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Economic Consequences of the 1933 Soviet Famine

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Abstract

Using recently discovered archival data, this article studies the changes in the Soviet population and the urbanization patterns after the 1933 famine. It documents that, although most of the direct victims lived in the rural areas, the famine is associated with a persistent negative change in the urban population. In fact, the rural population gradually recovered while urban settlements in more affected areas became permanently smaller. The paper shows that these changes were not planned in the First Five-Year Plan (1928--1933), but that subsequent plans may have incorporated and exacerbated the differences in urbanization that occurred during the years of rural crisis. The paper argues that the shortage of labor during the crucial years of the rapid industrialization hindered the development of cities in areas stricken by the famine. Thus, the timing of the shock to population appears to be important. While established urban networks tend to recover from large temporary negative shocks, the lack of people during construction and rapid growth might have a permanent negative impact.

JEL Codes: N34, O18, P25, R12, R13

Keywords: Russia, Famine consequences, Multiple equilibria

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1 Introduction

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

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

Using archival and published data, this paper studies the changes to the rural and urban population after the 1933 Soviet famine. It documents that, although most of the famine victims lived in rural areas, the famine is associated with a persistent drop of the urban population. In fact, after the famine, the rural population gradually recovered while the urban settlements in more affected areas became permanently smaller. The paper argues that the shortage of labor during the crucial years of rapid industrialization hindered the development of cities in the areas stricken by the famine. Thus, the *timing* of the shock to population appears to be an important factor. While established urban networks recover from large temporary negative shocks, the lack of people during construction and rapid growth might lead to a permanent negative change.

These findings are consistent with the classic model presented in Krugman (1991). Since the primary factor of the rural sector of the economy, land, is immobile, the rural population should be distributed in accordance with the land characteristics and, to equalize the marginal product of the rural labor, short-term shocks to rural population should have no persistent impact. Agglomerations, on the other hand, can form in different places because the urban capital is relatively more mobile and because of the increasing returns to agglomeration — that is, multiple urban equilibria are possible.

My study proceeds as follows. First, I employ a panel of 80 provinces spanning the presentday Belarus, Russia, and Ukraine and covering the years from 1897 to 2010. I use cross-sectional variation in the severity of the 1933 famine to study the post-famine changes to rural and urban population. I document that, in the provinces that experienced higher 1933 excess mortality, after 1933 the rural population declined but gradually recovered; by 1989 no significant differences could be found. By contrast, in the provinces that experienced higher 1933 excess mortality, after 1933 the urban population became permanently smaller. Naumenko (2021) shows that the 1933 famine was created by the government policies that targeted the grain-producing areas, and Markevich, Naumenko and Qian (2024) show that these policies were implemented with a bias against ethnic Ukrainians, creating a Ukrainian bias in famine mortality. This paper demonstrates that the post-famine changes to the urban population are not explained by the differences in grain suitability or ethnic composition. Moreover, the association between the 1933 famine exposure and post-famine drop in the urban population is robust to controlling for other population shocks: the Great Terror, the Gulag, the ethnic deportations, or geographic characteristics of provinces, such as existing railroad infrastructure or natural resources endowments.

Next, I demonstrate that, consistent with the post-famine changes in the rural and urban population, there are no persistent post-famine changes in the rural economy but there is a persistent change in the urban economy. That is, I show that in the long-run, grain production and sown area in the famine-stricken provinces are not different from the non-famine provinces, but electricity production in the famine-stricken provinces is permanently lower.

To see if the patterns observed between provinces are also present within provinces, I construct a panel of all urban-type settlements (towns) in the present-day Belarus, Russia, and Ukraine. This panel has roughly 3,200 towns and covers the years from 1897 to 2002. I calculate the 1933 excess mortality, grain suitability, and the 1926 rural share of ethnic Ukrainians in the 50 kilometer radius of each town. On the sample of towns that already existed in 1926 (before the famine), I show that towns located in the famine-stricken areas had smaller population after the famine; this change is permanent and is not explained by grain suitability or ethnic composition. Moreover, I demonstrate that the effect is driven by towns that were relatively smaller before the famine, consistent with the importance of agglomeration effects. On the sample of towns that were created after 1926, I show that in the famine-stricken areas towns were created later. Thus, the patterns observed in the population of towns are consistent with the changes in the urban population of provinces.

Two non-mutually exclusive forces may explain the recovery of the rural population: (1) postfamine differences in the natural rate of population increase (higher natality and lower mortality), and (2) post-famine differences in migration. To investigate (1), I complement and expand the natality and mortality data from Markevich, Naumenko and Qian (2024) and construct a panel of 25 regions that covers the years from 1899 to 1990. I show that, in the famine-stricken regions, immediately after the famine the natural rate of population increase was indeed higher, but this change did not last after 1939 and alone was not sufficient to explain the recovery of the rural population. There are no data on migration, but I conclude that differences in migration patterns must explain the rural recovery. Another indirect piece of evidence is that smaller towns rely more on local migration to grow, and, consistent with the smaller outmigration from the famine-stricken areas, the population of smaller towns declined most post-famine.

Finally, using the data from the First Five-Year Plan (1928–1933) I show that, before the famine, the government did not plan for the future famine-stricken areas to grow slower: the planned population, investment, industrial output, power plants capacity, or railroad construction did not differ for the future famine and non-famine areas. However, I show that Soviet plans were built from the achieved level — whatever outcomes were achieved by the end of one plan were incorporated into the next. I argue that it is possible that the rural crisis of 1931–1933 prevented much urban construction in the famine areas, and the differences in the achieved urban development could have been incorporated into the next plans and thus could have persisted.

Related Literature. This paper contributes to the literature studying the impact of short-term population shocks on long-term economic outcomes. Historians, urban scholars, and economists have long observed the remarkable resilience of cities to temporary adverse shocks to population and capital. Grübler (1998) points out that since antiquity very few urban settlements have actually vanished (Grübler, 1998, p. 188). Vale and Campanella (2005) present a collection of essays describing large-scale disasters and subsequent recovery of cities. Davis and Weinstein (2002) document that the cities of Hiroshima and Nagasaki recovered their population to the pre-war trend levels after the devastating WW2 bombing in just twenty years. In the follow-up work, Davis and Weinstein (2008) construct a detailed dataset of Japanese cities bombed during WW2 and again demonstrate that there were no long-term changes in population, share of aggregate manufacturing, or even industrial composition.

Brakman et al. (2004) study bombing of German cities during WW2 and find no significant long-term impact on West-German cities, although the authors cannot reject the hypothesis that growth of East-German cities follows a random walk. In a subsequent work, Bosker et al. (2007) argue that there is some evidence for multiple equilibria when geographic fundamentals are explicitly taken into account. Studying German cities, the authors find that distance to the Eastern border was an important factor affecting long-term development of West-German cities and the speed of post-WW2 recovery. Nevertheless, it might be argued that the evidence presented does not indicate the existence of multiple equilibria, but that the unique equilibrium changed due to changes in economic potential of the cities located close to the Eastern Border. Studying the division and reunification of Germany, Redding and Sturm (2008) use a standard new economic geography model and argue that the relative decline of West-German cities located near the Eastern border can be explained by the change in market access due to the partition of Germany. Miguel and Roland (2011) study U.S. bombing of Vietnam and find no long-term negative effects on local poverty rates, consumption levels, infrastructure, literacy or population density through 2002. Turning to temporary *positive* population shocks, Braun et al. (2017) investigate the inflow of refugees from East Germany to West Germany after WW2 and find a persistent effect on the spatial distribution of population within but not between interconnected local labor markets. The authors conclude that the persistence likely depends on the level of observation. In contrast, Feigenbaum et al. (2022) investigating the impact of Sherman's military march through Southern U.S. states during the American Civil War, document persistent (until 1920 when the observations stop) negative impact on the economy and argue that underdevelopment of local credit markets hindered the recovery process. In the pre-industrial context, Jedwab et al. (2024) document that after the Black Death pandemic, that wiped out 40% of the European population, cities recovered their pre-plague populations within two hundred years, although the recovery was not uniform and depended on location characteristics: land suitability and historical trade networks. Finally, in the Soviet context, Acemoglu et al. (2011) argue that the Holocaust had a persistent detrimental impact on urban population in Russia because at the time of the Holocaust Jews constituted the majority of the Soviet middle class, and therefore the Holocaust was a shock to social structure and human capital. Mikhailova (2018) documents persistent but economically small impact of evacuation of Soviet industry during WW2 on subsequent city growth. While most of these papers find no to small persistent effects, this paper finds large persistent changes to the urban population after a negative shock.

On the other hand, there is a small but growing body of evidence that factors that are irrelevant or even detrimental in the present day might affect economic development because these factors were beneficial in the past. For example, Nunn and Puga (2012) show that more rugged territories in Africa have higher incomes per capita, and they argue that the effect is because in the past rugged terrain created protection against slave trade. As noted, Bleakley and Lin (2012) demonstrate the importance of portage sites for the development of the cities in the U.S. Finally, Michaels and Rauch (2018) study the location of ancient Roman cities on the territory of contemporary England and France, and demonstrate that once an urban network is formed, only a complete collapse can change it. The authors document that Roman cities were likely to be located close to Roman roads. In England, where cities stopped functioning after the collapse of the Roman Empire, the new medieval towns were located closer to rivers taking advantage of more important river waterways, while in France medieval towns were more likely to be located in old Roman cities, suboptimally far from the rivers. Finally, Hanlon (2017) documents that British cities that relied on American cotton grew slower during the American Civil War and this temporary shock led to a persistent change in the level of city population. I contribute to this literature by showing that in addition to location characteristics or industrial composition, a short-term population shock during the time of rapid construction and growth can have a persistent impact.

This paper also contributes to the literature studying consequences of famines. Ó Gráda (2009) and Alfani and Ó Gráda (2017) present a concise history of famines. Many works have documented the negative consequences for survivors' and their children's health: predisposition to type-II diabetes of those en-utero exposed to starvation (Vaiserman et al., 2011; Ravelli et al., 1998; Barr et al., 2007), increased incidence of antisocial personality disorder and schizophrenia (Neugebauer et al., 1999; Clair et al., 2005; Susser and Lin, 1992), cardiovascular and other issues (Roseboom et al., 2001, 2006). Kuśnierz (2013) documents the deterioration of Ukrainian cities after the 1933 famine, especially of the smaller ones. Mesle et al. (2013) makes projections of what the long-term population of Ukraine would have been without the famine and other demographic shocks, but doesn't study the rural-urban split. Graziosi (2001) argues that after the 1933 famine the Soviet region underwent a qualitative transformation: from promises of future prosperity to the grim reality; and argues for more research on the long-term famine consequences. In an important contribution, Rozenas and Zhukov (2019) study the 1933 famine in Ukraine and argue that the post-famine political preferences of the population changed: to more loyalty when the oppressive regime was strong, and to more disloyalty when it was weak. I complement this literature by documenting macroeconomic changes in the size and location of the Soviet cities and hence economic development.

Finally, this paper also belongs to the literature on the economic history of the Soviet Union and Soviet industrialization. Zhuravskaya et al. (2024) provide an overview of this large and growing literature. Cheremukhin et al. (2017) studies Stalin's industrialization through the lens of a neoclassical macroeconomic growth model and documents its inefficiencies. My paper contributes a new observation to this literature — that the famine did not only take lives but it is also associated with reshaping of the size and location of the Soviet cities.

The rest of the paper is organized as follows. Section 2 gives a short description of Soviet industrialization and the 1933 famine. Section 3 describes the data I used and presents the main empirical findings. Section 4 discusses the possible mechanisms behind persistence. Section 5 concludes. Additional robustness checks, tables, figures, and data sources are presented in the Appendix.

2 Background

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

Russia entered WW1 in 1914, which led to a revolution in 1917. After a period of civil war, the Communist Party seized control over the country. In the newly created Soviet Union, the Communist government introduced drastic reforms, trying to abolish money, trade, and private property in agriculture and industry (in practice, it continued printing money leading to hyperinflation, and the black market persisted). By 1921, the Soviet GDP per capita was just 37% of the 1913 level. The economic crisis was so deep that Lenin had to reverse the course; in the spring of 1921 he declared the

New Economic Policy (NEP): agriculture and small-scale industry were allowed to operate on market principles again. NEP led to a rapid economic growth: by 1928, the Soviet GDP per capita was just 3% below the 1913 level (Markevich and Harrison, 2011).

By the late 1920's Stalin consolidated power within the Communist Party and in the late 1928 began the industrialization of the country launching the First Five-Year Plan for the economic development. Radical reforms were introduced. All industry and trade were nationalized, the government introduced price controls and rationing of consumer goods. A massive investment in industry and large-scale construction began. As a result, migration from the rural to urban settlements began to rise quickly, and the industrial production started increasing (Davies et al., 1994).

In agriculture, in 1929 Stalin introduced collectivization — forced transfer of private peasant property to collective farms managed by the government appointees according to the government plans. Collective farms and the remaining private peasants were allocated grain procurement quotas at the below-market prices, and private trade of food was banned. The government then used procured grain to feed rapidly growing cities and for export to pay for the imported machines. The combination of drop in production due to inefficient collective farms and the inflexible procurement policy by 1933 created the worst famine in Russian history, killing six to eight million people, most in the countryside.^{1,2} The famine was never acknowledged by the Soviet government, and industrialization of the economy continued even more rapidly after 1933 (Davies et al., 2014).

In the spring of 1932, when the crisis in agriculture was already apparent, the government reversed some of the strict policies: for working in collective farms, peasants were allowed to keep private plots and some livestock, and, after paying taxes, to sell their produce on the markets with free prices in the cities (*kolkhoz markets*). The government tried to remove the unpredictability and arbitrariness of procurement quotas; the collective farms' grain procurement quotas were linked to the planned sown area. This was too late to prevent the 1933 famine, but agriculture recovered rapidly after the famine. In 1935, food rationing was abolished. Collectivization continued and by the late 1930s more than 99% of peasants belonged to collective farms.

To stop the flow of refugees into the cities, in 1932 the internal passport system was introduced. Those employed in the cities were generally eligible for passports, but peasants were not. Kessler (2001) documents the introduction and development of the internal passport system and argues that it was used primarily to expel the undesirable population from large well-supplied cities like Moscow and Leningrad. The police periodically raided the urban barracks and those without passports were sent out of the cities. However, there was no one central catalog of those denied a passport, and people could move to another city and try getting a passport there. Similarly, Buckley (1995) argues that

¹Naumenko (2021) shows that higher collectivization rates in Ukraine are associated with higher famine mortality. Meng et al. (2015) studies the Great Chinese Famine and demonstrates the importance of inflexible procurement policy in contributing to the famine severity. Markevich et al. (2024) show that overall in the Soviet Union there was enough grain to avoid the disaster, had it been distributed more equally. Thus, government procurement and distribution policy exacerbated food shortages created by collectivization.

²Conquest 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). Andreev et al. (1990) measure excess mortality due to the famine to be 8.5 million. Davies and Wheatcroft argue that Andreev 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 the Russian parliament issued a special decree stating that 7 million people perished in the Soviet Union during this famine, Duma (2008). In Ukraine a team of researchers from the Institute for Demography and Social Studies headed by Ella Libanova estimates direct losses for Ukraine alone to be 3.4 million, Libanova (2008). In a more recent work, Mesle et al. (2013) argue that Ukraine was "missing" 4.6 million people by the 1939 census, including 2.6 million due to excess mortality. A team of researchers associated with the Harvard Ukrainian Research Institute estimate direct population losses in Ukraine to be 4.5 million, including 3.9 million excess deaths and 0.6 million lost births (Rudnytskyi et al., 2015).

the Soviet passport system had only marginal impact on the population mobility. Still, the internal passport system may have prevented even more peasants from moving to the cities.

From 1926 to 1939, the urbanization rate increased from 18% to 33%, and the urban population more than doubled: from 26 million to 55 million. Urbanization continued to rise after 1939, but in the history of the Soviet Union such high growth rates of urban population were never observed again.

3 Data and Results

This section presents the main findings of the paper: that the 1933 famine is associated with a shortterm drop in the rural population and a persistent drop in the urban population. It also documents that, consistent with the rural population, there were no persistent negative effects on the rural economy, but, consistent with the urban population, production of electricity became persistently lower in the famine areas. Next, the section studies the population of cities, towns, and other urbantype settlements (towns for brevity) and documents that, among the towns that existed before the famine, towns in the areas with higher 1933 excess mortality had persistently smaller population after the famine. Moreover, among the towns that were created after the famine, fewer were created by 1939 in the areas where the 1933 excess mortality was higher. Finally, the section considers possible mechanisms explaining these patterns: it refutes possible differential rates of the natural increase as the main driver of the recovery of the rural population, and describes the peculiarities of the Soviet planning system that could potentially have preserved the initial post-famine differences. Each section below describes the data used and explains the data construction process; the Data Appendix lists the exact source of every variable.

Rural and Urban Population

To study the changes in population and economic development after the 1933 famine, I construct a panel of 80 provinces. The sample covers the pre-1939 territory of the Soviet Union, for which famine mortality is available: from Belarus and Ukraine in the West to Siberia in the East. I use the 1989 administrative division; four provinces were expanded in 1939: Leningrad, Minsk, Odessa, and Vitebsk; for these, I use their pre-1939 borders. Figure 1a shows the provinces on the map.

The main outcome of interest is the province population. I use all available Russian/Soviet/Post-Soviet censuses: 1897, 1926, 1937, 1939, 1959, 1970, 1979, 1989, 2002, and 2010. In addition, I use 1913 data from the published statistical yearbooks, and the post-WW2 1950 province-level population hand-collected from the Russian State Archive of the Economy in Moscow. Since the administrative borders in the Russian Empire/Soviet Union were constantly changing from 1913 to 1959, selecting the right administrative borders and calculating data using these borders creates a considerable obstacle. I use the district (*uezd*) administrative map from Kessler and Markevich (2015) to calculate 1897 and 1913 population in 1989 administrative borders; I use disaggregated 1926 census data from Markevich, Naumenko and Qian (2024) to calculate 1926 population in 1989 administrative borders. To my knowledge, I am the first to use the 1937 census in economic analysis.³

The 1939 census has long been deemed unreliable due to the centralized additions (pripiski): it

 $^{^{3}}$ The preliminary counts of 1937 census showed population that was smaller than Stalin expected. The counting was stopped, the census discarded, and those responsible for it executed. Thus, only preliminary counts are available (Zhiromskaia et al., 1996).

was believed that in some territories population figures were inflated by the authorities. In recent years, Russian demographers have discovered these additions in the archives and published them (Bogoyavlenskiy, 2014). Therefore, I am able to use corrected 1939 population figures.

Presumably to hide the enormous population losses, the first post-WW2 census occurred in 1959, fifteen years after the war. Nevertheless, Soviet officials continued to maintain population estimates after the Second World War for planning and statistical purposes. Although the quality of these population estimates is probably lower than the quality of the census data, due to the Soviet population registration system (*propiska*) the data reflects the actual population fairly accurately. Red Army soldiers were gradually discharged during 1945–1948. Therefore, I use 1950 archival population estimates in my analysis.

After the collapse of the Soviet Union, the independent states of Belarus, Russia, and Ukraine conducted censuses in different years: Russia had censuses in 2002 and 2010, Ukraine had a census in 2001, Belarus had censuses in 1999 and 2009. Since Russia is the largest among these states, I use years of Russian censuses (2002 and 2010) for the province population panel and employ Belorussian and Ukrainian statistical yearbooks to get the corresponding population figures.

The main explanatory variable is the 1933 excess mortality. I use disaggregated district-level 1933 and 1928 mortality in Belarus, Russia, and Ukraine from Markevich, Naumenko and Qian (2024) and calculate excess mortality as the difference between 1933 mortality and 1928 mortality. Figure 1a plots the 1933 excess mortality on the map in 1989 administrative borders.

I use cross-province variation in the 1933 famine severity to estimate how post-famine population evolved. The main specification is as follows:

$$y_{i,r,t} = \beta Famine_i \times I_t^{post} + X'_{i,t}\gamma + \alpha_i + \delta_{r,t} + \epsilon_{i,r,t}$$
(1)

where *i* stands for province, t — year, and r — region. Famine_i is 1933 excess mortality in province i — the difference between 1933 mortality and 1928 mortality.⁴ The outcome of interest $y_{i,r,t}$ is either rural or urban population (*Ln* rural population, *Ln* urban population). I_t^{post} is an indicator denoting time after the 1933 famine, it equals one after 1933 and zero otherwise. $X'_{i,t}$ are province characteristics. α_i and $\delta_{r,t}$ are province and year-region fixed effects, and $\epsilon_{i,r,t}$ is the error term. Province fixed effects α_i account for unobserved heterogeneity between provinces, and year-region fixed effects control for common macroeconomic shocks and the possibility of different economic policies implemented in different regions. The interaction between excess mortality 1933 and post-famine indicator β is the main coefficient of interest. It captures how the population evolved in provinces more affected by the famine compared to those less affected.

First, I estimate a parsimonious descriptive specification with a few controls. To account for the fact that the famine was more severe in more grain-productive areas, $X'_{i,t}$ includes grain suitability interacted with year indicators. Since capital cities (Moscow, Leningrad, Kyiv, and Minsk) likely received preferential treatment — higher investment and better supplies to recover from the famine — I include the capital province indicator interacted with year indicators in province controls. Finally, Soviet statisticians split all provinces into the grain-producing Southern region and the grain-consuming Northern region; to account for the possibility that industrialization policies treated these regions differently, I control separately for grain consuming/producing region-year fixed effects.⁵

 $^{{}^{4}}$ I use 1928 mortality as a baseline because it is available for both provinces and districts within provinces. The results are similar if 1925–1929 mortality is used as a baseline instead; these are available upon request.

 $^{^{5}}$ The results are similar in instead of grain suitability interacted with year indicators I control for 1928 grain production

In all estimates, I follow Colella et al. (2019) and adjust standard errors for spatial correlation within 500 kilometers. Colella et al. (2019) note that too small or too large spatial adjustment will result in artificially small standard errors. The median province length in the sample is 312 kilometers. Appendix Table A1 shows that the 500 kilometer spatial correlation is the most conservative, it creates the largest standard errors.

Table 1 column (1) reports the estimates for rural population. The coefficient is negative but not statistically significant, and its magnitude is small: one standard deviation increase in 1933 excess mortality is associated with a post-famine decrease of rural population by 0.079 of a standard deviation. By contrast, column (4) shows the estimates for urban population: the coefficient is negative, statistically significant, and large in magnitude. One standard deviation increase in 1933 excess mortality is associated with a decrease of post-famine urban population by 0.201 of a standard deviation.

Next, columns (2) and (5) estimate the effect of the famine separately for pre-WW2 and post-WW2 years. That is, the estimates in these columns interact 1933 excess mortality separately with an indicator for 1937 and 1939 (the only two pre-WW2 censuses) and an indicator for the years of 1950 and after. There is a negative and statistically significant change in rural population in 1937 and 1939, but it becomes statistically indistinguishable from zero after 1950. By contrast, urban population in the provinces more affected by the famine is smaller in 1937 and 1939, and remains smaller after 1950 — both coefficients are statistically significant and large in magnitude.

To illustrate the changes in population, Figure 2 reports the average province population normalized by the 1926 value by quartiles of 1933 excess mortality. That is, for each province i and each year t I first calculate normalized population by dividing population in year t by the province's 1926 population, then break provinces into groups according to the severity of the 1933 famine, and then for each group and each year calculate the average normalized population. The first group includes 40 provinces with the 1933 excess mortality below the median, that is, below 8 deaths per 1,000. The second group consists of 20 provinces with the 1933 excess mortality in the 3rd quartile: above the median but below 75th percentile, that is, between 8 and 24 deaths per 1,000. The third group includes 20 provinces with 1933 excess mortality in the 4th quartile: above 75th percentile, that is, above 24 deaths per 1,000. Figure 2a shows rural population, and Figure 2b shows urban population.

Several important takeaways can be made from Figure 2. First, before the famine, the population in provinces in the 3rd and 4th quartiles of the 1933 excess mortality appear to have been changing similarly. From 1926 to 1937 the rural population declined for these provinces, and it declined most for the provinces in the 4th quartile of famine severity — where the mortality was the worst. The differences in rural population however did not last; by 1959 the provinces in the 4th quartile of famine severity had on average higher rural population than the less affected 3rd quartile. This is consistent with no persistent differences in rural population after the famine.

The pattern is different for the urban population. From 1926 to 1937 the urban population grows in all three groups of provinces, but it grows the least for the provinces in the 4th quartile of famine severity, where 1933 excess mortality was the highest. The differences in urban population then persist until 2010 when the data end.

Implicitly, the identifying assumption in the estimates presented in Table 1 is that provinces with similar characteristics would have had similar changes in population and economic development if not for the famine. To formally test that there were no differences in population changes before the famine,

per capita interacted with year fixed effects; these are available upon request.

I replace the interaction of 1933 excess mortality and post-famine dummy with a set of interactions of 1933 excess mortality and year indicators and estimate the following specification:

$$y_{i,r,t} = \sum_{\tau=1897}^{\tau=2010} \beta_{\tau} Famine_i \times I[t=\tau] + X'_{i,t}\gamma + \alpha_i + \delta_{r,t} + \epsilon_{i,r,t}$$
(2)

Figures 3a and 3b plot the coefficients estimated from specification (2) for the rural and urban population, respectively. They show that before the famine there are no significant differences in rural and urban population; in 1937 and 1939, provinces with higher famine mortality have lower rural and urban population, but the differences in rural population gradually disappear and become statistically indistinguishable from zero after 1950. By contrast, Figure 3b shows that the differences in urban population remain large and statistically significant until 2010 when the sample ends.

Naumenko (2021) and Markevich et al. (2024) show that the 1933 famine was created by the government policies — collectivization and grain procurement, and that the implementation of these policies was biased against ethnic Ukrainians, resulting in higher famine mortality in Ukrainian areas. It is possible that the industrialization and urban construction were also implemented with a similar bias. Therefore, columns (3) and (6) control for the 1926 rural Ukrainian population share interacted with the post-famine dummy. In addition, these estimates control for the Nazi occupation dummy interacted with year indicators. Finally, to better account for possible differences of industrialization policies in different regions of the country, columns (3) and (6) control for region-year fixed effects for the regions of the Northern consuming region, Ukraine, North Caucasus, Volga, Urals, and Siberia.⁶ Thus, the estimates compare provinces within the same region and year and that had similar ethnic composition before the famine. This expanded list of controls will be used as the baseline for all subsequent analysis.

Table 1 column (3) shows estimates for the post-famine rural population. They are similar to the ones in column (1): negative but small and not statistically different from zero. By contrast, in column (6) the estimates for the post-famine urban population are stronger than in column (4): statistically significant and larger in magnitude, one standard deviation increase in 1933 excess mortality is associated with a decrease of post-famine urban population by 0.333 of a standard deviation.⁷ Appendix Figure A1 shows the coefficients from specification (2) with the baseline controls; although less precise, they show the gradual recovery of the rural population and the persistent negative change in the urban population similar to Figure 3. Finally, columns (7) and (8) show separate estimates for the republics of Ukraine and Russia (omitted are four provinces of Belarus). Ukraine has only 18 provinces, so the estimates in column (7) are not statistically significant, but for both Ukraine and Russia the coefficients are negative and similar to the baseline in column (6).

Robustness

Table 2 presents robustness checks for the baseline estimates of the relationship between 1933 famine and post-famine urban population. For comparison, column (1) restates the baseline.

 $^{^6\}mathrm{The}$ region of Far East is not in the sample, there is no data on 1933 mortality there.

⁷Famine mortality and Ukrainian population share are highly correlated. Similar to estimates in Figure 3a in the present paper, Figure 3a in Markevich, Naumenko and Qian (2024) shows that rural population in the Ukrainian provinces experienced a temporary negative shock but then gradually recovered. Estimates in Table 1 columns (3) and (6) present a horse-race between the 1933 excess mortality interacted with post-famine indicator and the 1926 rural Ukrainian population share interacted with post-famine indicator. They show that famine mortality and not ethnic composition is driving post-famine differences.

First, I account for other shocks to population: the Great Terror of 1937–1938, the Gulag, and ethnic deportations. According to contemporary estimates, 765 thousand were executed during the Great Terror, 19 million went through the Gulag during its existence, including 3.7 million political prisoners, and indiscriminate ethnic deportations affected another 2 million (Zhuravskaya et al., 2024, Table 1). Importantly, the peak of these shocks occurred after the census in January 1937, so the short-term changes in the population associated with the famine cannot be explained away by these other shocks. However, they might have affected the economic development and the population in the long run.

The Great Terror. To account for the Great Terror, I first use the georeferenced data from Zhukov and Talibova (2018). They collect the individual-level data on those sent to the Gulag (repressed) or executed from the Memorial database. Columns (2) and (3) in Table 2 control for the number of repressed per 1926 population, and the number of executed per 1926 population. The number of repressed is positively correlated with the urban population, probably because the Great Terror disproportionately affected educated urban population. The coefficient of the 1933 excess mortality interacted with post-famine indicator remains statistically significant and is similar to the baseline.

The Gulag. Next, I account for the Gulag population. Mikhailova (2018) argues that the Gulag camps were used as an investment — within 20 to 50 kilometers of every important Soviet construction project there would be a camp with the prisoners providing free labor. Column (4) controls for the number of camps per province area. Indeed, camps are positively correlated with the urban population. Nevertheless, the coefficient of the 1933 excess mortality interacted with post-famine indicator remains negative, statistically significant at the 10% level, and in magnitude close to the baseline.

For some camps, the data on the size of the camp population is available. Column (5) restricts the sample to the provinces for which we know the Gulag population. For this subsample, the coefficient of Excess mortality 1933 interacted with post-famine indicator is larger in magnitude and is significant at the 1% level. Column (6) then controls for the total Gulag population from 1921 to 1960 per 1926 population. The Gulag population started increasing dramatically with the *dekulakization* campaign in 1930. Column (7) controls for the Gulag population from 1930 to 1960 per 1926 population. In both cases, the Gulag population is positively correlated with urban population, consistent with Mikhailova's interpretation of camps as investment. But the coefficient of the 1933 excess mortality interacted with post-famine indicator remains negative, statistically significant at the 1% level, and in magnitude close to the baseline in column (5).

Ethnic Deportations. Finally, the indiscriminate ethnic deportations affected ethnic Germans, Karachays, Kalmyks, Chechens and Ingushs, Kabardinians and Balkars, Crimean Tatars, Meskhetian Turks, and Koreans. Most of these groups resided in the areas where there is no data on 1933 mortality, so they are out of sample for the study of the impact of the famine. The two in-sample deported groups are ethnic Germans who mostly lived in the Saratov province and were deported in August 1941, and Crimean Tatars, who were deported in May 1944. Table 2 column (8) omits the provinces of Crimea and Saratov from the sample. The coefficient of 1933 excess mortality interacted with post-famine indicator remains statistically significant at the 10% level and is similar in magnitude to the baseline in column (1). **Transport and Geography.** The next group of robustness checks account for geographic characteristics that could have affected urban development. First, to account for the railroad network, column (9) controls for the number of 1932 railroad stations from Zhukov and Talibova (2018) per province area interacted with post-famine indicator. In column (10), I used the data on distance from the districts' administrative center to the nearest railroad station in 1930; I calculate province average of this distance and control for this average interacted with post-famine indicator. In both columns (9) and (10) the coefficient of the 1933 excess mortality interacted with post-famine indicator remains statistically significant at the 5% level and is similar in magnitude to the baseline in column (1).

Harrison (1988) and Harrison (1990) note that Stalin moved the Soviet industry to the East, creating a faster growth in the Urals and Siberia. Region-year fixed effects should account for this broad geographical preference. Nevertheless, column (11) controls for latitude and longitude interacted with post-famine indicator. The coefficient of 1933 excess mortality interacted with post-famine indicator remains statistically significant at the 5% level and is similar in magnitude to the baseline in column (1).

Natural Resources. Finally, natural resources was an important factor in Soviet industrialization. It is possible that grain-producing areas were poor with other natural resources and the lack of the natural resources and not the famine hindered urbanization after 1933. I proxy natural resources endowment with the 2006 oil and coal output (no Soviet data are available for oil and coal, and I selected pre-2008 year for which both Ukrainian and Russian data were available) — if the patterns in the data are driven by natural resources, the future coal and oil production should explain away the differences associated with the famine. Columns (12) and (13) control respectively the 2006 coal and oil output per 1926 population interacted with post-famine indicator. Coal is positively correlated with urbanization, consistent with its importance for industrialization, but the coefficient of the 1933 excess mortality 1933 interacted with post-famine indicator remains statistically significant at the 5% level and is similar in magnitude to the baseline in column (1).

Random Permutations. Finally, another way to see that the patterns in the data are unlikely to be driven by coincidence is to perform a random permutation test. I permute the 1933 excess mortality across provinces (this preserves the mean and variance of 1933 excess mortality, I just reshuffle it across provinces) and estimate specification (1) using this randomly permutated famine measure. I repeat the above procedure 10,000 times. Appendix Figure A2a shows a histogram of the resulting coefficients; it demonstrates that the probability of the baseline estimate to be driven by a coincidence is less than 1%.

Rural and Urban Economy

I complement the above analysis by considering the changes after the 1933 famine in the rural and urban economy. I collected province-level data on the state of the agricultural and industrial sectors: grain production, sown area, and production of electricity. For grain production and sown area the sample includes all years from 1900 to 1990 for which the data are available. For electricity production, the sample includes years from 1928 to 1969.⁸ I use the production and not the consumption of

⁸Before 1990, the electricity production was classified; I hand-collected the declassified data in the archives in Moscow. Although these data are supposed to have been declassified after 30 years, the declassification process was slow and I could not find the data on electricity production after 1969.

electricity because consumption is available for fewer years. However, for the years when data on electricity consumption is available, the correlation between production and consumption is above 0.99. According to Henderson et al. (2011), electricity is one of the best proxies for local GDP.

Table 3 reports the estimates. Columns (1) to (4) describe the agricultural sector. Columns (1) and (2) show that there is no statistically significant impact of the famine on grain production, and columns (3) and (4) show no impact of the famine on the sown area. This is consistent with the recovery of the rural population documented in Table 1. This is also consistent with the earlier finding reported in Figure 3c in Markevich, Naumenko and Qian (2024) — grain production appears to have recovered by 1936.

The pattern is different for the urban sector of the economy. Table 3 Columns (5) and (6) show that the 1933 famine is associated with a persistent decline in the production of electricity. The coefficients are negative and statistically significant at the 10% and 5% levels. The magnitude of the coefficients is somewhat smaller than the magnitude of the impact on the urban population: one standard deviation increase in the 1933 excess mortality is associated with a decrease of production of electricity by -0.156 of a standard deviation.

Thus, the results are consistent with the changes in the population: no persistent negative effect in the rural sector, but the urban sector appears to have been permanently affected.

Towns

To test whether the post-famine changes in the urban population are also observed within provinces, I construct a panel of urban settlements. In the Soviet classification, a settlement had an urban status (*poselok gorodskogo tipa, gorod*) if the majority of its inhabitants were employed away from agriculture; thus, even a small mining settlement would count as urban. For brevity, I refer to all urban-type settlements as towns. I used Russian towns from Mikhailova (2018) and added Belorussian and Ukrainian towns myself: I used every census from 1926 to 2002 to construct a panel of towns, and then, whenever possible, added their population from the 1897 census. This resulted in a panel of 3,312 towns that spans years from 1897 to 2002. I stop in 2002 because Ukraine's last census was conducted in December 2001.⁹ The town panel does not include years of 1913, 1950, or 1937, as town-level population data are not available for these years. The number of towns increases over time: from 1,055 in 1926 to roughly 3,200 in 1989 and 2002, and some towns cease to exist during that time. If a town was abandoned or lost urban status, its population is recorded as zero; if a town was initially independent but was later absorbed into an agglomeration, I counted it as part of an agglomeration for the whole period from 1897 to 2002.

I use the district-level 1933 excess mortality from Markevich, Naumenko and Qian (2024) to calculate the 1933 excess mortality within a 50 kilometer radius of each town, and then estimate the specification (1) on a panel of towns. Similar to the baseline controls in the province-level estimates, in the town-level estimates I control for the 1926 rural Ukrainian population share, grain suitability, and Nazi occupation dummy interacted with year indicators; in addition, I control for an indicator that the town was a province capital in 1932 interacted with year indicators.

Table 4 presents the estimates. First, I study how the towns' population changed after the famine among towns that already existed in 1926. Column (1) reports the estimates controlling for town and year fixed effects. The interaction of the 1933 excess mortality and post-famine indicators is

⁹Russia had a census in January 2002, Ukraine — in December 2001, Belarus — in February 1999. I use data from these censuses as 2002 town population.

negative, the coefficient is statistically significant at the 5% level. Its magnitude is sizable although smaller than the magnitude in the province-level estimates, one standard deviation increase in famine mortality decreases towns' population by 0.110 of a standard deviation. To study within-province patterns, Column (2) and all subsequent estimates control for town and province-year fixed effects. The coefficient of the interaction of the 1933 excess mortality and post-famine indicator is similar to the one in column (1). Column (3) splits post-famine time into the immediate (1939) and the longterm (1959 and later) periods. It shows that the famine is associated with immediate and persistent decline in towns' population.

Next, I test the main identifying assumption of the difference-in-differences estimates, that there are no differential trends within provinces in the towns' population before the famine. I estimate the coefficients of interactions of the 1933 excess mortality with year indicators for each year for which data are available, omitting 1926 as a reference year, as in specification (2). I include all the controls and town and province-year fixed effects as reported in Table 4 column (2). Only 1897 and 1926 town population data are available, so the estimates should be taken with caution; nevertheless, Figure 4a shows no pre-trend before the famine and a significant and persistent change after the famine. Thus, the within-province estimates are consistent with the province-level results presented earlier.

Similar to the province-level analysis, I run a random permutations test. I permute the 1933 excess mortality across towns and estimate the baseline specification as in Table 4 column (2) with this permutated excess mortality. I repeat the procedure 10,000 times. Appendix Figure A2b shows a histogram of the resulting coefficients. It demonstrates that the probability of the baseline estimate to be the result of a coincidence is below 1%.

In general, towns grow mostly due to migration. One might expect that smaller towns attracted mostly people from the surrounding rural areas, while larger cities could attract migrants from larger areas. Therefore, if outmigration to the urban areas was smaller in the territories stricken by the famine, it is possible that the impact of the famine might vary with the initial size of the settlement: the local shortage of rural labor should disproportionately affect growth of smaller urban settlements. To test this, I divide the sample into three groups: settlements that in 1926 had fewer than 10 thousand inhabitants, settlements that had between 10 and 25 thousand people, and more than 25 thousand. I then estimate the coefficient on the interaction of the 1933 excess mortality and post-famine indicator using specification (1) separately for each subsample, Table 4 columns (4) to (6) report the estimates. They show that indeed the effect of the famine on the settlements' population is driven by smaller settlements: the coefficients of the 1933 excess mortality interacted with post-famine indicator are negative, statistically significant at the 5% level, and large in magnitude for towns that were below 25 thousand in 1926. Thus, the negative impact of the famine on urban population appears to be driven by relatively smaller towns.

The number of towns grew from 1926 to 1989 (the growth stalled after 1989). For each location that was not yet a town in 1926, but would eventually become a town, Table 4 column (7) estimates specification (1) using the indicator that the location became a town as dependent variable. The interaction of the 1933 excess mortality and post-famine indicator is negative; that is, after the famine, fewer locations became towns in the areas hit by the famine. Column (8) reports two separate interaction coefficients on the 1933 excess mortality with the indicator that year equals to 1939 and the indicator that year is 1959 or later. It shows that famine locations were less likely to become towns in 1939, but the difference disappeared after 1959. Figure 4b shows the interactions of the 1933

excess mortality and year indicators: the effect is strong and negative in 1939 but gradually becomes zero. This is mechanical — the sample only includes locations that eventually did become towns, so the difference has to disappear by 1989. But it shows that among towns that were created after the famine, in the areas with higher 1933 excess mortality they were created later.¹⁰

4 Mechanism

Migration v. Natural Increase

After large famines the birth rates usually increase, correcting for the population losses and delayed births, and the death rates usually decrease, since weaker individuals have higher chances to have already perished during the famine. It is, therefore, possible that the recovery of the rural population in the famine-stricken areas is explained simply by the differential rates of the natural population increase.

To study the rate of natural increase, I expand data from Markevich, Naumenko and Qian (2024). They harmonized mortality and natality rates for 19 large Soviet regions for the years between 1924 and 1940; in particular, in their sample for the data availability reasons Ukraine was treated as one region. I split Ukraine into six provinces ending up with 25 regions, and add the birth and death rates from 1899 to 1914 and from 1950 to 1990. Thus, I construct a harmonized panel of 25 regions with data on birth and death rates from 1899 to 1990, omitting years around the WW1 and WW2. The rural birth and death rates are only available since 1927.

I use specification (2) to estimate the correlation between the rate of the natural population increase (birth minus death rate) and the 1933 famine severity. Since the relationship between the famine severity and the post-famine rate of population increase is biological (delayed births and accelerated deaths during the famine drive it), and to not rule out the biological explanation by overcontrolling, I try to be as parsimonious as possible: I only control for the grain suitability interacted with year fixed effects, and province- and republic-year fixed effects. I omit the years of crisis — 1931 to 1934 — from the sample, and use 1930 as a comparison year.

Figure 5a presents the estimates for the total natural increase rate and Figure 5b shows the estimates for the rural natural increase rate (Appendix Figure A3 plots the estimates for the birth and death rates separately, and Appendix Table A3 shows the exact coefficients with their standard errors). Indeed, it appears in 1935–1936 the rate of natural increase was higher in the famine areas, although the estimates are only statistically different from zero in 1936 and only for the total natural increase rate, not for rural. Moreover, after 1936 the differences in natural increase rates disappear. Yet according to the estimates presented in Figure 3a, the rural population was still smaller in the famine areas in 1937 and 1939. Thus, the differences in the natural increase rate alone were probably too short-lived to explain the gradual recovery of the rural population in the famine areas.

Since the differences in the rates of the natural population increase cannot explain the recovery of the rural population in the famine-stricken areas, the recovery must be explained by the differences in migration. Unfortunately, the data on migration within the Soviet Union are not yet available, therefore, I cannot directly distinguish between (1) a larger inflow of rural population from nonfamine areas to the famine-stricken areas and (2) a smaller outmigration to urban settlements in the famine-stricken areas. Evidence against (1) is that the known attempts at repopulation of the

¹⁰For towns that did not exist in 1926, the impact of famine on population is zero. This estimate is available upon request.

famine-stricken areas were on a small scale and did not seem successful. For example, Iefimenko (2013, 2015) studies repopulation attempts in Ukraine and argues that the number of new settlers was tiny compared to the number of famine victims, and many of the new settlers returned to their places of origin after observing the devastation in the famine-stricken countryside. Consistent with (2) is the evidence presented in the previous section: smaller towns were more affected, and smaller towns rely on migration from the local areas. I conclude that, although the evidence is indirect, the recovery of the rural population and the persistently smaller size of the urban population are consistent with smaller outmigration to cities from the famine-stricken areas.

Plans

Starting in 1928, the Soviet economy developed according to Five-Year Plans: the state directed investment and construction. It is possible then that the relative decline of the urban population in the future famine areas was planned by the government. Unfortunately, disaggregated data are only available for the First Five-Year Plan (1928–1933). Nevertheless, I use a cross-section of 18 plan regions from the First Five-Year Plan to study the planned economic development.

Table 5 tests if the differences in economic development were planned for the regions that will experience the famine in 1933. Each column estimates a relationship between the 1933 excess mortality and planned 1933 outcome controlling for the baseline outcome at the beginning of the plan and for the 1926 rural Ukrainian population share and grain suitability. I consider the planned population, investment, industrial output, power plants capacity, and railroad construction.

Columns (1) and (2) report the estimates for the planned 1933 rural and urban population. There is no relationship between planned population and the future famine: the 1933 excess mortality coefficients are statistically indistinguishable from zero and are small in magnitude. Columns (3) to (5) report estimates for the planned investment from 1928 to 1933 (controlling for 1926 urban population). Column (3) reports the planned total investment, column (4) reports the planned investment in Group A industries (production of means of production) — these were considered a priority by the government, and column (5) reports the planned investment in Group B industries (production of consumer goods). In all three columns the relationship between the 1933 excess mortality and planned investment is small in magnitude and statistically indistinguishable from zero. Finally, columns (6) to (8) report the estimates for the planned industrial output, power plant capacity, and railroad construction. Again, all coefficients of the 1933 excess mortality are small in magnitude and statistically indistinguishable from zero.

One might worry that for so few observations controlling for the 1926 rural Ukrainian share and grain suitability when estimating the correlation between the 1933 excess mortality and the planned outcomes is overcontrolling. Appendix Table A4 reports the estimates without controlling for Ukrainians and grain suitability. The results are similar to the ones in Table 5. Thus, there is no evidence that the Soviet government planned a different economic development path for the future famine areas already in 1928.

Soviet plans, however, were built from the achieved level — whatever outcome was achieved by the end of one plan period became incorporated as a starting point of the next plan. Figure 6 shows the actual and planned rural and urban population of the Soviet Union. Figure 6a shows that the government planned for the rural population to continue to increase, and when it did not increase as planned by the beginning of 1933, whatever rural population was achieved was incorporated into the Second Five-Year Plan; the Second Five-Year Plan expected the rural population to grow but instead the famine decimated it.¹¹ Similarly, Figure 6b shows that the government planned for the urban population to grow, but the actual growth was even faster than planned. Whatever urban population was achieved by the end of the First Five-Year Plan, the Second Five-Year Plan incorporated it as a starting point. The urban population continued to increase faster than planned during the Second Five-Year Plan. This "planning from the achieved level" may explain the persistent differences in the urban population in the famine areas.

To conclude, the patterns we observe in the data are as follows: the 1933 famine is associated with a short-term (pre-WW2) drop in the rural population and a persistent drop in the urban population. These are not explained by other pre-WW2 population shocks: the Great Terror, the Gulag, the ethnic deportations; these are also not explained by transport availability or natural resources. Consistent with the persistent drop in the urban population, the 1933 famine is also associated with a decline in the production of electricity. Moreover, in the famine areas, towns that existed before the famine grew slower, especially towns that had fewer than 25 thousand inhabitants before the famine; and in the famine areas fewer new towns were created after the famine. There is no evidence that these differences in economic development were planned in the First Five-Year Plan, but new plans incorporate the achieved levels of the previous plans and may thus preserve whatever differences in economic development to occur. Together, these patterns in the data are consistent with the following story: between 1926 and 1937, during the years of rural crisis, collectivization, and famine, relatively fewer people migrated to the urban areas in the territories that would be devastated by the 1933 famine. Although not planned originally, these differences were then preserved and exacerbated by the planning system which used the "planning from the achieved level" principle.

5 Conclusion

Understanding the formation of urban networks is one of the major questions in economics. Krugman (1991) theoretically predicted the possibility of multiple equilibria in urban network formation. To this day, however, only a few strong empirical examples supporting the existence of multiple equilibria were found. To the contrary, numerous studies demonstrated the resilience of formed urban networks to large temporary shocks to population and capital. This article presents evidence supporting the existence of multiple urbanization equilibria by demonstrating that local shortages of labor during rapid construction might prevent urban settlements from growing and that this effect from temporary negative shock to population can be persistent when the shock occurs during the construction of the urban network.

¹¹The Third Five-Year Plan did not publish planned population, possibly because of the huge population losses in the previous years.

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Tables

| | | | | Depende | ent Variable | : | | |
|---|----------------------|--------------------------|----------------------|---------------------------|--------------------------|---------------------------|------------------------|---------------------------|
| | Ln F | Rural Popul | ation | | | | | |
| | (1) | (2) | (3) | (4) | (5) | baseline (6) | Ukraine only (7) | Russia only (8) |
| Excess mortality 1933 \times Post-1933 | -2.416 (2.100) | | -2.058 (2.982) | -8.851^{***} (3.435) | | -14.635^{**} (7.088) | -14.834 (10.687) | -16.956^{**} (6.658) |
| Standardized Coef. | -0.079 | | -0.067 | -0.201 | | -0.333 | -0.416 | -0.231 |
| Excess mortality 1933 \times [1937, 1939] | | -3.886^{**} (1.598) | | | -7.516^{**} (3.082) | | | |
| Standardized Coef. | | -0.130 | | | -0.179 | | | |
| Excess mortality 1933 \times Post-1950 | | -1.996 (2.325) | | | -9.232^{**} (3.650) | | | |
| Standardized Coef. | | -0.069 | | | -0.234 | | | |
| Ukrainians 1926 \times Post-1933 | | | -0.386 (0.472) | | | 1.323^{**} (0.654) | $1.035 \\ (0.930)$ | 1.859^{**} (0.894) |
| Observations R-squared Provinces | $960 \\ 0.904 \\ 80$ | $960 \\ 0.904 \\ 80$ | $960 \\ 0.934 \\ 80$ | $960 \\ 0.921 \\ 80$ | $960 \\ 0.921 \\ 80$ | $960 \\ 0.934 \\ 80$ | $216 \\ 0.918 \\ 18$ | $696 \\ 0.938 \\ 58$ |

Table 1: The 1933 Famine and the Rural and Urban Population

Notes: Observations are at the province and year level. The sample includes provinces in Belarus, Russia, and Ukraine; and the years of 1897, 1913, 1926, 1937, 1939, 1950, 1959, 1970, 1979, 1989, 2002, and 2010. Estimates in columns (1)-(2) and (4)-(5) control for grain suitability × Year FE, capital province indicator × Year FE, province FE, and grain-consuming region indicator × Year FE. Estimates in columns (3) and (6)-(8) control for grain suitability × Year FE, capital province indicator × Year FE, the 1926 rural Ukrainian population share × Post-1933 indicator, Nazi occupation dummy × Year FE, province FE, and region-year FE. Standard errors are adjusted for spatial correlation within 500 km. ***p < 0.01, **p < 0.05, *p < 0.1

| | | | | | De | ependent Var | iable: Ln Ur | ban Popula | tion | | | | |
|---|---------------------------|--------------------------|---------------------------|--------------------------|----------------------------------|----------------------------|----------------------------|---|---------------------------|---------------------------|-----------------------------|---------------------------|---------------------------|
| | baseline (1) | (2) | (3) | (4) | w data on Gulag pop (5) | (6) | (7) | omit provinces w ethnic dep (8) | (9) | (10) | (11) | (12) | (13) |
| Excess mortality 1933 \times Post-1933 | -14.635^{**} (7.088) | -13.411* (7.004) | -14.567^{**} (7.087) | -13.773^{*} (7.087) | -24.816^{***} (4.757) | -24.184^{***} (5.047) | -24.176^{***} (5.048) | -13.893^{*} (7.945) | -14.874^{**} (7.058) | -14.677^{**} (7.053) | -12.724^{**} (6.238) | -14.148^{**} (6.752) | -14.158^{**} (7.083) |
| Standardized Coef. | -0.333 | -0.305 | -0.331 | -0.313 | -0.481 | -0.469 | -0.469 | -0.310 | -0.338 | -0.334 | -0.289 | -0.322 | -0.322 |
| # Repressed / 1926 pop × Post-1933 # Executed / 1926 pop × Post-1933 | | 5.425^{***} (1.779) | -7.523 | | | | | | | | | | |
| #Gulag camps per 1,000 km2 × Post-1933 | | | (17.059) | 1.026^{**} (0.506) | | | | | | | | | |
| Gulag pop 1921-1960 / 1926 pop \times Post-1933 | | | | (0.000) | | 0.116^{**} | | | | | | | |
| Gulag pop 1930-1960 / 1926 pop \times Post-1933 | | | | | | (0.000) | 0.117^{**} | | | | | | |
| 1932 RR stations per 1,000 km2 \times Post-1933 | | | | | | | (0.055) | | -0.413 | | | | |
| 1930 avg distance to RR \times Post-1933 | | | | | | | | | (0.000) | 0.000 | | | |
| Longitude \times Post-1933 | | | | | | | | | | (0.002) | 0.045^{**} | | |
| Latitude \times Post-1933 | | | | | | | | | | | (0.022) 0.052 (0.022) | | |
| Coal 2006 / pop 1926 \times Post-1933 | | | | | | | | | | | (0.055) | 0.832^{***} | |
| Oil 2006 / pop 1926 \times Post-1933 | | | | | | | | | | | | (0.106) | -2.001^{**} (0.937) |
| Observations R-squared Provinces | $960 \\ 0.934 \\ 80$ | $960 \\ 0.940 \\ 80$ | $960 \\ 0.934 \\ 80$ | 960 0.935 80 | $612 \\ 0.945 \\ 51$ | $612 \\ 0.950 \\ 51$ | $612 \\ 0.950 \\ 51$ | 936 0.933 78 | $960 \\ 0.934 \\ 80$ | $960 \\ 0.934 \\ 80$ | 960 0.939 80 | $960 \\ 0.940 \\ 80$ | $960 \\ 0.934 \\ 80$ |

Table 2: The 1933 Famine and the Urban Population: Robustness

Notes: Notes: Observations are at the province and year level. The sample includes provinces in Belarus, Russia, and Ukraine; and the years of 1897, 1913, 1926, 1937, 1939, 1950, 1959, 1970, 1979, 1989, 2002, and 2010. All estimates control for grain suitability × Year FE, capital province indicator × Year FE, the 1926 rural Ukrainian population share × Post-1933 indicator, Nazi occupation dummy × Year FE, province FE and region-year FE. Standard errors are adjusted for spatial correlation within 500 km. ***p < 0.01, **p < 0.05, *p < 0.1

| | | | Depend | lent variab | ole: | |
|---|------------------------|------------------------|------------------------|------------------------|---------------------------|---------------------------|
| | Ln Grain | | Ln Sov | vn Area | Ln Ele | ctricity |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Excess mortality 1933 \times Post-1933 | -0.450 (2.986) | | $1.476 \\ (3.005)$ | | -11.883^{**} (5.535) | |
| Standardized Coef. | -0.008 | | 0.021 | | -0.156 | |
| Excess mortality 1933 \times [1934, 1940] | | -1.253 (2.053) | | $0.663 \\ (1.866)$ | | -9.222^{*} (4.912) |
| Standardized Coef. | | -0.021 | | 0.011 | | -0.142 |
| Excess mortality 1933 \times Post-1946 | | -0.200 (3.576) | | $1.655 \\ (3.405)$ | | -12.770^{**} (5.971) |
| Standardized Coef. | | -0.003 | | 0.024 | | -0.169 |
| Observations R-squared Provinces | $3,349 \\ 0.948 \\ 80$ | $3,349 \\ 0.948 \\ 80$ | $4,819 \\ 0.953 \\ 80$ | $4,819 \\ 0.953 \\ 80$ | $1,435 \\ 0.953 \\ 80$ | $1,435 \\ 0.954 \\ 80$ |

Table 3: The 1933 Famine and the Rural and Urban Economy

Notes: Observations are at the province and year level. The sample includes provinces in Belarus, Russia, and Ukraine; and the years from 1900 to 1990 for which data are available. All estimates control for grain suitability × Year FE, capital province indicator × Year FE, the 1926 rural Ukrainian population share × Post-Famine indicator, Nazi occupation dummy × Year FE, province FE, and region-year FE. Standard errors are adjusted for spatial correlation within 500 km. ***p < 0.01, **p < 0.05, *p < 0.1

| Sample: | | Towns the | | Towns that don't exist in 1926 | | | | |
|--|---------------------------|---------------------------|-------------------------------|-----------------------------------|--------------------------|-------------------------|----------------------------|----------------------------|
| | | All | | < 10K | 10 - 25K | > 25K | | |
| | | | | | | | | |
| | | | Indicator that Town Exists | | | | | |
| | (1) | baseline (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Excess mortality 1933 \times Post-1933 | -5.928^{**} (2.425) | -5.780^{***} (2.066) | | -6.300^{**} (2.543) | -5.591^{**} (2.746) | -1.942 (3.293) | -0.692^{**} (0.337) | |
| Standardized Coef. | -0.110 | -0.107 | | -0.145 | -0.217 | -0.040 | -0.032 | |
| Excess mortality 1933 \times 1939 | | | -4.320^{***} (1.507) | | | | | -1.764^{***} (0.636) |
| Standardized Coef. | | | -0.092 | | | | | -0.115 |
| Excess mortality 1933 \times Post-1959 | | | -6.049^{***} (2.196) | | | | | -0.478 (0.346) |
| Standardized Coef. | | | -0.111 | | | | | -0.023 |
| Town FE, Year FE | \checkmark | | | | | | | |
| Town FE, Province-Year FE | | \checkmark | \checkmark | \checkmark | \checkmark | \checkmark | \checkmark | \checkmark |
| Observations R-squared Towns | $7,312 \\ 0.918 \\ 1,055$ | $7,312 \\ 0.939 \\ 1,055$ | $7,312 \\ 0.939 \\ 1,055$ | $4,338 \\ 0.890 \\ 673$ | $1,857 \\ 0.897 \\ 240$ | $1,117 \\ 0.978 \\ 142$ | $18,048 \\ 0.844 \\ 2,257$ | $18,048 \\ 0.844 \\ 2,257$ |

Table 4: The 1933 Famine and the Population of Towns

Notes: Observations are at the town and year level. The sample includes towns in Belarus, Russia, and Ukraine; and the years of 1897, 1926, 1939, 1959, 1970, 1979, 1989, and 2002. All estimates control for the 1926 rural Ukrainian population share, grain suitability, Nazi occupation dummy, and an indicator that a town was a province capital in 1932 interacted with year fixed effects, and town FE. Estimates in column (1) also control for year FE; estimates in columns (2)-(8) also control for province-year FE. Standard errors are adjusted for spatial correlation within 500 km. ***p < 0.01, **p < 0.05, *p < 0.1

| | | | | Depender | nt Variable: | | | |
|-------------------------------|--------------------------|--------------------------|----------------------------|---|--------------------------------------|--|--|--|
| | Planned Ln | Population 1933: | Planned | Ln Investment | 1928-33: | | | |
| | Rural (1) | Urban (2) | Total (3) | Group A: "means of production" (4) | Group B: consumer goods (5) | Planned Ln Industrial Output 1933 (6) | Planned Ln Power Plants Capacity 1933 (7) | Planned Ln Railroad Length 1933 (8) |
| Excess mortality 1933 | 4.116 (3.891) | 1.572 (2.557) | 1.651 (9.048) | -0.540 (7.849) | 9.369 (14.308) | -3.976 (5.512) | -16.798 (15.397) | 4.259 (3.129) |
| Standardized Coef. | 0.049 | 0.016 | 0.016 | -0.005 | 0.084 | -0.036 | -0.160 | 0.028 |
| Ln Rural Population 1926 | 0.944^{***} (0.047) | | | | | | | |
| Ln Urban Population 1926 | () | 1.014^{***} (0.051) | 0.957^{***} (0.123) | 0.890^{***} (0.144) | 1.159^{***} (0.145) | | | |
| Ln Industrial output 1928 | | () | () | (-) | () | 0.885^{***} (0.058) | | |
| Ln Power Plants Capacity 1928 | | | | | | (0.000) | 0.849^{***} (0.132) | |
| Ln Railroads 1928 | | | | | | | (0.102) | $\frac{1.018^{***}}{(0.019)}$ |
| Ukrainians 1926 | 0.049 (0.146) | 0.190 (0.256) | 1.142^{*} (0.547) | 1.851^{***} (0.587) | -0.927 (0.816) | 0.491 (0.352) | 1.624 (0.943) | -0.320 (0.201) |
| Grain Suitability | -0.059 (0.115) | -0.283 (0.180) | (1.598^{***}) (0.488) | (1.915^{***}) (0.534) | -0.792 (0.767) | -0.500 (0.341) | $(1.358)^{*}$ (0.749) | -0.183 (0.212) |
| Observations R sequence | 18 | 18 | 18 | 18 | 18 0.876 | 18 | 16 0.885 | 16 |

Table 5: The 1933 Famine and the First Five-Year Plan

Notes: Observations are at the region level. The sample includes regions of Belarus, Russia, and Ukraine; estimates in columns (7) and (8) have fewer observations because the source does not report planned power plant capacity and railroad construction for some regions. Huber-White robust standard errors are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1





Notes: Excess mortality 1933 is mortality in 1933 minus mortality in 1928. Figure (a) shows the sample of provinces, Figure (b) shows the sample of towns.





Notes: The figures show average population normalized by the 1926 value separately for 40 provinces where 1933 excess mortality was below the median, 20 provinces in the third quartile of 1933 excess mortality, and 20 provinces in the fourth quartile of 1933 excess mortality. The vertical line indicates the 1933 famine.

Figure 3: The Correlation Between 1933 Excess Mortality and Population Over Time: Province-Level Estimates



Notes: The figures plot the interaction coefficients of 1933 excess mortality and year dummy variables with their 95% confidence intervals. The coefficients and their standard errors are presented in Appendix Table A2, columns (1) and (3).

Figure 4: The Correlation Between 1933 Excess Mortality and Population Over Time: Town-Level Estimates



Notes: The figures plot the interaction coefficients of 1933 excess mortality and year dummy variables with their 95% confidence intervals. The coefficients and their standard errors are presented in Appendix Table A2, columns (5) and (6).

Figure 5: The Correlation Between 1933 Excess Mortality and Natural Increase Rate of Population (Natality minus Mortality) Over Time



Notes: The figures plot the interaction coefficients of 1933 excess mortality and year dummy variables with their 95% confidence intervals. The coefficients and their standard errors are presented in Appendix Table A3, columns (3) and (6).



Figure 6: Actual and Planned Soviet Population

Notes: The figures plot rural and urban Soviet population from December 1926, January 1937, and January 1939 censuses. For the inter-census years, rural and urban population estimates are constructed from the total population estimates from Andreev et al. (1993) and rural-urban migration from Wheatcroft and Davies (1994). Planned population is from Prezidium Gosplana SSSR (1930) and Gosudarstvennaya Planovaya Komissiya pri Sovete Narodnykh Komissarov Soyuza SSR (1934).

Appendix

| | | Depende | ent Variable: | Ln Urban Po | pulation | |
|--|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Excess mortality 1933 \times Post-1933 | | | -14. | 635 | | |
| | | 0 | | 1 | | |
| Creatial annualation within | | 100 | ver time corr | elation withi | n: | 500 |
| Spatial correlation within: | none | 100 years | 200 years | 300 years | 400 years | 500 years |
| 300 km | $(6.681)^{**}$ | $(5.199)^{***}$ | $(5.643)^{***}$ | $(5.786)^{**}$ | $(5.856)^{**}$ | $(5.898)^{**}$ |
| 400 km | $(6.970)^{**}$ | $(5.300)^{***}$ | $(5.736)^{**}$ | $(5.877)^{**}$ | $(5.946)^{**}$ | $(5.987)^{**}$ |
| 500 km | $(7.088)^{**}$ | $(5.355)^{***}$ | $(5.787)^{**}$ | $(5.927)^{**}$ | $(5.995)^{**}$ | $(6.036)^{**}$ |
| 600 km | $(6.817)^{**}$ | $(5.292)^{***}$ | $(5.729)^{**}$ | $(5.870)^{**}$ | $(5.939)^{**}$ | $(5.981)^{**}$ |
| 700 km | $(6.307)^{**}$ | $(5.162)^{***}$ | $(5.609)^{***}$ | $(5.753)^{**}$ | $(5.823)^{**}$ | $(5.865)^{**}$ |
| 800 km | $(5.983)^{**}$ | $(5.071)^{***}$ | $(5.525)^{***}$ | $(5.671)^{***}$ | $(5.743)^{**}$ | $(5.786)^{**}$ |
| 900 km | $(5.723)^{**}$ | $(4.998)^{***}$ | $(5.458)^{***}$ | $(5.606)^{***}$ | $(5.678)^{***}$ | $(5.721)^{**}$ |
| 1000 km | $(5.533)^{***}$ | $(4.942)^{***}$ | $(5.407)^{***}$ | $(5.556)^{***}$ | $(5.629)^{***}$ | $(5.673)^{***}$ |
| 1,100 km | $(5.361)^{***}$ | $(4.893)^{***}$ | $(5.362)^{***}$ | $(5.512)^{***}$ | $(5.586)^{***}$ | $(5.630)^{***}$ |
| 1,200 km | $(5.156)^{***}$ | $(4.839)^{***}$ | $(5.313)^{***}$ | $(5.464)^{***}$ | $(5.539)^{***}$ | $(5.583)^{***}$ |
| 1,300 km | $(4.923)^{***}$ | $(4.781)^{***}$ | $(5.260)^{***}$ | $(5.413)^{***}$ | $(5.488)^{***}$ | (5.533)*** |
| 1,400 km | $(4.702)^{***}$ | $(4.728)^{***}$ | $(5.212)^{***}$ | $(5.366)^{***}$ | $(5.442)^{***}$ | $(5.487)^{***}$ |
| 1,500 km | $(4.507)^{***}$ | $(4.683)^{***}$ | $(5.171)^{***}$ | $(5.327)^{***}$ | $(5.403)^{***}$ | (5.448)*** |
| 1,600 km | $(4.328)^{***}$ | $(4.643)^{***}$ | $(5.135)^{***}$ | $(5.292)^{***}$ | $(5.368)^{***}$ | $(5.414)^{***}$ |
| 1,700 km | $(4.176)^{***}$ | $(4.609)^{***}$ | $(5.104)^{***}$ | $(5.262)^{***}$ | $(5.339)^{***}$ | $(5.385)^{***}$ |
| 1,800 km | $(4.035)^{***}$ | $(4.577)^{***}$ | $(5.076)^{***}$ | $(5.235)^{***}$ | $(5.312)^{***}$ | (5.358)*** |
| 1,900 km | $(3.874)^{***}$ | $(4.543)^{***}$ | $(5.045)^{***}$ | $(5.205)^{***}$ | $(5.283)^{***}$ | $(5.329)^{***}$ |
| 2,000 km | $(3.704)^{***}$ | $(4.509)^{***}$ | $(5.014)^{***}$ | $(5.175)^{***}$ | $(5.253)^{***}$ | $(5.300)^{***}$ |
| Bootstrapped <i>p</i> -values: | | | | | | |
| cluster(vear) | 0.0005 | | | | | |
| cluster(province) | 0.046 | | | | | |
| cluster(province year) | 0.0581 | | | | | |
| Observations | | | 96 | 30 | | |
| R-squared | | | 0.9 | 34 | | |
| Provinces | | | 8 | 0 | | |

| Table A1: Standard Er | errors of the Baseline | Estimate of Excess | mortality 19 | $033 \times \text{Pos}$ | st-1933 |
|-----------------------|------------------------|--------------------|--------------|-------------------------|---------|
|-----------------------|------------------------|--------------------|--------------|-------------------------|---------|

Notes: The table reports standard errors and bootstrapped *p*-values of the Excess mortality 1933 × Post-1933 coefficient for different levels of spatial and over time correlation; see Colella et al. (2019) for details. ***p < 0.01, **p < 0.05, *p < 0.1

| Sample: | | Prov | vinces | | Towns that exist in 1926 | Towns that don't exist in 1926 |
|--|---|------------------------------|---------------------------------|---|-----------------------------|-----------------------------------|
| | | | Ľ | ependent Va | riable: | |
| | Ln Rural | Population | Ln Urban | Population | Ln Town Population | Indicator that Town Exists |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Excess mortality 1933 \times 1897 | 1.862 | 0.158 | 2.753 | 5.206 | -0.081 | |
| Excess mortality 1933 \times 1913 | (1.007) | -0.304 | (3.210) 0.141 | (3.300) 2.474 (5.211) | (1.155) | |
| Excess mortality 1933 \times 1937 | (1.346) -2.758** | (0.849) -3.725 | (2.677) -7.012*** | (5.211) -10.577** | | |
| Excess mortality 1933 \times 1939 | (1.249) -2.773** | (2.883) -1.916 | (1.711) -6.091*** | (4.596) -11.786*** | -4.337*** | -1.764^{***} |
| Excess mortality 1933 \times 1950 | (1.088) -1.550 | (2.544) -3.136 | (1.992) -9.059*** | (4.361) -14.306*** | (1.362) | (0.636) |
| Errora montolity 1022 × 1050 | (1.320) | (2.589) | (2.750) | (4.915) | ۲ 200*** | 1.056* |
| Excess mortanty 1955 × 1959 | (1.544) | (2.941) | (2.907) | (4.860) | (1.942) | (0.591) |
| Excess mortality 1933×1970 | -0.549 (2.123) | -2.659 (3.413) | -8.119^{***} (2.891) | -12.590^{***} (4.658) | -5.880^{***} (2.083) | -1.097^{**} (0.487) |
| Excess mortality 1933 \times 1979 | 0.216 (2.426) | -2.358 (3.456) | -7.789^{***} (3.014) | -11.818^{**} (4.659) | -6.075^{***} (2.107) | -0.536 (0.486) |
| Excess mortality 1933 \times 1989 | (2.120) 0.105 (2.520) | (3.130) -1.309 (2.250) | -7.698^{**} | -11.596^{**} | -6.386^{***} | 0.101 (0.262) |
| Excess mortality 1933 \times 2002 | -0.885 | (3.259) | -8.399*** | -11.215** | -6.669*** | 0.199 |
| Excess mortality 1933 \times 2010 | (2.866) -2.162 (3.045) | (3.168) -0.663 (3.292) | (3.085) -8.553*** (3.020) | (4.594) -10.868** (4.525) | (2.321) | (0.278) |
| Ukrainians 1926 \times Year FE Observations | 960 | (0.202) √ 960 | 960 | (4.525) ✓ 960 | √ 7 312 | √ 18.048 |
| R-squared Provinces/Towns | $\begin{array}{c} 0.905\\ 80 \end{array}$ | 0.936 80 | 0.921 80 | $\begin{array}{c} 0.934\\ 80 \end{array}$ | $0.939 \\ 1,055$ | 0.845 2,257 |

Table A2: The Correlation Between 1933 Excess Mortality and Population Over Time: Provinceand Town-Level Estimates

Notes: In columns (1)-(4), observations are at the province and year level. The sample includes provinces in Belarus, Russia, and Ukraine; and the years of 1897, 1913, 1926, 1937, 1939, 1950, 1959, 1970, 1979, 1989, 2002, and 2010. In columns (1) and (3), the estimates control for grain suitability × Year FE, capital province indicator × Year FE, province FE, and grain-consuming region indicator × Year FE. In columns (2) and (4), the estimates control for grain suitability × Year FE, capital province indicator × Year FE, the 1926 rural Ukrainian population share × Post-1933 indicator, Nazi occupation dummy × Year FE, province FE, and region-year FE. In columns (5)-(6) observations are at the town and year level. The sample includes towns in Belarus, Russia, and Ukraine; and the years of 1897, 1926, 1939, 1959, 1970, 1979, 1989, and 2002. The estimates control for the 1926 rural Ukrainian population share, grain suitability, Nazi occupation dummy, and an indicator that a town was a province capital in 1932 interacted with year fixed effects, town FE, and province-year FE. Standard errors are adjusted for spatial correlation within 500 km. ***p < 0.01, **p < 0.05, *p < 0.1

| | Dependent Variable: | | | | | | | |
|--|---------------------|-----------|---|--------------------|--------------------|--|--|--|
| | Natality | Mortality | Natural Increase (Natality – Mortality) | Rural Natality | Rural Mortality | Rural Natural Increase (Natality – Mortality) | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | | |
| Excess mortality 1933×1899 | -0.003 | 0.058 | -0.061 | | | | | |
| E (11, 1022 · 1000 | (0.071) | (0.060) | (0.053) | | | | | |
| Excess mortality 1933×1900 | (0.048) | (0.010) | (0.038) | | | | | |
| Excess mortality 1033 × 1001 | (0.074) 0.022 | (0.040) | (0.043) 0.024 | | | | | |
| Excess mortanty 1955 × 1901 | (0.022) | (0.052) | (0.024) | | | | | |
| Excess mortality 1933×1902 | -0.0002 | 0.033 | -0.034 | | | | | |
| 1000 100 <u>_</u> | (0.060) | (0.059) | (0.030) | | | | | |
| Excess mortality 1933×1903 | 0.058 | 0.014 | 0.044 | | | | | |
| , | (0.076) | (0.051) | (0.036) | | | | | |
| Excess mortality 1933 \times 1904 | 0.058 | 0.050 | 0.009 | | | | | |
| | (0.056) | (0.051) | (0.049) | | | | | |
| Excess mortality 1933 \times 1906 | -0.035 | 0.023 | -0.058 | | | | | |
| | (0.119) | (0.063) | (0.089) | | | | | |
| Excess mortality 1933×1907 | 0.017 | 0.031 | -0.014 | | | | | |
| E / 1022 · 1000 | (0.064) | (0.057) | (0.029) | | | | | |
| Excess mortality 1933 \times 1908 | (0.032) | (0.018) | (0.014) | | | | | |
| Emong montality 1022 × 1000 | (0.008) | (0.053) | (0.037) | | | | | |
| Excess mortanty 1955 × 1909 | (0.070) | (0.022) | -0.024 | | | | | |
| Excess mortality 1933 × 1910 | 0.001 | (0.048) | -0.051 | | | | | |
| Excess mortanty 1955 × 1910 | (0.001) | (0.052) | (0.031) | | | | | |
| Excess mortality 1933×1911 | 0.015 | 0.060 | -0.045 | | | | | |
| | (0.078) | (0.056) | (0.049) | | | | | |
| Excess mortality 1933×1912 | -0.035 | -0.012 | -0.023 | | | | | |
| U U | (0.067) | (0.067) | (0.069) | | | | | |
| Excess mortality 1933 \times 1913 | -0.010 | -0.002 | -0.009 | | | | | |
| | (0.075) | (0.047) | (0.044) | | | | | |
| Excess mortality 1933 \times 1914 | -0.001 | 0.013 | -0.014 | | | | | |
| | (0.067) | (0.032) | (0.045) | | | | | |
| Excess mortality 1933 \times 1924 | -0.021 | 0.010 | -0.031 | | | | | |
| | (0.058) | (0.035) | (0.037) | | | | | |
| Excess mortality 1933×1927 | -0.066 | -0.004 | -0.062 | | | | | |
| E | (0.054) | (0.033) | (0.048) | 0.047 | 0.057** | 0.000 | | |
| Excess mortality 1933 \times 1928 | -0.049 | (0.001) | -0.049 | -0.047 | -0.057^{+++} | (0.009) | | |
| Excess mortality 1023 × 1020 | 0.049) | (0.031) | (0.049) | (0.057) 0.061 | (0.023) 0.046** | (0.052) 0.107* | | |
| Excess mortanty 1955 × 1929 | (0.005) | (0.014) | (0.019) | (0.001) | (0.020) | (0.052) | | |
| Excess mortality 1933×1935 | (0.032) | -0.052 | 0.085 | 0.091 | -0.024 | 0.116 | | |
| 1000 moreancy 1000 // 1000 | (0.055) | (0.031) | (0.052) | (0.076) | (0.034) | (0.079) | | |
| Excess mortality 1933×1936 | 0.101 | -0.030 | 0.130** | 0.150* | -0.017 | 0.167^{*} | | |
| | (0.063) | (0.046) | (0.056) | (0.081) | (0.049) | (0.090) | | |
| Excess mortality 1933 \times 1937 | 0.010 | -0.057 | 0.067 | 0.059 | -0.017 | 0.076 | | |
| | (0.077) | (0.038) | (0.068) | (0.113) | (0.044) | (0.107) | | |
| Excess mortality 1933 \times 1938 | 0.016 | -0.042 | 0.059 | 0.070 | -0.009 | 0.079 | | |
| | (0.069) | (0.036) | (0.049) | (0.094) | (0.043) | (0.081) | | |
| Excess mortality 1933 \times 1939 | -0.003 | -0.032 | 0.030 | 0.040 | 0.002 | 0.037 | | |
| | (0.052) | (0.042) | (0.040) | (0.075) | (0.047) | (0.072) | | |
| Excess mortality 1933×1940 | -0.036 | -0.074* | 0.038 | 0.017 | -0.026 | 0.043 | | |
| E | (0.056) | (0.041) | (0.039) | (0.074) | (0.042) | (0.068) | | |
| Excess mortality 1933 \times 1950 | -0.095** (0.020) | -0.018 | -U.U77* (0.041) | -0.044 | (0.020) | -0.063 | | |
| Excess mortality 1022×10^{21} | 0.009) | (0.024) | (U.U41) 0.072* | (000.0) 0 0 0 0 | 0.052) | 0.070) | | |
| Excess moreancy 1955 × 1951 | (0.030) | (0.024) | (0.073) | (0.050) | (0.013) | (0.040) | | |
| | (0.000) | (0.044) | (0.000) | (0.001) | (0.002) | (0.001) | | |

| Table A3: | The Correlation Between 19 | 933 Excess Mortality | and Natality, | Mortality, | and Natural |
|-----------|----------------------------|----------------------|---------------|------------|-------------|
| | Increase Rate of Popula | tion (Natality minus | Mortality) Ov | ver Time | |

Continued on the next page

Table A3 – Continued from the previous page

| Excess mortality 1933 x 1952 -0.094** -0.097 -0.0441 -0.077 (0.037) Excess mortality 1933 x 1953 -0.064 -0.003 -0.019 -0.0101 0.049 Excess mortality 1933 x 1954 -0.049 0.0383 -0.0153 -0.0153 0.0384 Excess mortality 1933 x 1955 -0.056* 0.0031 (0.056) (0.057) -0.033 -0.064 Excess mortality 1933 x 1956 -0.057* 0.0031 (0.027) (0.033) -0.064 Excess mortality 1933 x 1957 -0.054* 0.0055 -0.064* -0.027 0.033 -0.066 Excess mortality 1933 x 1957 -0.054* 0.032 (0.037) (0.037) -0.056 Excess mortality 1933 x 1957 -0.054* 0.033 (0.0461) (0.037) -0.058 Excess mortality 1933 x 1957 -0.054* 0.033 (0.037) (0.038) -0.033 Excess mortality 1933 x 195 -0.054* 0.033 (0.037) (0.037) (0.037) Excess mortality 1933 x 195 -0.056* 0.037 (0.037) <th></th> <th>(1)</th> <th>(2)</th> <th>(3)</th> <th>(4)</th> <th>(5)</th> <th>(6)</th> | | (1) | (2) | (3) | (4) | (5) | (6) |
|--|---------------------------------------|-------------------|---------|-------------------|------------------|---------|---------|
| | Excess mortality 1933×1952 | -0.094** | -0.009 | -0.085** | -0.042 | 0.024 | -0.066 |
| Excess mortality 1933 × 1953 -0.061 -0.003 -0.063 -0.063 0.0391 0.0493 -0.049 Excess mortality 1933 × 1954 -0.049 0.033 -0.055 0.0335 (0.064) Excess mortality 1933 × 1955 -0.066* 0.0361 (0.0351) (0.0661) (0.0361) (0.0371) (0.0662) Excess mortality 1933 × 1956 -0.055* 0.0065 -0.0669* -0.027 (0.033) (0.0431) (0.0451) (0.0571) (0.033) (0.0541) (0.0561) (0.0571) (0.0571) (0.0571) (0.033) (0.0571) (0.033) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.058) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) (0.0571) <td< td=""><td></td><td>(0.039)</td><td>(0.025)</td><td>(0.041)</td><td>(0.067)</td><td>(0.033)</td><td>(0.067)</td></td<> | | (0.039) | (0.025) | (0.041) | (0.067) | (0.033) | (0.067) |
| | Excess mortality 1933×1953 | -0.064 | -0.003 | -0.061 | -0.001 | 0.049 | -0.049 |
| Excess mortality 1933 x 1954 -0.049 0.0261 (0.0363) (0.058) (0.0355) (0.0364) Excess mortality 1933 x 1955 -0.056* 0.0044 -0.059 -0.033 (0.0635) (0.0355) (0.0364) (0.0355) (0.0357) (0.0357) (0.0357) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0351) (0.0371) (0.056) (0.037) (0.035) (0.037) (0.037) (0.037) (0.037) (0.037) (0.037) (0.037) (0.037) (0.038) (0.037) (0.038) (0.037) (0.038) (0.037) (0.038) (0.037) (0.038) (0.037) (0.038) (0.037) (0.038) (0.037) (0.038) (0.037) (0.038) (0.037) (0.038) (0.037) (0.038) (0.037) (0.038) (0.037) (0.038) (0.037) (0.038) (0.037) | - | (0.038) | (0.030) | (0.039) | (0.059) | (0.035) | (0.064) |
| | Excess mortality 1933 \times 1954 | -0.049 | 0.003 | -0.052 | -0.005 | 0.033 | -0.038 |
| $ \begin{split} \begin{aligned} & \text{Excess mortality 1933 x 195} & -0.65^{\circ 0} & 0.044 & -0.059 & -0.013 & 0.034 & -0.046 \\ & (0.036) & (0.037) & (0.062) & (0.037) & (0.062) \\ & \text{Excess mortality 1933 x 1957} & -0.064^{\circ 0} & 0.027 & (0.033) & (0.036) & (0.054) \\ & (0.037) & (0.023) & (0.033) & (0.037) & (0.036) & (0.054) \\ & (0.037) & (0.023) & (0.039) & (0.037) & (0.037) & (0.056) \\ & (0.037) & (0.029) & (0.039) & (0.039) & (0.033) & -0.067 \\ & (0.037) & (0.029) & (0.039) & (0.043) & (0.037) & (0.063) \\ & (0.037) & (0.029) & (0.039) & (0.043) & (0.037) & (0.069) \\ & (0.037) & (0.029) & (0.042) & (0.049) & (0.033) & -0.071 \\ & (0.040) & (0.029) & (0.041) & (0.070) & (0.033) & (0.068) \\ & (0.040) & (0.029) & (0.041) & (0.070) & (0.038) & (0.072) \\ & Excess mortality 1933 x 1963 & 0.008 & -0.031 & (0.037) & (0.069) \\ & (0.038) & (0.029) & (0.041) & (0.070) & (0.038) & (0.071) \\ & \text{Excess mortality 1933 x 1963 & 0.002 & (0.036) & (0.037) & (0.069) \\ & (0.036) & (0.030) & (0.037) & (0.069) & (0.033) & (0.071) \\ & \text{Excess mortality 1933 x 1963 & 0.002 & (0.036) & (0.035) & (0.010 \\ & (0.034) & (0.030) & (0.035) & (0.035) & (0.039) & (0.068) \\ & \text{Excess mortality 1933 x 1965 & 0.007 & 0.010 & -0.033 & 0.066 & (0.039) & (0.068) \\ & \text{Excess mortality 1933 x 1965 & 0.017 & 0.003 & 0.0661 & (0.039) & (0.068) \\ & \text{Excess mortality 1933 x 1965 & 0.017 & 0.003 & 0.0661 & (0.039) & (0.069) \\ & \text{Excess mortality 1933 x 1965 & 0.010 & -0.003 & 0.061 & 0.035 & 0.011 \\ & (0.034) & (0.034) & (0.033) & (0.066) & (0.039) & (0.069) \\ & \text{Excess mortality 1933 x 1965 & 0.017 & 0.003 & 0.061 & 0.032 & 0.019 \\ & \text{Excess mortality 1933 x 1965 & 0.017 & 0.003 & 0.061 & 0.032 & 0.019 \\ & (0.034) & (0.031) & (0.035) & (0.035) & (0.039) & (0.072) \\ & \text{Excess mortality 1933 x 196 & 0.017 & 0.003 & 0.061 & 0.032 & 0.018 \\ & \text{Excess mortality 1933 x 196 & 0.017 & 0.003 & 0.061 & 0.032 & 0.018 \\ & \text{Excess mortality 1933 x 196 & 0.017 & 0.003 & 0.0041 & 0.032 & 0.019 \\ & \text{Excess mortality 1933 x 197 & 0.003 & 0.006 & -0.002 & 0.047 & 0.024 \\ & (0.037) & ($ | | (0.032) | (0.026) | (0.036) | (0.058) | (0.035) | (0.062) |
| | Excess mortality 1933 \times 1955 | -0.056* | 0.004 | -0.059 | -0.013 | 0.034 | -0.046 |
| $ \begin{split} & \begin{tabular}{l l l l l l l l l l l l l l l l l l l $ | | (0.030) | (0.027) | (0.035) | (0.056) | (0.037) | (0.062) |
| | Excess mortality 1933 \times 1956 | -0.055* | 0.005 | -0.060* | -0.027 | 0.033 | -0.060 |
| $ \begin{split} & \begin{tabular}{l} \begin{tabular}{l} $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $$ | | (0.028) | (0.027) | (0.030) | (0.053) | (0.036) | (0.054) |
| $\begin{array}{ccccc} (0.022) & (0.028) & (0.033) & (0.054) & (0.037) & (0.066) \\ Excess mortality 1933 x 1959 & -0.032 & (0.066) & -0.037 & (0.059) & (0.033) & (0.063) \\ Excess mortality 1933 x 1959 & -0.032 & (0.066) & -0.037 & (0.011 & 0.031) & -0.020 \\ (0.040) & (0.029) & (0.042) & (0.0642) & (0.063) & (0.037) & (0.068) \\ Excess mortality 1933 x 1960 & -0.023 & (0.008 & -0.013 & (0.021 & 0.035) & -0.014 \\ (0.040) & (0.029) & (0.041) & (0.027) & (0.038) & (0.072) \\ Excess mortality 1933 x 1961 & -0.012 & (0.007 & -0.019 & (0.028 & 0.036 & -0.008 \\ (0.038) & (0.029) & (0.039) & (0.069) & (0.037) & (0.070) \\ Excess mortality 1933 x 1962 & -0.006 & (0.080 & -0.014 & (0.036 & (0.033) & (0.071) \\ (0.036) & (0.030) & (0.037) & (0.069) & (0.033) & (0.071) \\ Excess mortality 1933 x 1963 & 0.002 & 0.006 & -0.001 & (0.046) & (0.033) & (0.071) \\ (0.031) & (0.030) & (0.036) & (0.066) & (0.033) & (0.068) \\ Excess mortality 1933 x 1964 & (0.02) & (0.030) & (0.034) & (0.066) & (0.033) & (0.068) \\ Excess mortality 1933 x 1966 & (0.0131) & (0.031) & (0.066) & (0.039) & (0.068) \\ Excess mortality 1933 x 1966 & (0.0131) & (0.031) & (0.031) & (0.066) & (0.039) & (0.071) \\ Excess mortality 1933 x 1966 & (0.017) & 0.005 & (0.012 & (0.066) & (0.039) & (0.072) \\ Excess mortality 1933 x 1969 & (0.017 & 0.005 & 0.012 & (0.066) & (0.039) & (0.072) \\ Excess mortality 1933 x 1969 & (0.007 & 0.001 & (0.051 & (0.039) & (0.072) \\ Excess mortality 1933 x 1960 & (0.007 & 0.001 & (0.051 & (0.043) & (0.072) \\ Excess mortality 1933 x 1970 & (0.032 & (0.037) & (0.037) & (0.037) & (0.037) & (0.037) \\ (0.037) & (0.032) & (0.037) & (0.067) & (0.043) & (0.072) \\ Excess mortality 1933 x 1970 & (0.032 & (0.037) & (0.037) & (0.047) & (0.047) \\ Excess mortality 1933 x 1971 & (0.030 & (0.037) & (0.037) & (0.047) & (0.047) & (0.047) \\ Excess mortality 1933 x 1971 & 0.007 & 0.001 & 0.051 & (0.041) & (0.074) \\ Excess mortality 1933 x 1971 & 0.007 & 0.001 & 0.051 & (0.043) & (0.076) \\ Excess mortality 1933 x 1971 & 0.003 & (0.068) & (0.047) & (0.047) & (0.047) & (0.048$ | Excess mortality 1933 \times 1957 | -0.064* | 0.005 | -0.069** | -0.027 | 0.033 | -0.060 |
| $ \begin{array}{llllllllllllllllllllllllllllllllllll$ | | (0.032) | (0.028) | (0.033) | (0.054) | (0.037) | (0.056) |
| $\begin{array}{ccccc} (0.037) & (0.029) & (0.039) & (0.053) & (0.031) & (0.030) \\ (0.040) & (0.029) & (0.042) & (0.066) & (0.031) & (0.068) \\ Excess mortality 1933 \times 1960 & -0.031 & 0.021 & 0.035 & -0.014 \\ (0.040) & (0.029) & (0.041) & (0.071) & (0.038) & (0.072) \\ Excess mortality 1933 \times 1961 & -0.012 & 0.007 & -0.019 & 0.028 & 0.036 & -0.008 \\ (0.033) & (0.029) & (0.069) & (0.037) & (0.070) \\ Excess mortality 1933 \times 1962 & -0.006 & 0.008 & -0.014 & 0.036 & 0.035 & 0.001 \\ (0.034) & (0.030) & (0.036) & (0.043) & (0.038) & (0.071) \\ Excess mortality 1933 \times 1963 & 0.002 & 0.006 & -0.004 & 0.044 & 0.038 & (0.071) \\ Excess mortality 1933 \times 1963 & 0.002 & 0.006 & -0.004 & 0.044 & 0.038 & (0.068) \\ Excess mortality 1933 \times 1964 & 0.002 & 0.006 & -0.004 & 0.044 & 0.033 & (0.068) \\ Excess mortality 1933 \times 1964 & 0.002 & 0.009 & -0.007 & 0.047 & 0.039 & (0.069) \\ & (0.034) & (0.030) & (0.035) & (0.066) & (0.039) & (0.068) \\ Excess mortality 1933 \times 1964 & 0.002 & 0.009 & -0.007 & 0.047 & 0.039 & (0.069) \\ & (0.034) & (0.031) & (0.035) & (0.066) & (0.039) & (0.069) \\ Excess mortality 1933 \times 1960 & 0.011 & -0.003 & 0.041 & 0.032 & 0.011 \\ & (0.034) & (0.031) & (0.034) & (0.067) & (0.039) & (0.071) \\ Excess mortality 1933 \times 1967 & 0.014 & 0.010 & 0.052 & 0.035 & 0.018 \\ & (0.034) & (0.031) & (0.033) & (0.069) & (0.039) & (0.072) \\ Excess mortality 1933 \times 1960 & 0.007 & 0.001 & 0.051 & 0.034 & 0.018 \\ & (0.037) & (0.032) & (0.037) & (0.065) & (0.049) & (0.072) \\ Excess mortality 1933 \times 197 & 0.008 & -0.011 & 0.051 & 0.027 & 0.023 \\ & (0.037) & (0.033) & (0.033) & (0.067) & (0.047) & (0.071) \\ Excess mortality 1933 \times 197 & 0.008 & -0.001 & 0.051 & 0.024 & 0.022 \\ & (0.037) & (0.033) & (0.033) & (0.067) & (0.041) & (0.071) \\ Excess mortality 1933 \times 197 & 0.003 & 0.006 & -0.002 & 0.047 & (0.043) \\ & (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.071) \\ Excess mortality 1933 \times 197 & 0.003 & 0.006 & -0.002 & 0.047 & 0.024 \\ & (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.077) \\ Excess mortality 1933 \times 197 & 0.003 & 0.006 & -0.$ | Excess mortality 1933 \times 1958 | -0.059 | 0.004 | -0.063 | -0.024 | 0.033 | -0.057 |
| $ \begin{array}{llllllllllllllllllllllllllllllllllll$ | | (0.037) | (0.029) | (0.039) | (0.059) | (0.038) | (0.063) |
| | Excess mortality 1933 \times 1959 | -0.032 | 0.006 | -0.037 | 0.011 | 0.031 | -0.020 |
| Excess mortality 1933 x 1960 -0.023 0.008 -0.031 0.021 0.035 -0.014 (0.040) (0.029) (0.041) (0.070) (0.038) (0.072) Excess mortality 1933 x 1961 -0.012 0.007 -0.019 0.028 0.036 -0.008 Excess mortality 1933 x 1962 -0.006 0.008 -0.014 0.036 0.037 (0.070) Excess mortality 1933 x 1963 0.002 0.006 -0.004 0.044 0.038) (0.069) Excess mortality 1933 x 1964 0.002 0.009 -0.007 0.047 0.038 0.006 Excess mortality 1933 x 1965 0.007 0.011 -0.0035 (0.035) (0.036) (0.034) (0.037) (0.039) (0.069) Excess mortality 1933 x 1965 0.010 0.007 0.014 0.012 0.060 0.031 (0.039) (0.072) Excess mortality 1933 x 1966 0.017 0.005 0.012 0.060 0.031 0.029 Excess mortality 1933 x 1968 0.017 0.0051 | | (0.040) | (0.029) | (0.042) | (0.066) | (0.037) | (0.068) |
| $\begin{array}{cccc} (0.040) & (0.029) & (0.041) & (0.070) & (0.038) & (0.072) \\ (0.038) & (0.029) & (0.039) & (0.067) & (0.037) & (0.070) \\ (0.038) & (0.039) & (0.039) & (0.069) & (0.037) & (0.070) \\ (0.036) & (0.036) & (0.037) & (0.069) & (0.038) & (0.071) \\ (0.036) & (0.030) & (0.037) & (0.069) & (0.038) & (0.071) \\ (0.034) & (0.030) & (0.036) & (0.065) & (0.038) & (0.068) \\ (0.034) & (0.030) & (0.036) & (0.065) & (0.039) & (0.068) \\ (0.034) & (0.030) & (0.036) & (0.066) & (0.039) & (0.068) \\ (0.034) & (0.030) & (0.031) & (0.036) & (0.066) & (0.039) & (0.068) \\ (0.034) & (0.031) & (0.035) & (0.066) & (0.039) & (0.069) \\ (0.034) & (0.031) & (0.033) & (0.066) & (0.039) & (0.071) \\ (0.034) & (0.031) & (0.033) & (0.066) & (0.039) & (0.071) \\ (0.034) & (0.031) & (0.033) & (0.066) & (0.039) & (0.072) \\ (0.034) & (0.031) & (0.033) & (0.066) & (0.039) & (0.072) \\ (0.034) & (0.031) & (0.033) & (0.066) & (0.039) & (0.072) \\ (0.034) & (0.031) & (0.033) & (0.066) & (0.039) & (0.072) \\ (0.034) & (0.031) & (0.033) & (0.066) & (0.039) & (0.072) \\ (0.035) & (0.031) & (0.034) & (0.067) & (0.031) & (0.027) \\ (0.036) & (0.032) & (0.037) & (0.067) & (0.031) & (0.027) \\ (0.037) & (0.032) & (0.037) & (0.067) & (0.041) & (0.072) \\ (0.037) & (0.032) & (0.037) & (0.067) & (0.041) & (0.073) \\ (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.073) \\ (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.076) \\ (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.076) \\ (0.036) & (0.033) & (0.037) & (0.067) & (0.041) & (0.076) \\ (0.036) & (0.033) & (0.037) & (0.067) & (0.041) & (0.077) \\ (0.036) & (0.033) & (0.037) & (0.067) & (0.041) & (0.076) \\ (0.036) & (0.033) & (0.037) & (0.067) & (0.043) & (0.076) \\ (0.036) & (0.033) & (0.037) & (0.067) & (0.041) & (0.077) \\ (0.036) & (0.033) & (0.037) & (0.066) & (0.043) & (0.076) \\ (0.036) & (0.033) & (0.037) & (0.066) & (0.042$ | Excess mortality 1933×1960 | -0.023 | 0.008 | -0.031 | 0.021 | 0.035 | -0.014 |
| Excess mortality 1933 x 1961 -0.012 0.007 -0.019 0.028 0.036 -0.008 (0.070) Excess mortality 1933 x 1962 -0.006 0.008 -0.014 0.036 0.035 0.001 (0.070) Excess mortality 1933 x 1963 0.002 0.006 -0.004 0.044 0.034 0.010 (0.034) (0.030) (0.036) (0.037) (0.069) (0.038) (0.071) (0.034) (0.034) (0.036) (0.036) (0.047 0.039) 0.009 (0.034) (0.036) (0.036) (0.047 0.039) 0.009 (0.034) (0.030) (0.034) (0.066) (0.039) (0.068) (0.035) (0.035) (0.066) (0.039) (0.069) (0.035) (0.035) (0.066) (0.039) (0.069) (0.035) (0.066) (0.039) (0.069) (0.035) (0.035) (0.066) (0.039) (0.069) (0.035) (0.031) (0.035) (0.066) (0.039) (0.069) (0.071) (0.035) (0.031) (0.033) (0.066) (0.039) (0.071) (0.035) (0.031) (0.033) (0.067) (0.039) (0.071) (0.035) (0.031) (0.031) (0.033) (0.067) (0.039) (0.072) (0.035) (0.031) (0.031) (0.033) (0.066) (0.039) (0.072) (0.035) (0.031) (0.031) (0.033) (0.066) (0.039) (0.072) (0.035) (0.031) (0.031) (0.033) (0.066) (0.039) (0.072) (0.035) (0.031) (0.034) (0.066) (0.039) (0.072) (0.035) (0.031) (0.034) (0.067) (0.039) (0.072) (0.035) (0.031) (0.034) (0.067) (0.039) (0.072) (0.035) (0.031) (0.034) (0.067) (0.039) (0.072) (0.035) (0.031) (0.033) (0.067) (0.039) (0.072) (0.035) (0.031) (0.033) (0.067) (0.039) (0.072) (0.037) (0.036) (0.032) (0.035) (0.067) (0.039) (0.072) (0.037) (0.067) (0.039) (0.071) (0.033) (0.067) (0.039) (0.072) (0.037) (0.067) (0.041) (0.071) (0.053) 0.026 0.027 (0.037) (0.037) (0.067) (0.041) (0.071) (0.033) (0.037) (0.067) (0.041) (0.071) (0.033) (0.037) (0.067) (0.041) (0.071) (0.033) (0.037) (0.067) (0.041) (0.073) (0.033) (0.037) (0.067) (0.041) (0.073) (0.037) (0.067) (0.041) (0.073) (0.037) (0.063) (0.045) (0.047) (0.033) (0.037) (0.067) (0.044) (0.076) (0.033) (0.037) (0.065) (0.044) (0.076) (0.033) (0.037) (0.065) (0.044) (0.076) (0.033) (0.037) (0.063) (0.045) (0.073) (0.066) (0.037) (0.063) (0.045) (0.073) (0.066) (0.037) (0.063) (0.045) (0.073) (0.066) (0.037) (0.063) (0.045) (0.073) (0.066) (0.050) (0.044) (0.073) (0.066) (0.050) (0.044) (0.073) (0.066) (0.050) (0.074) (0.036 | | (0.040) | (0.029) | (0.041) | (0.070) | (0.038) | (0.072) |
| $ \begin{array}{ccccc} (0.038) & (0.029) & (0.039) & (0.037) & (0.077) & (0.070) \\ (0.036) & (0.036) & (0.036) & (0.037) & (0.068) & (0.037) & (0.068) \\ (0.036) & (0.030) & (0.037) & (0.065) & (0.038) & (0.071) \\ (0.034) & (0.030) & (0.030) & (0.065) & (0.038) & (0.068) \\ (0.034) & (0.030) & (0.030) & (0.065) & (0.038) & (0.068) \\ (0.034) & (0.030) & (0.030) & (0.066) & (0.039) & (0.068) \\ (0.034) & (0.030) & (0.031) & (0.066) & (0.039) & (0.068) \\ (0.034) & (0.033) & (0.031) & (0.035) & (0.066) & (0.039) & (0.068) \\ (0.034) & (0.031) & (0.033) & (0.066) & (0.039) & (0.071) \\ (0.034) & (0.031) & (0.033) & (0.066) & (0.039) & (0.071) \\ (0.034) & (0.031) & (0.033) & (0.066) & (0.039) & (0.071) \\ (0.034) & (0.031) & (0.033) & (0.069) & (0.039) & (0.072) \\ (0.034) & (0.031) & (0.033) & (0.069) & (0.039) & (0.072) \\ (0.035) & (0.031) & (0.033) & (0.066) & (0.039) & (0.072) \\ (0.035) & (0.031) & (0.033) & (0.066) & (0.039) & (0.072) \\ (0.035) & (0.031) & (0.033) & (0.066) & (0.039) & (0.072) \\ (0.036) & (0.032) & (0.031) & (0.033) & (0.067) & (0.039) & (0.072) \\ (0.037) & (0.032) & (0.037) & (0.067) & (0.041) & (0.071) \\ (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.071) \\ (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ (0.035) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ (0.036) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ (0.035) & (0.033) & (0.037) & (0.063) & (0.045) & (0.076) \\ (0.035) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ (0.035) & (0.033) & (0.037) & (0.066) & (0.042) & (0.022) \\ (0.035) & (0.033) & (0.037) & (0.066) & (0.042) & (0.074) \\ (0.036) & (0.033) & (0.037) & (0.067) & (0.041) & (0.075) \\ (0.036) & (0.033) & (0.037) & (0.066) & (0.043) & (0.076) \\ (0.046) & (0.040) & (0.033) & (0.067) & (0.045) & (0.076) \\ (0.045) & (0.046) & (0.043) & (0.037) & (0.066) & (0.052) & (0.079) \\ (0.035) & (0.0$ | Excess mortality 1933×1961 | -0.012 | 0.007 | -0.019 | 0.028 | 0.036 | -0.008 |
| $ \begin{array}{c} \text{Excess mortality 1933 \times 1962} & -0.006 & 0.008 & -0.014 & 0.035 & 0.035 & 0.001 \\ & (0.036) & (0.030) & (0.037) & (0.069) & (0.038) & (0.071) \\ Excess mortality 1933 \times 1963 & 0.002 & 0.006 & -0.004 & 0.044 & 0.038 & 0.0068 \\ & (0.034) & (0.030) & (0.036) & (0.065) & (0.038) & (0.068) \\ \text{Excess mortality 1933 \times 1964 & 0.002 & 0.009 & -0.007 & 0.047 & 0.039 & 0.009 \\ & (0.034) & (0.030) & (0.034) & (0.066) & (0.039) & (0.068) \\ \text{Excess mortality 1933 \times 1965 & 0.07 & 0.010 & -0.003 & 0.047 & 0.035 & 0.011 \\ & (0.031) & (0.035) & (0.031) & (0.033) & (0.066) & (0.039) & (0.069) \\ \text{Excess mortality 1933 \times 1967 & 0.014 & 0.010 & 0.004 & 0.052 & 0.035 & 0.018 \\ & (0.034) & (0.031) & (0.033) & (0.067) & (0.039) & (0.072) \\ \text{Excess mortality 1933 \times 1968 & 0.17 & 0.005 & 0.012 & 0.060 & 0.031 & 0.029 \\ & (0.035) & (0.031) & (0.033) & (0.069) & (0.039) & (0.072) \\ \text{Excess mortality 1933 \times 1968 & 0.017 & 0.005 & -0.011 & 0.051 & 0.034 & (0.072) \\ \text{Excess mortality 1933 \times 1969 & 0.007 & 0.008 & -0.001 & 0.051 & 0.034 & (0.072) \\ \text{Excess mortality 1933 \times 1969 & 0.007 & 0.001 & 0.051 & 0.034 & (0.071) \\ \text{Excess mortality 1933 \times 1970 & 0.008 & 0.007 & 0.001 & 0.051 & 0.034 & 0.018 \\ & (0.036) & (0.032) & (0.037) & (0.067) & (0.040) & (0.071) \\ \text{Excess mortality 1933 \times 1972 & 0.030 & 0.066 & -0.002 & 0.047 & 0.024 \\ & (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.073) \\ \text{Excess mortality 1933 \times 1973 & 0.002 & 0.005 & -0.003 & 0.046 & 0.021 & 0.025 \\ & (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ \text{Excess mortality 1933 \times 1975 & 0.002 & 0.005 & -0.003 & 0.046 & 0.022 & 0.024 \\ & (0.036) & (0.033) & (0.037) & (0.067) & (0.041) & (0.075) \\ \text{Excess mortality 1933 \times 1975 & 0.002 & 0.005 & -0.003 & 0.046 & 0.022 & 0.024 \\ & (0.036) & (0.033) & (0.037) & (0.067) & (0.041) & (0.075) \\ \text{Excess mortality 1933 \times 1977 & 0.032 & -0.006 & -0.022 & 0.042 & 0.019 \\ & (0.045) & (0.040) & (0.037) & (0.065) & (0.045) & (0.075) \\ \text{Excess mortality 1933 \times 1977 & 0.032 & -0.006 & -0.022 & 0.034 & 0.037 \\$ | F | (0.038) | (0.029) | (0.039) | (0.069) | (0.037) | (0.070) |
| | Excess mortality 1933×1962 | -0.006 | 0.008 | -0.014 | 0.036 | 0.035 | 0.001 |
| $ \begin{array}{c} \text{Excess mortality } 1933 \times 1963 & 0.002 & 0.006 & -0.007 & 0.047 & 0.038 & 0.008 \\ & (0.034) & (0.036) & (0.036) & (0.065) & (0.038) & (0.068) \\ \text{Excess mortality } 1933 \times 1964 & 0.002 & 0.009 & -0.007 & 0.047 & 0.038 & 0.009 \\ & (0.034) & (0.030) & (0.034) & (0.066) & (0.039) & (0.068) \\ \text{Excess mortality } 1933 \times 1965 & 0.007 & 0.010 & -0.003 & 0.047 & 0.035 & 0.011 \\ & (0.035) & (0.031) & (0.033) & (0.067) & (0.039) & (0.069) \\ \text{Excess mortality } 1933 \times 1966 & 0.010 & 0.007 & 0.003 & 0.051 & 0.032 & 0.019 \\ & (0.034) & (0.031) & (0.033) & (0.067) & (0.039) & (0.071) \\ \text{Excess mortality } 1933 \times 1966 & 0.017 & 0.005 & 0.012 & 0.066 & 0.031 & 0.029 \\ & (0.034) & (0.031) & (0.033) & (0.069) & (0.039) & (0.072) \\ \text{Excess mortality } 1933 \times 1968 & 0.017 & 0.005 & 0.012 & 0.066 & 0.031 & 0.029 \\ & (0.035) & (0.031) & (0.034) & (0.068) & (0.039) & (0.072) \\ \text{Excess mortality } 1933 \times 1969 & 0.007 & 0.008 & -0.001 & 0.051 & 0.034 & 0.018 \\ & (0.034) & (0.031) & (0.032) & (0.065) & (0.040) & (0.072) \\ \text{Excess mortality } 1933 \times 1970 & 0.008 & 0.007 & 0.001 & 0.051 & 0.027 & 0.023 \\ & (0.037) & (0.032) & (0.037) & (0.065) & (0.040) & (0.071) \\ \text{Excess mortality } 1933 \times 1971 & 0.007 & -0.001 & 0.053 & 0.026 & 0.027 \\ & (0.037) & (0.032) & (0.037) & (0.067) & (0.041) & (0.073) \\ \text{Excess mortality } 1933 \times 1972 & 0.003 & 0.006 & -0.002 & 0.047 & 0.024 & 0.022 \\ & (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ \text{Excess mortality } 1933 \times 1974 & 0.003 & 0.006 & -0.002 & 0.047 & 0.024 & 0.022 \\ & (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ \text{Excess mortality } 1933 \times 1976 & 0.001 & 0.037 & 0.046 & 0.021 & 0.025 \\ & (0.036) & (0.033) & (0.037) & (0.067) & (0.043) & (0.076) \\ \text{Excess mortality } 1933 \times 1976 & 0.001 & 0.002 & -0.002 & 0.042 & 0.014 & 0.027 \\ & (0.036) & (0.033) & (0.037) & (0.067) & (0.043) & (0.075) \\ \text{Excess mortality } 1933 \times 1977 & -0.032 & -0.006 & -0.027 & 0.050 & 0.007 & 0.043 \\ & (0.045) & (0.040) & (0.037) & (0.065) & (0.045) & (0.075) \\ Excess mort$ | F (11) 1022 (1002 | (0.036) | (0.030) | (0.037) | (0.069) | (0.038) | (0.071) |
| | Excess mortality 1933 \times 1963 | (0.002) | (0.006) | -0.004 | 0.044 | (0.034) | (0.010) |
| $ \begin{array}{c} \text{Excess mortality } 193 \times 1967 \\ (0.034) \\ (0.034) \\ (0.033) \\ (0.034) \\ (0.033) \\ (0.035) \\ (0.031) \\ (0.034) \\ (0.034) \\ (0.034) \\ (0.034) \\ (0.034) \\ (0.034) \\ (0.034) \\ (0.034) \\ (0.034) \\ (0.033) \\ (0.034) \\ (0.033) \\ (0.034) \\ (0.033) \\ (0.034) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.033) \\ (0.031) \\ (0.034) \\ (0.031) \\ (0.034) \\ (0.031) \\ (0.032) \\ (0.035) \\ (0.032) \\ (0.037) \\ (0.032) \\ (0.037) \\ (0.046) \\ (0.037) \\ (0.037) \\ (0.037) \\ (0.046) \\ (0.037) \\ (0.037) \\ (0.046) \\ (0.037) \\ (0.037) \\ (0.045) \\ (0.0$ | Erroge montality 1022 × 1064 | (0.034) | (0.030) | (0.030) | (0.065) | (0.038) | (0.068) |
| | Excess mortanty 1955 × 1904 | (0.002) | (0.009) | -0.007 | (0.047) | (0.039) | (0.009) |
| | Excess mortality 1023 × 1065 | (0.034) | (0.030) | (0.034) | (0.000) | (0.039) | (0.008) |
| | Excess mortanty 1955 × 1905 | (0.007) | (0.021) | (0.035) | (0.047) | (0.030) | (0.060) |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $ | Excess mortality 1933 × 1966 | 0.010 | (0.051) | 0.003 | 0.051 | (0.039) | 0.009) |
| $ \begin{array}{cccc} Excess mortality 1933 \times 1967 & (0.037) & (0.037) & (0.037) & (0.037) & (0.037) & (0.037) \\ & (0.034) & (0.031) & (0.033) & (0.069) & (0.039) & (0.072) \\ Excess mortality 1933 \times 1968 & 0.017 & 0.005 & 0.012 & 0.060 & 0.031 & 0.029 \\ & (0.035) & (0.031) & (0.033) & (0.068) & (0.039) & (0.072) \\ Excess mortality 1933 \times 1969 & 0.007 & 0.008 & -0.001 & 0.051 & 0.034 & 0.018 \\ & (0.034) & (0.031) & (0.032) & (0.067) & (0.039) & (0.067) \\ Excess mortality 1933 \times 1970 & 0.008 & 0.007 & 0.001 & 0.051 & 0.027 & 0.023 \\ & (0.036) & (0.037) & (0.035) & (0.065) & (0.040) & (0.071) \\ Excess mortality 1933 \times 1971 & 0.007 & 0.007 & -0.001 & 0.053 & 0.026 & 0.027 \\ & (0.037) & (0.032) & (0.037) & (0.067) & (0.041) & (0.073) \\ Excess mortality 1933 \times 1972 & 0.003 & 0.005 & -0.003 & 0.046 & 0.021 & 0.022 \\ & (0.037) & (0.033) & (0.037) & (0.067) & (0.041) & (0.074) \\ Excess mortality 1933 \times 1973 & 0.003 & 0.005 & -0.003 & 0.046 & 0.021 & 0.025 \\ & (0.037) & (0.033) & (0.037) & (0.067) & (0.043) & (0.076) \\ Excess mortality 1933 \times 1974 & 0.03 & 0.005 & -0.003 & 0.046 & 0.021 & 0.025 \\ & (0.036) & (0.033) & (0.037) & (0.065) & (0.042) & (0.073) \\ Excess mortality 1933 \times 1975 & 0.002 & 0.005 & -0.003 & 0.046 & 0.022 & 0.024 \\ & (0.036) & (0.033) & (0.037) & (0.063) & (0.043) & (0.074) \\ Excess mortality 1933 \times 1976 & 0.001 & 0.002 & -0.002 & 0.042 & 0.014 & 0.027 \\ & (0.036) & (0.033) & (0.037) & (0.063) & (0.043) & (0.074) \\ Excess mortality 1933 \times 1976 & 0.001 & 0.002 & -0.002 & 0.042 & 0.014 & 0.027 \\ & (0.036) & (0.040) & (0.037) & (0.063) & (0.043) & (0.074) \\ Excess mortality 1933 \times 1978 & -0.037 & -0.008 & -0.029 & 0.039 & 0.007 & 0.032 \\ & (0.046) & (0.040) & (0.037) & (0.067) & (0.051) & (0.084) \\ Excess mortality 1933 \times 1978 & -0.037 & -0.008 & -0.029 & 0.039 & 0.007 & 0.032 \\ & (0.046) & (0.040) & (0.038) & (0.069) & (0.051) & (0.084) \\ Excess mortality 1933 \times 1978 & -0.037 & -0.008 & -0.029 & 0.039 & 0.007 & 0.032 \\ & (0.048) & (0.040) & (0.038) & (0.066) & (0.045) & (0.072) \\ Excess mortality 1933 \times 1978 & -0$ | Excess mortanty 1999 × 1900 | (0.034) | (0.031) | (0.034) | (0.067) | (0.032) | (0.013) |
| | Excess mortality 1933×1967 | 0.014 | 0.010 | 0.004 | (0.052) | (0.035) | 0.018 |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | | (0.034) | (0.031) | (0.033) | (0.069) | (0.039) | (0.072) |
| | Excess mortality 1933×1968 | 0.017 | 0.005 | 0.012 | 0.060 | 0.031 | 0.029 |
| $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$ | | (0.035) | (0.031) | (0.034) | (0.068) | (0.039) | (0.072) |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$ | Excess mortality 1933×1969 | 0.007 | 0.008 | -0.001 | 0.051 | 0.034 | 0.018 |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | , , , , , , , , , , , , , , , , , , , | (0.034) | (0.031) | (0.032) | (0.067) | (0.039) | (0.069) |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | Excess mortality 1933 \times 1970 | 0.008 | 0.007 | 0.001 | 0.051 | 0.027 | 0.023 |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | | (0.036) | (0.032) | (0.035) | (0.065) | (0.040) | (0.071) |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | Excess mortality 1933 \times 1971 | 0.007 | 0.007 | -0.001 | 0.053 | 0.026 | 0.027 |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | | (0.037) | (0.032) | (0.037) | (0.067) | (0.041) | (0.073) |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | Excess mortality 1933 \times 1972 | 0.003 | 0.006 | -0.002 | 0.047 | 0.024 | 0.022 |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | | (0.037) | (0.033) | (0.037) | (0.067) | (0.041) | (0.074) |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | Excess mortality 1933 \times 1973 | 0.003 | 0.005 | -0.003 | 0.046 | 0.021 | 0.025 |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | | (0.037) | (0.033) | (0.039) | (0.067) | (0.043) | (0.076) |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | Excess mortality 1933×1974 | 0.003 | 0.008 | -0.005 | 0.047 | 0.028 | 0.019 |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | | (0.036) | (0.033) | (0.037) | (0.065) | (0.042) | (0.073) |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | Excess mortality 1933×1975 | 0.002 | 0.005 | -0.003 | 0.046 | (0.022) | 0.024 |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | D (1) 1000 1070 | (0.036) | (0.033) | (0.037) | (0.063) | (0.043) | (0.074) |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | Excess mortality 1933×1976 | 0.0001 | (0.002) | -0.002 | 0.042 | 0.014 | 0.027 |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | F | (0.035) | (0.034) | (0.037) | (0.063) | (0.045) | (0.075) |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | Excess mortality 1933 \times 1977 | -0.033 | -0.000 | -0.027 | (0.050) | (0.007) | (0.043) |
| Excess mortality 1933 \times 1978-0.037-0.008-0.0290.0390.0070.032(0.046)(0.040)(0.036)(0.065)(0.052)(0.079)Excess mortality 1933 \times 1979-0.032-0.008-0.0240.0390.0040.035(0.048)(0.040)(0.038)(0.069)(0.050)(0.080)Excess mortality 1933 \times 1980-0.003-0.004-0.0030.0370.0160.021(0.039)(0.036)(0.038)(0.065)(0.045)(0.072)Excess mortality 1933 \times 1981-0.031-0.003-0.0270.0320.0070.026(0.048)(0.041)(0.041)(0.070)(0.053)(0.082) | Excess mortality 1023 × 1078 | (0.043) | (0.040) | (0.037) | (0.007) | (0.051) | (0.064) |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | Excess mortanty 1955 X 1978 | -0.037 (0.046) | -0.008 | -0.029 (0.036) | (0.039 | (0.007) | (0.032) |
| Excess mortality 1933 \times 1979-0.032-0.003-0.003-0.0240.0390.0040.039Excess mortality 1933 \times 1980-0.003-0.0004-0.0030.0370.0160.021(0.039)(0.036)(0.038)(0.065)(0.045)(0.072)Excess mortality 1933 \times 1981-0.031-0.003-0.0270.0320.0070.026(0.048)(0.041)(0.041)(0.070)(0.053)(0.082) | Excess mortality 1033×1070 | (0.040) | (0.040) | (0.030) | (0.003) | (0.052) | (0.079) |
| Excess mortality 1933 \times 1980-0.003-0.0004-0.0030.0370.0160.021(0.039)(0.036)(0.038)(0.065)(0.045)(0.072)Excess mortality 1933 \times 1981-0.031-0.003-0.0270.0320.0070.026(0.048)(0.041)(0.041)(0.070)(0.053)(0.082) | Excess mortanty 1355 × 1319 | (0.032) | -0.008 | (0.024) | (0.039 (0.00) | (0.004) | (0.035 |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | Excess mortality 1933 \times 1080 | -0.003 | -0.0004 | -0.003 | 0.037 | 0.016 | 0.000) |
| Excess mortality 1933×1981 -0.031-0.003-0.0270.0320.0070.026 (0.048) (0.041) (0.041) (0.041) (0.070) (0.053) (0.082) | 2 | (0.039) | (0.036) | (0.038) | (0.065) | (0.045) | (0.072) |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$ | Excess mortality 1933 \times 1981 | -0.031 | -0.003 | -0.027 | 0.032 | 0.007 | 0.026 |
| | | (0.048) | (0.041) | (0.041) | (0.070) | (0.053) | (0.082) |
| Excess mortality $1933 \times 1982 -0.030 -0.001 -0.029 0.040 0.016 0.024$ | Excess mortality 1933×1982 | -0.030 | -0.001 | -0.029 | 0.040 | 0.016 | 0.024 |
| (0.049) (0.041) (0.038) (0.070) (0.052) (0.080) | v | (0.049) | (0.041) | (0.038) | (0.070) | (0.052) | (0.080) |

 $Continued \ on \ the \ next \ page$

| Table A3 – Continued from the previous page | | | | | | | | | |
|---|---------|---------|---------|---------|---------|---------|--|--|--|
| | (1) | (2) | (3) | (4) | (5) | (6) | | | |
| Excess mortality 1933×1983 | -0.029 | -0.006 | -0.023 | 0.047 | 0.005 | 0.042 | | | |
| | (0.046) | (0.042) | (0.039) | (0.068) | (0.054) | (0.084) | | | |
| Excess mortality 1933 \times 1984 | -0.031 | -0.007 | -0.024 | 0.042 | -0.003 | 0.045 | | | |
| | (0.048) | (0.043) | (0.044) | (0.068) | (0.056) | (0.088) | | | |
| Excess mortality 1933 \times 1985 | 0.002 | -0.003 | 0.005 | 0.041 | 0.008 | 0.033 | | | |
| | (0.037) | (0.038) | (0.041) | (0.064) | (0.046) | (0.076) | | | |
| Excess mortality 1933 \times 1987 | -0.007 | 0.001 | -0.008 | 0.043 | 0.023 | 0.019 | | | |
| | (0.036) | (0.038) | (0.036) | (0.063) | (0.054) | (0.076) | | | |
| Excess mortality 1933 \times 1988 | -0.025 | 0.002 | -0.028 | 0.046 | 0.025 | 0.021 | | | |
| | (0.047) | (0.043) | (0.042) | (0.065) | (0.054) | (0.077) | | | |
| Excess mortality 1933×1989 | 0.010 | -0.003 | 0.013 | 0.046 | 0.026 | 0.020 | | | |
| | (0.036) | (0.037) | (0.037) | (0.062) | (0.044) | (0.068) | | | |
| Excess mortality 1933 \times 1990 | -0.007 | -0.002 | -0.005 | 0.058 | 0.022 | 0.036 | | | |
| | (0.050) | (0.044) | (0.044) | (0.066) | (0.054) | (0.077) | | | |
| Observations | 1,390 | 1,390 | 1,390 | 1,034 | 1,034 | 1,034 | | | |
| R-squared | 0.964 | 0.952 | 0.911 | 0.955 | 0.860 | 0.946 | | | |
| Admistrative Units | 25 | 25 | 25 | 25 | 25 | 25 | | | |

Notes: Observations are at the region and year level. The sample includes regions in Belarus, Russia, and Ukraine; and the years from 1899 to 1990 for which the data are available. All estimates control for grain suitability × Year FE, province and republic-year FE. Huber-White robust standard errors are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1

| | Dependent Variable: | | | | | | | |
|--|---|--------------------|--|---|--|--|--|--|
| | Planned Ln Population 1933: | | Planned Ln Investment 1928-33: | | | | | |
| | Rural (1) | Urban (2) | Total (3) | Group A: "means of production" (4) | Group B: consumer goods (5) | Planned Ln Industrial Output 1933 (6) | Planned Ln Power Plants Capacity 1933 (7) | Planned Ln Railroad Length 1933 (8) |
| Excess mortality 1933 | 4.580 (3.967) | 2.778 (3.599) | 9.158 (7.069) | 13.507 (8.113) | -2.540 (8.654) | -0.322 (3.231) | -2.896 (6.305) | 0.347 (2.246) |
| Standardized Coef. | 0.054 | 0.028 | 0.087 | 0.126 | -0.023 | -0.003 | -0.028 | 0.002 |
| Ln Rural Population 1926 Ln Urban Population 1926 | $\begin{array}{c} 0.943^{***} \\ (0.044) \end{array}$ | 1.021*** | 1.002*** | 0.961*** | 1.130*** | | | |
| Ln Industrial output 1928 | | (0.040) | (0.113) | (0.124) | (0.155) | 0.903^{***} (0.040) | | |
| Ln Power Plants Capacity 1928 | | | | | | | 0.863^{***} (0.155) | |
| Ln Railroads 1928 | | | | | | | | $\frac{1.010^{***}}{(0.017)}$ |
| Observations R-squared | $\begin{array}{c} 18 \\ 0.970 \end{array}$ | $\frac{18}{0.956}$ | $\begin{array}{c} 18 \\ 0.845 \end{array}$ | $\frac{18}{0.788}$ | $\begin{array}{c} 18 \\ 0.848 \end{array}$ | $\frac{18}{0.967}$ | $\begin{array}{c} 16 \\ 0.833 \end{array}$ | $\begin{array}{c} 16 \\ 0.993 \end{array}$ |

Table A4: The 1933 Famine and the First Five-Year Plan: Fewer Controls

Notes: Observations are at the region level. The sample includes regions of Belarus, Russia, and Ukraine; estimates in columns (7) and (8) have fewer observations because the source does not report planned power plant capacity and railroad construction for some regions. Huber-White robust standard errors are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1

Figure A1: The Correlation Between 1933 Excess Mortality and Population Over Time: Province-Level Estimates, Baseline Controls



Notes: The figures plot the interaction coefficients of 1933 excess mortality and year dummy variables with their 95% confidence intervals. The coefficients and their standard errors are presented in Appendix Table A2, columns (2) and (4).



Figure A2: Random Permutation Test: Permute Excess Mortality 1933

Notes: The figures are histograms of the interaction coefficients (Excess mortality $1933 \times Post-1933$) estimated from 10,000 iterations. The red vertical lines indicate the baseline estimates reported in the tables.



Figure A3: The Correlation Between 1933 Excess Mortality and Natality and Mortality Over Time

Notes: The figures plot the interaction coefficients of 1933 excess mortality and year dummy variables with their 95% confidence intervals. The coefficients and their standard errors are presented in Appendix Table A3, columns (1)-(2) and (4)-(5).

Data Sources

Province-level Panel

Province Population. 1897, 1926, 1939, 1959, 1970, 1979, 1989, 2002: censuses from Demoscope (https://www.demoscope.ru/weekly/ssp/census.php); 1913 – Tsentralnyy Statisticheskiy Komitet MVD (1914); 1937: Zhiromskaia et al. (1996); 1950: Russian Stage Archive of the Economy (Rossiyskiy Gosudarstvennyy Arkhiv Ekonomiki, RGAE) 1562/329/4464–4465; 2010: Russia: census from Demoscope (https://www.demoscope.ru/weekly/ssp/census.php), Ukraine: Osaulenko (2010), Belarus: https://www.demoscope.ru/weekly/ssp/bel_pop_reg.php. The 1939 census figures are corrected by Bogoyavlenskiy (2014). 1897, 1913, 1926, 1937, 1939, and 1950 figures are calculated in the 1989 administrative borders using the 1897 administrative map from Kessler and Markevich (2015) and hand-created administrative maps for later years. The population of provinces of Leningrad, Minsk, Odessa, and Vitebsk is adjusted to the pre-1939 borders.

Excess mortality 1933. Markevich, Naumenko and Qian (2024)

Grain suitability. FAO GAEZ portal, gaez.iiasa.ac.at. Grain suitability is wheat suitability for rain-fed low-input agriculture. Mean values for province polygons are used.

Ukrainians 1926. The rural Ukrainian population share according to the 1926 census is from Markevich, Naumenko and Qian (2024).

Nazi occupation indicator. RGAE 1562/329/2263

The 1937–1938 Purges. The number of individuals sentenced under Article 58 (repressed) and the number of individuals executed under Article 58 are from Zhukov and Talibova (2018).

The Gulag. The number of camps and the Gulag population from 1921 to 1960 is from Mikhailova (2018).

Railroads. Locations of the 1932 railroad stations is from Zhukov and Talibova (2018); distance from the district administrative center to the nearest railroad station is from Tsentralnyy Ispolnitelnyy Komitet Soyuza SSR Vserossiyskiy Tsentralnyy Ispolnitelnyy Komitet (1931).

Natural resources. The 2006 coal and oil production. Coal production in Russia is from the Russian Federal State Statistics Service (Rosstat), https://rosstat.gov.ru/bgd/regl/b08_13/IssWWW.exe/Stg/d3/13-23.htm, Ukraine: Osaulenko (2008). Oil: Rosstat, http://www.gks.ru/bgd/regl/b08_13/IssWWW.exe/Stg/d3/13-27.htm

Grain production and sown area. 1900–1913: Obukhov (1927); 1928, 1932–1940: RGAE 1562/329/1409; 1950–1990: Narkhoz SSSR.

Electricity production. 1928, 1932, 1937–1939: province passports from RGAE 1562/329/3883-3892; 1940, 1950–1955: RGAE 1562/33/2376; 1959: RSAE 1562/33/3810; 1969: RGAE 1562/33/7500.

Town-level Panel

Town Population. A panel of Russian towns is from Mikhailova (2018). I added all Belorussian and Ukrainian towns (*gorod, poselok gorodskogo tipa*) manually by matching data from all available Soviet and post-Soviet censuses: 1897, 1926, 1939, 1959, 1970, 1979, 1989, 2002. The censuses are from Demoscope, (https://www.demoscope.ru/weekly/ssp/census.php).

Excess mortality 1933. The 1933 excess mortality within 50 kilometer radius of each town is calculated using data from Markevich, Naumenko and Qian (2024)

Grain suitability. Grain suitability within 50 kilometers of each town is calculated using rainfed low-input wheat suitability from FAO GAEZ portal, gaez.iiasa.ac.at.

Ukrainians 1926. The rural share of ethnic Ukrainians within 50 kilometer radius of each town is calculated using the 1926 census data from Markevich, Naumenko and Qian (2024).

Nazi occupation indicator. M.L.Dudarenko et al. (1985)

First Five-Year Plan (1928–1933)

All data: planned population, investment, industrial output, power plant capacity, and railroad length is from Prezidium Gosplana SSSR (1930)

Natality and Mortality Panel

Number of live births and deaths. 1899–1913: Yezhegodnik Rossii (1904–1915). 1925–1940: Markevich, Naumenko and Qian (2024), 1950–1990: Demoscope, https://www.demoscope.ru/weekly/ ssp/ussr.php

Population. Censuses; between censuses the population was interpolated.

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