930 collectivization rate (Section 4.3.1, Table 12, Column (2)).

(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 12, Column (2)).

Tables

Table 1: Summary statistics of the main variables used (Section 3).

	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 3 provides details on data construction and Table E1 lists the exact source of every variable used.

Table 2: Aggregate harvest, yield, and procurement in Ukraine (Section 4.1).

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).

Table 3: 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 (Section 4.2).

	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%. Section 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 1 shows summary statistics of the main variables.

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.

Table 4: Policies and mortality (Section 4.2).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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 5: 1932 aggregated yield, harvest, and procurement (Section 4.2.1).

	Collectivization, %	Yield, c/ha			Harvest, mln t			Procurement share, %		Procurement mln t	
	Jan 1, 1932	total	coll	ind	total	coll	ind	coll	ind	coll	ind
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(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 4.2.1 for details.

Table 6: Drop in livestock. District level estimates (Section 4.2.1).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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 7: Socialized land. District level estimates (Section 4.2.1).

	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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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.

Table 8: Mortality and the average size of collective farms. District level estimates (Section 4.2.1).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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 9: Sown area. District level estimates (Section 4.2.1).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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 10: Total impact of government policies on death toll (Section 4.2).

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 4.2 provides details on the estimates construction

Table 11: Ethnic composition and mortality (Section 4.3).

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	✓	✓	✓	✓
Policy controls		✓		✓
Province FE	✓	✓	✓	✓
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	✓	✓	✓	✓
Policy controls × Famine		✓		✓
Year FE	✓	✓	✓	✓
Region FE	✓	✓	✓	✓
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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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.

Table 12: Exposure to the government policies. District level estimates (Section 4.3.1).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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 13: Enforcement of the government policies. District level estimates (Section 4.3.2).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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.

Appendices

Contents

A Weather and famine accounting

Table A1: Reported and predicted harvest in Ukraine (Section 4.1, Figure 6).

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 2. Column (2) presents predicted harvest calculated by the author. 95% confidence interval is reported in brackets. See section 4.1 for details.

B Robustness checks for Section 4.2

Table B1: Collectivization and natality. District level estimates (Section 4.2).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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 B2: Collectivization and mortality. District level estimates. Alternative collectivization data (Section 4.2).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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 B3: Collectivization and mortality. District level estimates.
Alternative mortality data from HURI (Section 4.2).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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 B4: Collectivization and mortality. District level estimates.
Controlling for the weather in 1931 and 1932 (Section 4.2).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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.

Table B5: Collectivization and mortality. Region level estimates. Controlling for the weather in 1931 and 1932 (Section 4.2).

Dependent variable: Mortality 1933						
Weather controls:	Absolute values		Demeaned			
	1931	1932	1931	1932	1931	1932
	(1)	(2)	(3)	(4)	(5)	(6)
Collectivization 1930	0.050**	0.068***	0.038*	0.059**	0.069**	0.071**
	(0.024)	(0.022)	(0.021)	(0.023)	(0.026)	(0.026)
Group A workers pc 1930	0.008	0.094	-0.062	0.009	0.045	0.029
	(0.231)	(0.167)	(0.220)	(0.202)	(0.134)	(0.130)
Ln(distance to a railroad)	-0.003	0.001	-0.001	-0.000	-0.001	-0.001
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Spring temperature	0.007	-0.006	0.005	-0.007		
	(0.022)	(0.021)	(0.020)	(0.026)		
Spring precipitation	0.001*	0.000	0.000	0.000		
	(0.000)	(0.000)	(0.000)	(0.000)		
June temperature	-0.017	0.016*	-0.048***	0.022		
	(0.017)	(0.008)	(0.011)	(0.014)		
June precipitation	-0.000	0.000	0.001*	0.000		
	(0.000)	(0.000)	(0.000)	(0.000)		
Grain pc predicted					-0.104*	-0.105
					(0.058)	(0.061)
Baseline controls	✓	✓	✓	✓	✓	✓
Observations	36	36	36	36	36	36
R^2	0.750	0.780	0.869	0.779	0.670	0.661

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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.

Table B6: Collectivization and mortality. Region level estimates.
Controlling for the weather in 1931 and 1932 (Section 4.2).

Dependent variable: Mortality						
Weather controls:	Absolute values		Demeaned			
	$t-2$	$t-1$	1931	1932	1931	1932
	(1)	(2)	(3)	(4)	(5)	(6)
Collectivization × Famine	0.059***	0.058***	0.059***	0.058***	0.063***	0.063***
	(0.019)	(0.018)	(0.019)	(0.018)	(0.022)	(0.022)
Group A workers pc × Famine	0.091	-0.060	0.091	-0.060	0.040	0.034
	(0.147)	(0.138)	(0.147)	(0.138)	(0.108)	(0.106)
Ln(distance to a railroad) × Famine	-0.002	-0.001	-0.002	-0.001	-0.003	-0.002
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)
Spring temperature	-0.004	0.003	-0.004	0.003		
	(0.003)	(0.003)	(0.003)	(0.003)		
Spring precipitation	0.000	0.000**	0.000	0.000**		
	(0.000)	(0.000)	(0.000)	(0.000)		
June temperature	-0.020***	0.017***	-0.020***	0.017***		
	(0.007)	(0.005)	(0.007)	(0.005)		
June precipitation	0.000	0.000	0.000	0.000		
	(0.000)	(0.000)	(0.000)	(0.000)		
Grain pc predicted					-0.009	-0.005
					(0.018)	(0.009)
Year FE	✓	✓	✓	✓	✓	✓
Region FE	✓	✓	✓	✓	✓	✓
Baseline controls × Famine	✓	✓	✓	✓	✓	✓
Observations	108	108	108	108	108	108
R^2	0.922	0.934	0.922	0.934	0.891	0.891

*** – significance at less than 1%; ** – significance at 5%; * – significance at 10%. Robust standard errors are reported in brackets. Section 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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.

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[36]. As already mentioned in Section **??**, 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[37]. 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*[38], – 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 collectivization rate. Using the normalization is important. Areas where spring *usually* starts earlier are better suited for agriculture. According to the discussion in Sectio **??**, it is likely that the government tried to collectivize faster ares 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

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

[37] "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)

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

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 below (Section **??**) 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 B7 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 **??** 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.

Table B7: Effect of collectivization on 1933 mortality.
Instrumental variable estimates (Appendix, Section B).

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 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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.

C Robustness checks for Section 4.3

Table C1: Ethnic composition and mortality in 1933.
Controlling for the weather in 1931 and 1932 (Section 4.3).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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.

Table C2: Ethnic Ukrainians and mortality in 1933.
Controlling for access to healthcare facilities (Section 4.3).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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 C3: Ethnicities and natality in 1933 (Section 4.3).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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 C4: Ethnicities and mortality in 1933. Alternative mortality data (Section 4.3).

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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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.

D Robustness checks for Section 4.3.1

Table D1: Placebo test: ethnic Ukrainians and collectivization in 1927 and 1930 (Section 4.3.1). Okrug 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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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 D2: 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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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 D3: 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 3 provides details on data construction and Table E1 lists the exact source of every variable used. Table 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.

E Data sources

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)
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.

Continued on next page

Table E1 – *Continued from previous page*

Variable	Source
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.