DISCUSSION PAPER SERIES

DP18761

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Viktor Malein, Tamar Matiashvili and Francisco Beltrán Tapia

ECONOMIC HISTORY

ISSN 0265-8003

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Discussion Paper DP18761
Published 18 January 2024
Submitted 16 January 2024

Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

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JEL Classification: N33, J16, Z13, N53

Keywords: Famine, Sex ratios, Folklore

Viktor Malein - viktor.malein@ekh.lu.se
Lund University

Tamar Matiashvili - tamrim@stanford.edu
Stanford University

Francisco Beltrán Tapia - francisco.beltran.tapia@ntnu.no
Norwegian University of Science and Technology and CEPR

Culture, Economic Stress, and Missing Girls[1]

Viktor Malein, Lund University

Tamar Matiashvili, Stanford University

Francisco J. Beltrán Tapia, Norwegian University of Science and Technology

This version January 2024

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[1] We would like to thank Ran Abramitzky, Daniel Fetter, and Martin Dribe, as well as the participants of the 2023 ASREC conference at Bocconi University, the 14th Swedish Economic History Meeting, the seminar at the Centre for Economic Demography at Lund University, Economic History Seminar at the University of Helsinki, participants of various Stanford workshops, and other meetings for their valuable comments and suggestions.

A daughter is someone else's treasure. To take care and feed, teach and guard, and give in marriage.
(Russian proverb)[2]

1. Introduction

Cultural and social norms dictate how we interact with each other, how we work, how we organize families, and even how we die. Who gets a lifeboat when the ship is sinking? Who gets the food when there is little available? Women may have had better chances of surviving the Titanic, but in many other contexts, they face discrimination ranging from human capital investments to domestic violence. Crises such as famine can expose pre-existing gender biases as they hide in the background during normal times. Studying the aftermath of a crisis, can we see how much of the gender gap we observe across all dimensions is due to cultural gender norms? How much of existing heterogeneity is due to differences along this dimension?

We document the causal effect of ethnicity-specific gender norms on sex-biased mortality response to a resource shock.[3] By leveraging unique folklore data collected by anthropologists (Michalopoulos and Xue 2021), we show that a devastating famine that affected the Russian Empire in 1891-1892 resulted in higher male-to-female child sex ratios in those districts where the oral traditions of the population tend to depict women as submissive and stupid.[4] We thus causally tie entrenched gender norms to gender-biased mortality.

The 1891-1892 Famine and the subsequent Cholera outbreak in the Russian Empire contributed to approximately half a million deaths (Charnysh 2022), affecting one of the most ethnically diverse parts of the Empire – the Volga Region. Twenty different ethnic groups resided in the Volga Region at this time. In 1891, crop failure combined with depleted reserves from previous years led to a severe food shortage. Families faced difficult intrahousehold resource allocation decisions – and unlike adults, infants and children were wholly reliant on their parents' decisions.

[2] The original version: "Дочь — чужое сокровище. Холь да корми, учи да стереги, да в люди отдай." (Source)
[3] Section 5.6 discusses conditions under which our empirical estimates can be interpreted as causal.
[4] The original data was collected by Berezkin 2015. Then, Michalopoulos and Xue (2021) demonstrated a wide range of possibilities for using this data in economic research (e.g., studying the economic status of women).

Each ethnic group varied significantly in its view of women. We utilize oral motifs data from Michalopoulos and Xue (2021), who use Berezkin's *Folklore and Mythology Catalog* (2015), which collects oral motifs from over 1,000 ethnic groups. These authors take the *Catalog* and group various motifs from a given ethnic group by themes. Of particular interest to us, they code whether an oral motif depicts men or women as submissive or stupid.[5] To calculate female negative bias for each ethnic group, we calculate the difference between the number of submissive-stupid motifs depicting women and men as such, divided by the total number of motifs. We then create a population-weighted average of this measure for each district of the Russian Empire. The 5%-95% percentile range shows sizable variation of 5.5%-10%. Other themes suggesting discrimination against women also appear in the database. Prominent themes include role in domestic affairs, violence, physical activity, and sexuality. For studying resource allocation decisions, we believe the measure of submissiveness and stupidity to be most relevant, and we verify this assumption statistically.

We validate our female negative bias measure against other proxies of gender equity. We find that the marriage age of female brides was negatively correlated with this measure. Additionally, we find that places with higher bias had lower female labor force participation rates and lower women's employment share in high-skill professions in 1897. Thus, we have high confidence that this measure truly captured ingrained gender biases that were correlated with women's life outcomes.

To identify the causal effect of gender norms on sex-biased mortality due to famine, we study cohorts born before and thus affected by the famine, and those born after this shock. We leverage information on the provision of food relief from the central government to the population in the affected areas to construct a district-level measure of famine intensity. Additionally, we leverage historical climate data to predict food provision from the government. Our predicted measure reflects only a deviation of 1891 precipitation and temperature levels from long-term mean values. Thus, it allows us to overcome potential

[5] Some examples of descriptions of motifs found in the Catalog that Michalopolous and Xue (2021) rate as likely depicting women as submissive and dependent include: "a magic medicine demonstrates that the only chaste woman is a servant girl, orphan, etc. King chooses the chaste one," or "a task-giver asks the hero to get a woman."

biases if the food distribution was affected by factors correlated with our measure of gender bias. In general, our findings are consistent for both measures of famine intensity.

Ultimately, we are interested in the interaction of the negative female bias with our famine measure. If it is true that higher negative female bias leads to higher male-to-female survival rates, we expect that the coefficient of the interaction will be positive. Indeed, we find this to be true – the cohorts exposed to both higher gender bias and higher famine intensity demonstrate relatively higher sex ratios. It indicates relatively higher survival chances for boys. We also demonstrate the importance of the economic factors. We find that the relative survival chances of girls in the areas afflicted by famine increase with a higher economic value of female labor measured by female labor force participation. However, accounting for economic factors does not explain away the effect of culture. It indicates the importance of deep-rooted gender stereotypes independently of economic considerations. Importantly, we demonstrate that accounting for religion does not remove the significance of the effects associated with cultural norms. Hence, aspects of cultural identity seem to matter independently of religion.

We strengthen the interpretation of our regression analysis by comparing the effects of exposure to famine with exposure to cholera outbreak caused by the spread of pandemic disease from Asia that hit both the famine-stricken and other areas in 1892. We demonstrate that the coefficient on the interaction between the measures of cholera exposure and gender bias has low statistical precision and magnitude. While parents had agency in food distribution and thus survival outcomes during the famine, they had limited agency over survival outcomes of contagious diseases. That gender bias does not explain mortality from a low-agency cause of death strengthens our results.

We further validate our findings by performing several sensitivity checks. We account for outliers, spatial autocorrelation in residuals, and an alternative definition of the outcome variable. Additionally, our findings hold after incorporating gender-biased motifs other than submissiveness into regression analysis. We report these exercises after the main results.

In its essence, our paper connects pre-existing gender norms, a resource shock, and populations' gender-biased mortality response. Thus, we contribute to the literature on cultural and economic origins of anti-women discrimination outcomes; the literature on missing girls in a historical context; and the literature on causal effects of resource shocks on demographic evolution.

The phenomenon of "missing girls," especially in South and East Asia, sub-Saharan Africa, and the Caucasus, is well documented (e.g., Sen 1992, Das Gupta, M. and Shuzhuo 1999, Hesketh and Xing 2006; Anderson and Ray, 2010; Chao et al. 2019). Despite the huge literature sparked by this phenomenon, there is limited causal evidence that reveals specific mechanisms driving son preference.

One strand of the literature directly connects women's relative economic value and their survival chances. Alesina, Giuliano, and Nunn (2013, 2018) find that plow-based farming favored men because it required physical strength, leading to men having higher economic value in societies that relied on plows. Xue (2016) finds that improvements in women's economic role caused by the Cotton Revolution in Imperial China improved the social status of women. In a more modern context, Qian (2008) explored how specific agricultural reforms, which favored crops that women were particularly skilled at cultivating, led to increased income for women. This increase in female income, in turn, is directly correlated with higher survival rates for girls in China. Likewise, an exogenous shift in the price of dowry increases the cost of raising girls and reduces their survival chances (Bhalotra et al., 2020). Furthermore, recent findings by Becker (2022) demonstrate that younger ages at marriage, for example, child marriage, are particularly prevalent among descendants of historically pastoral societies.

An alternative explanation, however, underlines the role played by cultural dimensions, such as patrilocality, patrilineality, and other social norms, making sons responsible for old-age support and religious rituals (Jayachandran 2015). It is shown empirically that daughters in India are weaned sooner than sons. In this regard, breastfeeding suppresses post-natal fertility prompting mothers with preferences for sons to limit their breastfeeding to get to their fertility target (Jayachandran & Kuziemko, 2011).

We connect existing gender norms and sex-biased vital outcomes using a "natural experiment" of a famine that hit ethnicities with different beliefs about women's values and induced a resource constraint, resulting in sex-biased resource allocation and, thus, mortality. The important contribution of our study is demonstrating the superior role of culture over economic factors in explaining the survival chances of girls. It therefore relates to the literature showing the persistence of gender norms even after dramatic changes in the economic environment (e.g., Grosjean & Khattar, 2019; Baranov et al., 2023; Galor et al., 2020).

Our work also contributes to the literature on the "missing girls" phenomenon within historical Europe, especially in Southern and Eastern regions, at least until the first decades of the 20th century (Beltrán Tapia and Gallego-Martínez 2017; Szoltysek et al. 2022; Beltrán Tapia and Malein 2022; Beltrán Tapia and Cappelli 2023). All these studies stress that the interaction between son preference and economic deprivation affected girls' survival chances (Beltrán Tapia and Szoltysek 2022)[6]. The most extreme case was probably Greece, where at least 5 percent of girls died from neglect right after birth or experienced differential treatment during infancy and childhood (Beltrán Tapia and Raftakis 2022). A body of literature documents similar effects, even among adults, in mortality and health outcomes (e.g., Klasen, 1998; Horrell, Meredith & Oxley, 2009; McNay, Humphries, and Klasen, 2005).

Finally, our study contributes to the literature tying resource shocks and gender-biased consequences. First, our results confirm a well-documented pattern that women generally have higher survival chances in harsh environmental conditions (e.g., Zarulli et al., 2018).[7] However, this general pattern masks a high heterogeneity evident in region-specific studies. For example, Aldashev and Guirkinger (2012) find that following an economic crisis that occurred between 1898 and 1908 due to the Russian army's entry into Kazakhstan, there was an observed increase in male-to-female population ratios. By contrast, during the great Finnish famine of the 1860s, the sex ratio did not increase (Pitkänen, 1893), pointing to underlying heterogeneities of sex ratio response to resource shocks. Bhalotra (2010) finds that infant mortality in India is strongly counter-cyclical – it is much higher during economic downturns – and the increased mortality comes entirely from girls. On the other hand, in Indonesia, a financial crisis did not lead to worse outcomes

[6] Son preference, in turn, was linked to the important roles assigned to males in agricultural and pastoral societies and the lack of female labor opportunities for females, as well as patrilocal arrangements, the dowry system, an adverse marriage market, and other social and cultural factors that further decreased the bargaining position of girls (Beltrán Tapia and Szoltysek 2022).

[7] We demonstrate that aggregated sex ratios at age 0-4 tend to be lower in the areas with higher mortality rates, not caused by famine.

for girls in health, education, or mortality (Levine and Ames, 2003). What can cause such differences across countries? Our paper shows that heterogeneities in cultural norms can mediate the effect of resource shocks on gender-biased investments, suggesting that these relationships should always be viewed in their specific contexts.

The rest of the paper is organized as follows. In section 2, we provide background information on the Russian Empire's demographic landscape and prevalent gender norms and discuss the causes of the 1891-92 Famine. Section 3 discusses data sources and the construction of the main variables. Section 4 formulates the testing hypothesis and describes our methodology. In section 5, we present our main results and robustness checks. Section 6 concludes.

2. Historical context

Although the Russian Empire was one of the largest producers of cereal in the world, famines occurred regularly throughout the 19th and the first half of the 20th centuries (Wheatcroft 1983; Livi-Bacci 1993; Adamets 2002, 158).[8] According to some historians, one of the major features separating 19th-century Russia from Western Europe was its inability to eliminate these catastrophes (Hoch, 1989, 55). Although all regions were equally subjected to the risk of famines up to 1870, these crises became increasingly more localized, especially in the Volga region, the northern Caucasus, southern Ukraine, and Kirghizia (Adamets 2002, 160). Contemporaries were well aware of the importance of this problem, as well as of rural poverty in general, and aimed various vital reforms at tackling these (such as the abolition of serfdom in 1861 or the agrarian reform of 1907).

The 1891-92 famine was the last large mortality crisis of the *ancien régime* in Russia (Adamets 2002, 163). According to various estimates, around half a million people died, making this episode equivalent to the 1846 Irish and 1877 Madras famines (Long 1988).[9] The famine especially hit the Volga basin, a region where different ethnic and religious

[8] Terrible famines occurred during the Civil War (1921-23), the collectivization period (1932-33), and 1946-47.

[9] It is important to stress that Famine mostly contributed to the population losses indirectly by weakening immune system and make it more vulnerable to infectious diseases such as typhus and cholera (Wheatcroft 1992; Henze, 2010).

groups lived together (Orthodox Russians and Ukrainians, Protestant and Catholic Germans, and various groups of Muslim populations – see Figure A1).

The extremely adverse climate conditions were the main trigger of this crisis. Soil scientist P. Zemyatchenskii provided a historical account of the detrimental role of climatic factors:

The dry autumn […], the snowless winter and, finally, the dry spring turned the top layer of […] earth partly into a dry dust, [and] partly into a fine-grained, crumbly, powder, which, with the onset of strong storms in April, lost their hold, and were raised up in whole clouds, concealing the sun's rays and turning day into night. Witnesses unanimously testified that the phenomenon had such a dreadful and frightening character that everyone expected 'the end of the world.'[10]

As a result, the crop failure in 1891 was the most significant calamity over a thirty-year span (Figure 1). Accordingly, it caused a significant negative income shock for peasantry: grain production and real wages of agricultural workers reached their two-decade trough (Figure 2).

The Russian government attempted to reduce the negative consequences of crop failure by providing food loans to the population in the affected areas. However, the results of this relief campaign were often delayed due to bureaucratic issues and limited access to transport infrastructure (Charnysh, 2022)[11]. Figure A2 shows that most government relief was distributed only in 1892, while the food shortage was already present in 1891. This suggests that the conditions of many households during 1891 were particularly vulnerable.

The famine hit an impoverished society with extremely low standards of living[12]. Infant and child mortality rates were extremely high, probably the highest in Europe, due

[10] Piotr Zemyatchenskii, 'Velikoanadol´skii uchastok', Trudy Ekspeditsii, snaryazhennoi Lesnym Departmentom, pod rukovodstvom professora Dokuchaeva, Nauchnii otdel, 1, 1894, 3, p. 15, cited in Johnson, E. M. (2015).

[11] Almost 12 million people were receiving assistance in the form of food and seed loans or employment on public works at the height of the relief effort in early 1892 (Charnysh 2022).

[12] In 1875, life expectancy was about 30 and 33 years for males and females, respectively (Adamets 2002, 162; Hoch 1998). Apart from cyclical fluctuations due to epidemics and poor harvests, average mortality rates did not in fact change much between 1867 and 1909 (Adamets 2002, 162). Although the view that living standards were stagnant in late Imperial Russia has been recently challenged (see, for instance, Mironov 2012, Markevich and Zhuravskaya 2018 or Natkhov and Vasilenok 2023), Russian peasants nonetheless lived at the verge of subsistence as infant mortality rates and the very famine itself testify (see also Dennison and Nafziger 2012). The decades before the famine, the Empire witnessed explosive population growth and a decline in the average peasant's land allotment (Engel 1994, 2; Moon 1999, 32).

to mass poverty and cultural factors (Ransel 1991). Broadly speaking, in the European part of the Russian Empire, only about half of the children survived to age five, but this average masks significant regional differences (Patterson 1995; Glavatskaya et al. 2017; Natkhov and Vasilenok, 2023)[13]. Religious and ethnic dimensions influenced childcare practices that, in turn, shaped infant and child mortality rates (Patterson 1995; Glavatskaya et al. 2017; Bonneuil and Fursa 2017). Orthodox Russians suffered by far the highest mortality rates, followed by Catholics, Protestants, and Muslims (with similar levels; Natkhov and Vasilenok 2023)[14]. Peasants' resignation and fatalism about the fate of their offspring were not only entangled with beliefs about how many mouths they could actually feed (Frieden 1978, 246) but could have also entailed undernutrition and neglect as additional factors increasing infant and child mortality, especially of less valued children. For instance, worsening economic circumstances increased excess female mortality in Kazakhstan at the turn of the 20th century, especially in poorer households (Aldashev and Guirkinger 2012).

It is therefore plausible to hypothesize that, under the harsh circumstances caused by a large famine, families treated their sons and daughters differently, especially considering the strong son preference that characterized Russian society at that time (Malein and Beltrán Tapia 2022). Strong patriarchal institutions subordinated women to their fathers and husbands (Evans Clement 1991, 5-7; Glickman 1991, 148-150)[15]. The system of apportioning land and strict patrilocal rules favored boys, so parents had incentives to treat their sons and daughters differently. Anecdotal evidence suggests this was the case (Semyonova 1973, 8-9; Ransel 1988, 130; Moon 1999, 182-184, 192; Avdeev et al. 2004, 726). Likewise, the evidence of infanticide, and especially of child abandonment, also suggests the presence of son preference.[16]

The 1891-92 famine was a tragic event that hit an impoverished and highly patriarchal society. In contexts marked by poverty, external shocks that intensify the competition for scarce resources can disproportionately impact those with less social value.

[13] Infant mortality Perm's province in 1896-97 was as high as 437 deaths per thousand live births (Bakharev and Glavatskaya 2019, 206).
[14] Jews enjoyed significantly lower mortality rates early in life (Natkhov and Vasilenok, 2023).
[15] A more detailed explanation of the Russian patriarchal system during this period can be found in Evans Clement (1991, 5-7), Glickman (1991, 148-150), Worobec (1991, 175-216) and Engel (1994, 8-25).
[16] See Malein and Beltrán Tapia 2022 for a longer discussion of these issues.

Therefore, if boys were preferred to girls and thus held a higher social value, girls would have experienced greater peril. The rest of the article explores whether this was the case by turning to the wealth of information provided by the 1897 Russian Empire Census and other data sources.

3. Data

3.1 Child sex ratios

We construct our primary outcome variable – the ratio between boys and girls - by leveraging the 1897 population Census. This was the first and only true population census designed to fully register the population and its socioeconomic and demographic characteristics (Rowney and Stockwell, 1978). Following contemporary international statistical practices, qualified enumerators visited every household in each village, wrote down the number of individuals living there, and classified a rich set of demographic characteristics: age (birth year) and gender, literacy, occupational status, and ethnic and religious denominations. The 1897 census was not likely to suffer from crisis-related underreporting since it was taken several years after the 1891-1892 Famine and was not plagued by any major famine, disease, or war in a relatively regular year. Crucially, the 1897 Census contains information about the size of the population by birth year and gender at the city and district (rural) level. Since the 1891 Famine affected rural areas, we use the latter to construct sex ratios. We keep only cohorts born after 1887 – children who either were in early childhood or infancy or were not born during the 1891 Famine event. It allows us to focus on the effects of Famine on the most vulnerable groups of the population entirely dependent on parents. Thus, we constructed a panel of the gender-specific cohorts born between 1887 and 1897 and calculated the ratio of boys to girls (sex ratios) for the cohorts born before and after the 1891 famine event. Therefore, those born before 1892 were exposed to the famine, while those born after were never exposed. Figure A3 shows a histogram of the distribution of sex ratios in the estimation sample.

One of the common concerns regarding census data is the presence of age heaping, which is well documented in the literature (see Charnysh 2022). Specifically, in our setting, the concern is that age heaping could depend on gender, e.g., census respondents could report their sons' ages more accurately than their daughters'. Potentially, it could create imbalances in the sex ratios and bias our results. Reassuringly, we find no correlation between the measure of age heaping (Myers index) and constructed sex ratios, which strengthens the validity of our data (Figure A4).[17]

3.2. The measure of female discrimination based on gender roles in Folklore.

The main challenge in studying the effects of gender discrimination practices is that such practices are hidden, and it is difficult to convert them into a quantitative measure. However, as Michalopoulos and Xue (2021) demonstrate, the differences in oral traditions (folklore) explain the variation in gender disparities across modern societies (e.g., countries, groups of migrants). More specifically, the authors explore the dataset of oral traditions of 958 societies across the globe, originally compiled by anthropologist and folklorist Yuri Berezkin, which reflects various topics, such as environmental events (e.g., volcano eruption), trust, fraudulent/risk-taking behavior, and, essential for this paper, gender roles. The study identified 1,073 gender-related motifs within these oral traditions. Among these, 30% depict women as submissive and dependent, while only 12% describe men in such terms. The authors found that countries and ethnic groups with a higher prevalence of motifs favoring men have lower female labor force participation rates today. The results by Michalopoulos and Xue (2021) demonstrate that folklore data reflect deep-rooted gender attitudes that originated from the historical past and persisted over time. These data are naturally compelling to us, as they are free from many confounding factors associated with analyzing facets of ethnic or religious groups recorded contemporaneously with the studied event. These gender norms had existed for centuries and were likely brought about by events far removed from the causes or consequences of the 1891 famine.

We use these data in the following way: first, we link each ethnic group from Michalopoulos and Xue's (2021) sample to the corresponding group in the 1897 Census. Next, within each ethnic group g's set of motifs, we calculate the proportion of the motifs containing the image of women as submissive and stupid relative to men:

[17] Beltrán Tapia and Malein (2022) provides a comprehension discussion of the 1897 census data and further validity checks for constructed sex ratios.

$$Share\ motifs_g = \frac{\#\ female\ submissive\ motifs\ _g - \#male\ submissive\ motifs_g}{\#\ total\ motifs_g}$$

We take the difference between the female and male motifs to account for such instances where certain groups may have had a multitude of motifs related to submissiveness/stupidity of both men and women. Counting only female or male motifs may have overestimated gender-specific negative bias.

We then aggregate these group-specific measures at the district level using the group's population shares as weights to obtain a population-weighted average of our bias measure:

$$Female\ negative\ bias\ _i = \sum_{g=1}^{G} Share\ motifs_g \times Share\ pop_{gi}$$

Figure A5 shows the spatial distribution of our female negative bias measure. Variation was relatively large in the Volga region, enabling us to conduct meaningful statistical analysis using this variable.

To validate our measure of gender stereotypes based on folklore, we turn to the results by demographers showing that a low female age at marriage is one of the components of the patriarchal index. It consistently predicts higher sex ratios in historical Europe and western Siberia (see Szołtysek et al., 2017). Accordingly, we assume that a lower marriage age among women would indicate a lower female bargaining position and their disadvantageous status in society.

We derive information about the age and marital status of women from the 1897 Census.[18] We first compute the average marriage age of women over different age groups at the district level. Then, we regress marriage age on the folklore-based measure of the female bias and district-level characteristics (e.g., average precipitation, temperature, exogenous soil productivity, and province dummies). Figure 3 demonstrates a negative correlation between the two measures.

[18] We collected data on age and marriage status only for a subsample of the provinces affected by the famine.

Furthermore, we reveal a negative correlation between the folklore-based measure of gender bias and female labor force participation and women's employment share in high-skill occupations (Figure 3). Taking together, these results indicate that women in the areas with higher gender bias had lower agency over their marriage and limited opportunities in the labor market. Collectively, our findings demonstrate that folklore-based measure of gender discrimination indeed reflects the disadvantaged economic and social status of women in society.

3.3. The geography of the famine

This article aims to assess how the 1891-92 famine shaped the survival chances of boys and girls. As explained above, the famine mainly affected the Volga basin, a highly diverse region where different ethnic and religious groups lived together. Although these most severely affected provinces were hit first, the famine progressed further and affected the provinces in the northern and central regions. The central government supplied food relief in the affected areas. Figure 4 shows the actual shares of the population receiving food support in 1891. Hence, our food relief measure allows us to measure the intensive margin of the exposure to the famine. We validate this measure by showing its high correlation with the 1891 harvest productivity (Figure A7)[19].

One of the concerns regarding this measure of famine intensity is that food provision in the affected districts can be correlated with various factors (e.g., the prevalence of particular gender norms), which can bias the results of our analysis.[20] To mitigate this concern, we first demonstrate that our measure of gender bias is orthogonal to the provision of food support (Figure A8). Additionally, we construct an alternative measure that exploits districts' exposure to climate shock – adverse climate conditions that triggered the 1891 famine. We use historical climate data to explain variation in the distribution of food relief by climate shocks observed during the winter, spring, and summer seasons of 1891. To construct the measure, we compute the average temperature and precipitation for each

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[19] To compute a measure of harvest we take an average of rye, summer wheat, winter wheat and potato yields weighted by the crop's sown area. The yield = total harvest – seeds / total sq. sown land.

[20] For example, Charnysh (2022) shows correlation between the relative amount of food supply and the district's share of non-orthodox population.

month and climate station using daily observations from 1892-1901 as a reference period[21]. Then, we take monthly averages of temperature and precipitation in 1891 and compute the climate shocks as follows:

$$z_{im,1891} = \frac{x_{im,1891} - \underline{x_{im}}}{\sigma_{im}}$$

Given that index i denotes a climate station, and m stands for a month, $\underline{x_{im}}$ is an average of precipitation/temperature observed in the month m between 1892 and 1901 at climate station i. σ_{im} is a standard deviation of monthly temperature/precipitation observed in 1892-1901. As we observe 1891 climate shocks at the climate station level, we create a spatial grid covering the Russian Empire's territory. Then, for each empty grid cell (unobserved climate data), we compute values using the *Inverse-Probability-Weighting* (IPW) method and aggregate grid values to the district level. We utilize information about 14 climate shocks that affected the harvesting period in 1891 (between January and July of 1891) alongside exogenous soil productivity[22] to predict the proportion of the district's population receiving food relief from the government. Then, we use predicted values to measure famine intensity in our subsequent analysis.

Table A2 shows the estimated coefficients. Our estimates are consistent with a general narrative provided by historians emphasizing the detrimental impact of the dry early spring that left grain seeds unprotected from frost, followed by a hot summer. This is consistent with Figure A9 showing that unusually high temperatures in July 1891 hit Low Volga and Southern Provinces in the European part of Russia.

By construction, the predicted measure reflects only the differences in climate conditions in 1891 and cannot be biased due to the government's preferences and local economic conditions. In Section 5, we provide the results based on both actual and predicted measures of food provision.

[21] Our data includes historical daily temperature and precipitation observation from 52 climate stations in the European part of the Russian Empire. We obtain the data from National Oceanic and Atmospheric Administration (NOAA) https://www.ncdc.noaa.gov/cdo-web/

[22] We apply the Caloric Suitability Index constructed by Galor & Özak, 2016.

3.4. Additional variables

We draw data on births and infant mortality from the Vital Statistics volumes collected by the Ministry of Internal Affairs. The vital statistics in the Russian Empire in the second half of the 19th and the beginning of the 20th century were primarily based on metric books by clergymen. In 1865, the government introduced the procedure of reporting data to the state authorities, who then aggregated data at the district level and sent it to the Central Statistical Committee (CSC). The Central Statistical Committee reported data in tabular format in annual statistical volumes "Dvizhenie Naselenija" (Population Movement). Novosel'skij (1916) reports that statisticians followed a universal and reliable data collection program. The data prepared by CSC demonstrated consistency with alternative sources, such as the State Medical Department's mortality indicators, that signal the data's suitability for statistical analysis (Rashin, 1956). We leverage this data to construct infant mortality rates and birth ratios that we include as control variables in our causal analysis.[23]

Additionally, we augment our dataset with exogenous variables that can affect the formation of gender norms and intensity of the 1891 Famine: soil productivity, temperature, precipitation, ruggedness, distances from the district's centroid to a navigable river, coastline, and capitals (Moscow and Saint-Petersburg)[24]. Table A1 provides summary statistics of the main variables.

4. Methodology

4.1. Hypotheses

Absent gender-specific preferences, the biological disadvantage of boys, which other studies demonstrate (e.g., Zarulli 2018) and we also observe in our data (see Figure A10), should theoretically be aggravated by the extreme living conditions during the famine. Then, exposure to famine should result in relatively *lower* sex ratios among the surviving

[23] The important caveat is that administrative mortality records report combined data for both rural areas and cities located in these districts (the separate data is only available for large cities). Since the Famine was predominantly a rural phenomenon, the measures based on administrative data are less accurate. Still, it reflects useful information we utilize in our regression analysis as control variables.

[24] As a measure of exogenous soil productivity, we use the Caloric Suitability Index (Galor and Özak, 2016). GAEZ provides climate data, and the computation of the distances is based on the Russian Empire shape file supplied by Kessler, Gijs, 2017, "Maps," https://hdl.handle.net/10622/DN9QDM, IISH Data Collection, V2. Ruggedness data is provided by D. Puga https://diegopuga.org/data/rugged/

cohorts born before 1892 and thus affected by the famine. These children would have been between the ages of 0-4 when the famine hit in 1891. However, if families somewhat prioritized boys, the results could be different. If cultural norms favouring boys matter, the joint impact of famine intensity and gender bias should offset the female biological advantage. Thus, our main testing hypothesis is that in the presence of cultural bias against women, the famine effect results in relatively *higher* sex ratios among exposed cohorts.

4.2 Empirical Strategy

We investigate the joint effect of gender bias and exposure to the 1891 Famine on the survival chances of girls relative to boys by leveraging district-level variation in exposure to the 1891 famine and prevalence of the cultural norms against women with cohort-level variation in the birth year (before and after the 1891 famine). Equations 1.1 and 1.2 formalize our difference-in-differences approach. Equation 1.1 tests the general impact of famine intensity on the survival chances of girls, whereas the equation 1.2 tests the heterogeneity of the famine effect on sex ratios depending on the prevalence of the gender bias:

$$Sex\ ratio_{it} = \gamma_i + \mu_t + \beta_1 1(Year < 1892)_t \times Famine_{i,1891} + \delta X_{it} + \varepsilon_{it} \quad \textbf{(1.1)}$$

$$Sex\ ratio_{it} = \gamma_i + \mu_t + \beta_1 1(Year < 1892)_t \times Famine_{i,1891} + \beta_2 1(Year < 1892)_t \times Famine_{i,1891} \times Bias_i + \delta X_{it} + \varepsilon_{it} \quad \textbf{(1.2)}$$

$Sex\ ratio_{it}$ represents the cohort-specific ratio of boys relative to girls. This measure reflects the relative survival chances of girls. $1(Year < 1892)_t$ denotes a binary indicator that is equal to one for the cohorts born between 1887-1891 – before or during the famine; and equal to zero for the cohorts born between 1893-1897[25]. The 1892 cohort is excluded

[25] To analyze the sex ratios, we limit our sample to European provinces and exclude the Caucasus region. We do it for three main reasons. Firstly, we want to make the sample consist of administrative mortality data available only for European provinces. Secondly, the sex ratios in Caucasus provinces seem to be highly distorted (in some cases, we observe values above 1.5-2), and we need to investigate these cases further. Thirdly, the Caucasus region differed from the European part in many dimensions and can be considered an outlier. It is worth noting that the Caucasus region was outside the 1891 famine area.

in our main estimation because the supplied food relief mainly reached the target population in 1892 – the year following the harvest failure (see Figure A2). Hence, the harsh resource constraints created by harvest failure were partially alleviated by 1892. The cholera epidemic also struck in 1892, exposing the population to both famine and cholera shocks[26]. $Famine_{i,1891}$ measures the proportion of the district's population that received food support from the central government during the relief campaign in 1891-1892. γ_i and μ_t capture all time-invariant district-level characteristics as well as the factors associated with particular cohorts.

Vector X_{it} includes additional controls derived from administrative mortality and birth records. Firstly, we include the ratio between boys and girls at birth to account for the effect of nutritional stress on the probability of giving birth to a son or daughter (Myers, 1978). Secondly, we account for the mortality factor. It is worth stressing that the mortality rate is a crucial predictor of sex ratios (see Figure A10). Even though we account for average differences in mortality across districts by including district fixed effects there is a possibility that areas with generally low or high mortality environments differentially respond to crises such as famine.[27] Moreover, we observe a considerable correlation between non-Orthodox population groups and mortality rates (see Figure A11). Since our measure of cultural bias against women reflects variation in the population shares of ethnic groups, it is crucial to account for differences in mortality in our regression analysis[28]. Accordingly, we augment our regression specification by including the size of the cohort (normalized to the district's average size of cohorts in 1887-1897) and the interaction of famine intensity ($1(Year < 1892)_t \times Famine_{i,1891}$) with the average rate of infant mortality observed in 1887-1897 (excluding famine years). Additionally, we include interactions of other characteristics (see Figure 5) with the famine intensity. Together these controls capture whether areas with various observables (e.g., geographical location, climate) responded differently to famine shock. The more restrictive version of equation (1)

[26] Our results nonetheless do not change when we include 1892.
[27] We provide a detailed discussion of this issue in section 5.6.
[28] There is a high correlation between religious and ethnic minorities.

also includes the interaction of province indicators with cohort dummies, allowing us to account for all province-specific factors varying across cohorts.[29]

The sign and significance of the coefficient β_1 in equation 1.1 reflects the two opposite effects discussed above: biological factors ("—") and gender bias ("+"). If positive, it would indicate the stronger impact of gender bias. The coefficient β_2 reflects the joint importance of gender cultural norms and resource constraints created by famine for the relative survival chances of girls. Positive and significant β_2 would support our testing hypothesis.

5. Results

5.1. 1891-1892 Famine and population losses

First, we apply a simple cross-section regression approach and show that the 1891-1892 Famine produced a significant death toll on the population (see Figure 6).[30] Moving from the 5th to the 95th percentile of the famine intensity increases the infant mortality rate in 1891 by 3.8 deaths per 100 births, corresponding to an 18 % increase relative to the sample mean of 21.13. These estimates confirm that the 1891 famine was probably the most adverse demographic shock in the late 19th-century Russian Empire. Population losses resulting from the 1891 Famine are also evident in population data from the 1897 Census. The relative size of the cohorts born before 1892 in the affected districts is significantly lower than those in the non-famine districts. In particular, our estimation shows that the cohorts in the districts with high famine intensity (95^{th}) were 8-10.2 % smaller, a result consistent with the infant mortality data and with the dramatic effect of this demographic shock. (Table 1).

5.2. Gender bias and survival chances of girls

Regression analysis based on equation 1.1 provides results consistent with the proposed hypothesis. It is important to emphasize that in the case of neutral gender norms, exposure

[29] Provinces formed the first unit of administrative division in the Russian Empire. District ("uezd") and county ("volost") constituted second and third units. The 1897 Census data is available mostly at district level.
[30] See also spatial variation in 1891 infant mortality rates on Figure A8.

to famine shock should theoretically produce a negative impact on sex ratios. However, one can observe that the coefficient β_1 on famine intensity is positive and significant (Table 2, column 1). It means that the survival advantages of girls in the areas hit by the famine were offset by other factors.

We then estimate the equation 1.2 with an additional interaction term $1(Year < 1892)_t \times Famine_{i,1891} \times Bias_i$. The coefficient β_2 appears with a positive sign although not statistically significant (Table 2, column 2). However, the addition of province-by-cohort fixed effects and then additional controls interacted with the bias measure improves the magnitude and significance of the coefficient β_2 (Table 2, column 3-6). In section 5.6, we discuss which additional controls affect the precision and magnitude of the coefficient β_2. It is also worth mentioning that both cohort-varying controls – sex ratio at birth and cohort size have significant coefficients with expected signs.

Our results indicate that the combination of famine shock and cultural bias against women accounted for the decreased survival chances of girls. Quantitatively, our estimates imply that moving from 5 % to 95 % of famine intensity with an average value of bias against women would decrease the relative survival chances of girls born before 1892 by approximately 8 % compared to the cohorts born after the famine [1.631*0.63*0.078].

Given the sample average sex ratio [0.985] and the corresponding size of the cohorts of boys and girls [2262 and 2290], the obtained estimate translates to the decrease in the number of girls per average cohort by 166 [2262 / (0.985+0.08) – 2290].

Further, we estimate a flexible regression specification by interacting the measure of gender bias with cohort indicators and limiting the sample to the districts with high famine intensity (> 75th percentile).

$$Sex\ ratio_{it} = \gamma_i + \mu_t + \sum_{t=1887;t\neq 1893}^{1887} \beta_t Year_t \times Bias_i + \delta X_{it} + \varepsilon_{it} \mid Famine_{i,1891} > 75^{th} \quad \mathbf{(2)}$$

The estimation results correspond to the estimates reported in Table 2. As Figure 7 shows, the cohorts born before 1892 have consistently higher sex ratios in the famine districts with higher gender bias.

5.3. Accounting for the economic value of female labor

To test whether the effect of cultural norms is arising from economic factors affecting the relative value of girls, we extend our analysis by including interactions of famine exposure with measures reflecting the economic value of female labor and general economic development: share of women in high-skilled occupations, female labor force participation rate, share of industrial workers in the labor force and urbanization rate. Additionally, we account for the differences in agricultural specialization (crop farming vs. cattle breeding) by including the interaction of famine intensity with a proportion of workers employed in cattle breeding in the regression. Crop farming, in the Russian Empire was associated with intensive female labor, unlike cattle breeding. The purpose of this exercise is to test whether adding the proxies for the value of female labor can explain away the effect associated with gender bias.

As Table 3 demonstrates, the measures reflecting women's economic status appear with expected signs (female labor force participation). However, their inclusion does not alter the magnitude and significance of the gender bias coefficient. It stresses the importance of cultural factors in driving gender-discriminatory practices under harsh conditions.

5.3. Accounting for religion and different groups of motifs

In Table 4, we test whether the joint importance of famine and gender bias on sex ratios holds after accounting for religious factors. We augment our regression specification by adding interactions between famine intensity and district-level population shares of the main religious groups (Muslims, Protestants, Catholics, Jews, and Old Believers). Interestingly, one can observe that adding religious groups does not alter the sign and significance of the coefficient on gender bias. The coefficients on religious groups remain significant after including the measure of gender bias (except Muslims), indicating that religion played an important role in explaining the survival chances of girls independently of cultural norms expressed in folklore.

5.5. Robustness and additional results

Proceeding further, we test the robustness of our findings when switching from actual famine intensity to the predicted one based on climate data (see Section 3). It allows us to account for potential biases in our estimates if the food relief in the areas affected by famine was driven by unobservable factors other than crop failure and food shortage. Our estimation results, presented in Table 5, demonstrate that switching to the predicted measure of famine intensity reveals the same pattern – the cohort sex ratios increase with a joint increase of predicted famine intensity and gender bias.

One of the potential concerns regarding the interpretation of our findings is the spread of infectious diseases that could trigger differential mortality rates among boys and girls in the areas hit by famine. It is a documented fact that the areas affected by the 1891 famine were also hit by cholera in the subsequent year (see Figure 8), although the cholera outbreak was wider in geographic scope. To test the significance of exposure to infectious disease, we collect data on registered cholera cases in each year between 1887 and 1895.[31] One can see the large spike in the number of cholera cases in 1892 (Figure A12) that was primarily caused by the pandemic originated in Asia and then brought to the southern provinces of the Russian Empire via trade routes and then to the areas on the North through the Volga river (Henze, 2010). Leveraging this data, we construct the measure of exposure to cholera, which varies by cohort and district. Then, we augment regression equation (1) by including an additional interaction term: $1(Year < 1892)_t \times Cholera_{it} \times Bias_i$.

$$Y_{it} = \gamma_i + \mu_t + \beta_1 1(Year < 1892)_t \times Famine_{i,1891} + \beta_2 1(Year < 1892)_t \times Famine_{i,1891} \times Bias_i + \beta_3 1(Year < 1892)_t \times Cholera_{it} \times Bias_i + \delta X_{it} + \varepsilon_{it} \quad \textbf{(3)}$$

It allows us to disentangle the effect of the drastic resource shock created by famine from the effects of the spread of infectious diseases. The results of our analysis presented in Table 6 indicate that the joint effect of famine and gender bias is not affected by accounting for the spread of cholera. We interpret this in favor of the proposed hypothesis. Since parents have limited or no agency over the impact of highly contagious diseases (cholera), gender bias should not influence the relative survival chances of girls.[32]

[31] Unfortunately, the information on the spread of cholera is not available in 1896 and 1897. We impute missing values using observations from 1895.
[32] This is a plausible assumption given that most of the rural population was poor with general lack of knowledge of hygiene and limited access to healthcare facilities.

We provide several additional exercises to test: 1) the sensitivity of the results to the alternative computation of the standard errors (columns 2-4 in Table A3); 2) sensitivity to outliers (columns 5-8 in Table A3 and Figure A13); 3) an alternative definition of the outcome when we apply the percentage of boys in cohort instead of sex ratios (Table A4) and 4) sensitivity to the addition of other groups of motifs (Table A5). Additionally, we compare our baseline estimates (column 4 in Table 2) with the estimates obtained after reshuffling the distribution of gender motifs across ethnic groups (permutation test, Figure A14).

Overall, our results are robust to all sensitivity checks.

5.6. Causal interpretation of the empirical findings

In this section, we discuss the conditions under which our empirical findings can be interpreted as causal.

First, the causal interpretation of our findings requires that the famine intensity is properly measured. This assumption would be violated if the government applied a discriminative approach, providing fewer or lower food loans to ethnic/religious minorities. In that case we would underestimate the true intensity of famine and introduce a downward bias in our estimates. We mitigate this concern by applying the predicted measure of famine intensity as explained above. Further, we do not observe a significant empirical link between major groups of non-Orthodox minorities and the provision of food relief (Figure A15). Thus, we are confident that our findings are not biased due to improperly measured famine intensity.

Secondly, our regression model should be correctly specified and include all covariates of gender bias that have significant effects on sex ratios when interacted with famine intensity. Specifically, ethnic groups can be associated with differences in gender norms and general mortality rates that both affect the relative survival chances of girls. For example, it is well documented in the literature that Muslim minorities practiced breast-feeding for a longer period, which negatively affected mortality and hence pushed sex ratios upward. (Natkhov and Vasilenok, 2023). Demographers also indicated that the lack of day-care, especially during harvests, contributed to infant and child mortality in the 19th century Imperial Russia (Tezjakov, 1904). Hence, specialization in less female-labor-intensive activities (e.g., cattle breeding), observed among specific ethnic groups, could increase the amount of time available for day-care and thus indirectly affect mortality and sex ratios.

Therefore, the main threat to our identification strategy is that omitted covariates associated with high mortality could produce stronger or weaker effects during the famine. Without accounting for these interactive effects our estimate of the gender bias effect can be biased and lack precision. This is a valid concern given that the infant mortality rate is indeed positively correlated with gender bias (Figure 5).

We illustrate the importance of the mortality factor by testing the significance of the coefficient on the interaction term $1(Year < 1892)_t \times Famine_{i,1891} \times Infant\ Mortality\ Rate_i$, where $Infant\ Mortality\ Rate_i$ represents an average infant mortality rate at the district level excluding 1891-1892 Famine years. As Table A6 demonstrates, the coefficient on the interaction term is negative and statistically significant. It indicates that the survival chances of boys in the areas with generally high mortality were aggravated further by the famine conditions.

Then, Figure A16 illustrates the importance of accounting for the mortality factor when estimating the effect of gender bias on sex ratios. The magnitude of the coefficient on $1(Year < 1892)_t \times Famine_{i,1891} \times Bias_i$ increases and the precision improves significantly when we control for mortality (Augmented vs Base model). However, adding other controls in the model produces only a small impact on the coefficient of interest (Full model). Therefore, it is unlikely that the interaction of potential omitted covariates with famine intensity could produce sizeable changes in the coefficient of interest.

Finally, famine intensity could trigger migration from the affected to non-affected regions after 1892. Since we observe sex ratios in 1897, it could introduce measurement error and bias our estimation results. To address this concern, we argue that the likelihood of permanent migration among children and other dependent family members was lower compared to male adults due to institutional constraints in Imperial Russia (tax and redemption payments for the members of land communes, and necessary permission from local authorities). In addition, we show empirically that famine intensity does not significantly increase the likelihood of migration measured by the share of local-born residents in the district population (Figure A17).

6. Concluding remarks

Adverse economic shocks place families under severe resource constraints. The need to ration the scant available resources can, in turn, exacerbate existing gender inequalities, especially in contexts where the perceived relative value of raising boys and girls is different. Studying the 1891-1892 Russian famine, one of the most devastating catastrophes in Russian history, this article sheds light on how culture shapes the allocation of resources and care within families under harsh economic circumstances. Leveraging the relative importance in which women are depicted as submissive or stupid in the oral traditions of different ethnic groups, our identification strategy relies on a difference-in-differences estimation that compares the cohorts born before and after the famine in the areas with different intensity of famine. Our results show that girls suffered higher mortality rates than boys in areas hit by the famine where cultural norms penalised women. Facing severe scarcity, families prioritised boys, which negatively affected girls' survival chances.

In order to avoid potential endogeneity in measuring the intensity of the famine using the provision of food relief, we construct an exogenous measure that links the intensity of the famine to the deviation in rainfall and temperature levels experienced during the shock. Likewise, the cholera outbreak that hit the Russian Empire after the pandemic provides a placebo test since parents had limited influence over who survived contagious diseases. In contrast to their role in allocating resources under the severe scarcity characterised by the famine, the gender-bias measure employed here shows no effect on the sex-specific mortality outcomes arising from the cholera epidemic.

As well as robust to different specifications, our exercise rules out that other mechanisms are driving the results and, therefore, stresses the crucial importance of cultural dimensions in driving gender discrimination. In this regard, although girls enjoyed better survival chances in areas where female labour participation was higher, including this dimension in the empirical exercise does not affect the cultural channel. Moreover, the cultural mechanism stressed here, namely the belief in women's submissiveness and stupidity, remains significant after accounting for religious factors. Even though our estimates demonstrate the importance of religion, the cultural channel is mainly independent of it.

The main limitation of our approach is that we do not have enough information to identify whether female excess mortality is driven by outright neglect (i.e., female infanticide) and/or by prioritising boys when allocating the scarce resources that are needed for survival in such an extreme crisis. In addition, our main explanatory variable measures the gender bias according to how women are depicted in the oral tradition of different ethnicities. However, we do not observe sex ratios at the ethnicity-district levels, so we rely on a population-weighted measure of the relative importance of each ethnicity in the districts' population. Further research based on more detailed census or administrative data can overcome this limitation. Even though our findings refer to a specific historical period and country – late 19th century Imperial Russia – we believe they can provide potentially generalizable insights into the "missing girls" phenomenon observed in other countries with a predominantly agrarian economy and strong patriarchal norms.

We envision several directions for further research. Firstly, since *the Folklore* dataset represents 958 groups worldwide, it offers a possibility to directly apply the methodological approach of this paper in other historical and contemporary settings. It creates a promising research avenue that can significantly improve our understanding of the impact of cultural norms on the survival chances of women, particularly during environmental catastrophes. Secondly, it is worth studying the devastating effects of exposure to famine on survivors. One of the potential research questions to explore is whether the government's inability to adequately respond to adverse agricultural shocks (such as the 1891-1892 Russian Famine) undermined existing social and political order and led to its radical changes. Finally, further research is needed to explore the relationship between gender norms and sex ratios in dynamics. It is worth exploring other famines, such as the Russian famine of 1921–1922 and Holodomor (1932-1933). It can bring evidence on whether the transformative effects of the 1917 Russian Revolution on cultural and social spheres changed the survival strategies of families compared to the 1891-1892 famine.

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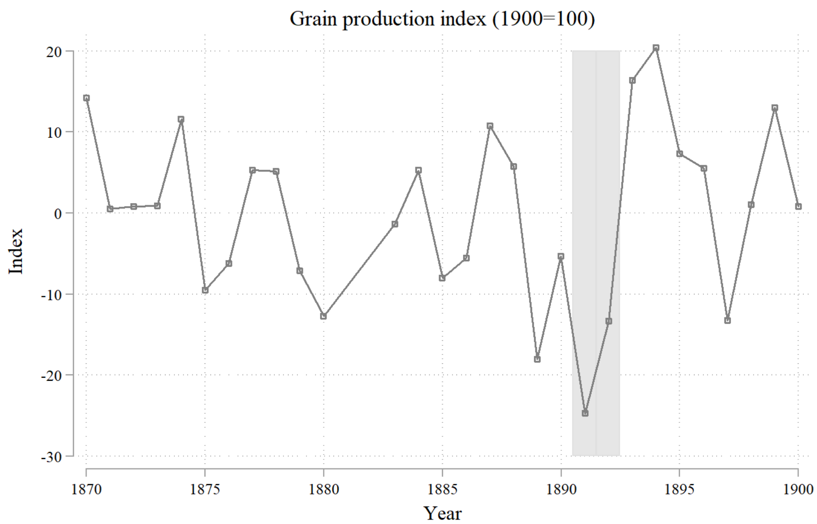
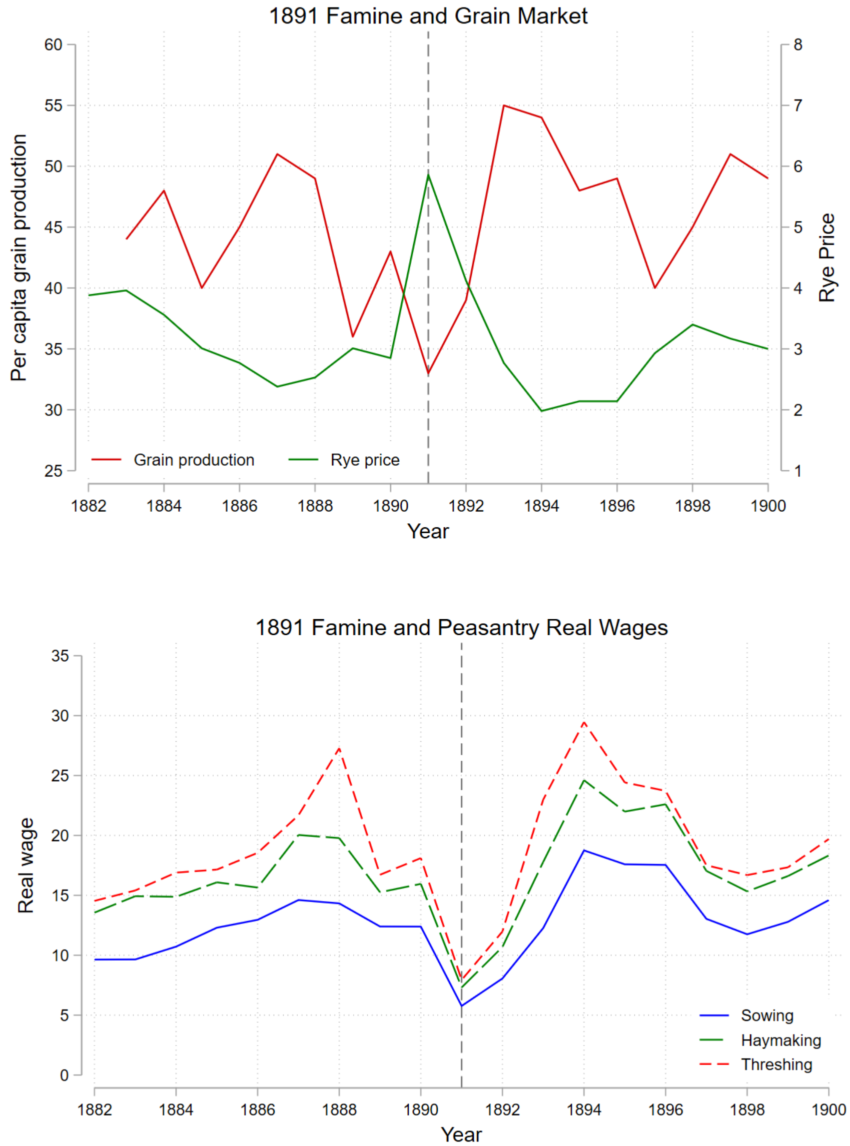
Figures and Tables

Figure 1. Russian Empire grain production index (de-trended) in 1870-1900



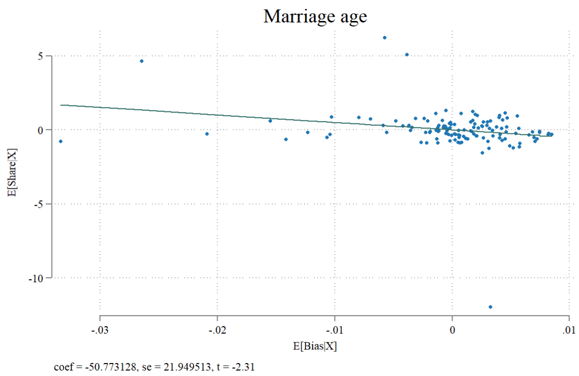
Source: Raymond W. Goldsmith, “The Economic Growth of Tsarist Russia 1860 1913," Economic Development and Cultural Change, 9 (April 1961): 446.

Figure 2. Relationship between exposure to 1891 famine, Agricultural Prices and Income

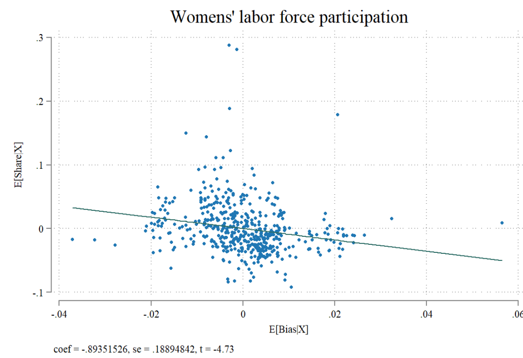


Note – This figure shows the evolution of grain production and real wages of agricultural workers (by job category) between 1882 and 1900. Vertical dashed line represents 1891 Famine. Data source: V.M. Obukhov "Dvizhenie urozhaev v evrop. Rossii v period 1883-1915 gg." and S.G. Strumilin "Dinamika posennoi platy za 1883-1916 gg." The data is reported by Wheatcroft in Edmondson, L., & Waldron, P. (Eds.). (1992).

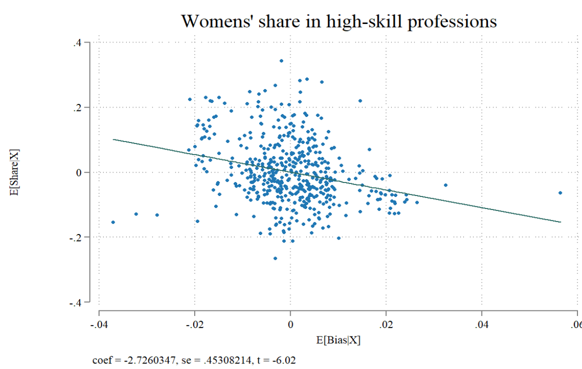
Figure 3. Gender bias and woman's age at marriage, labor force participation and employment in high-skilled occupations



(a)



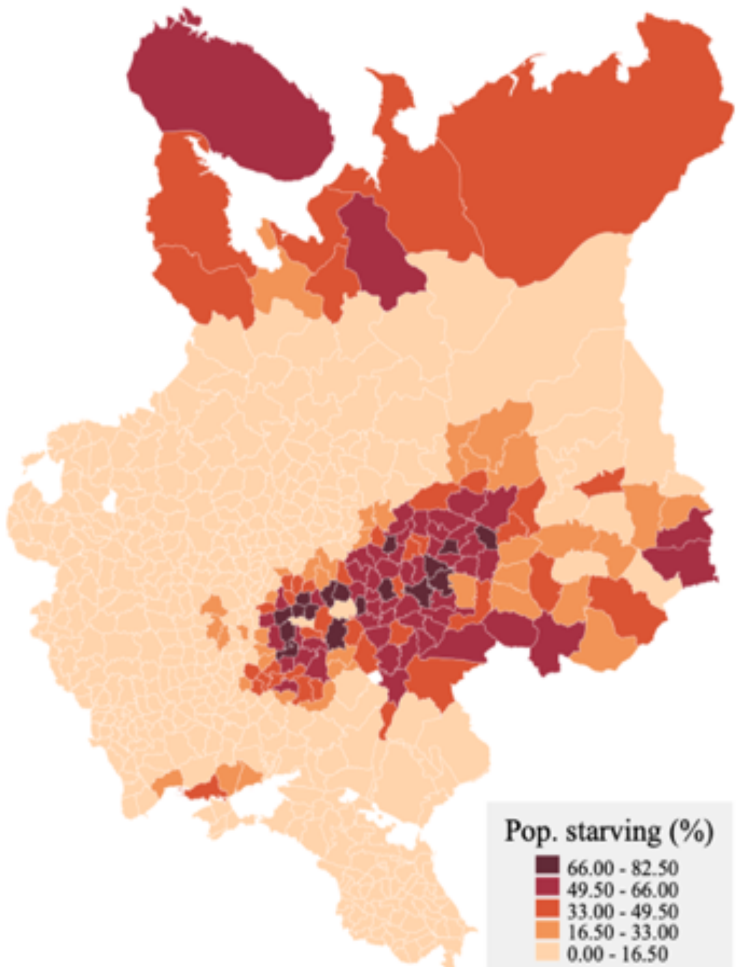
(b)



(c)

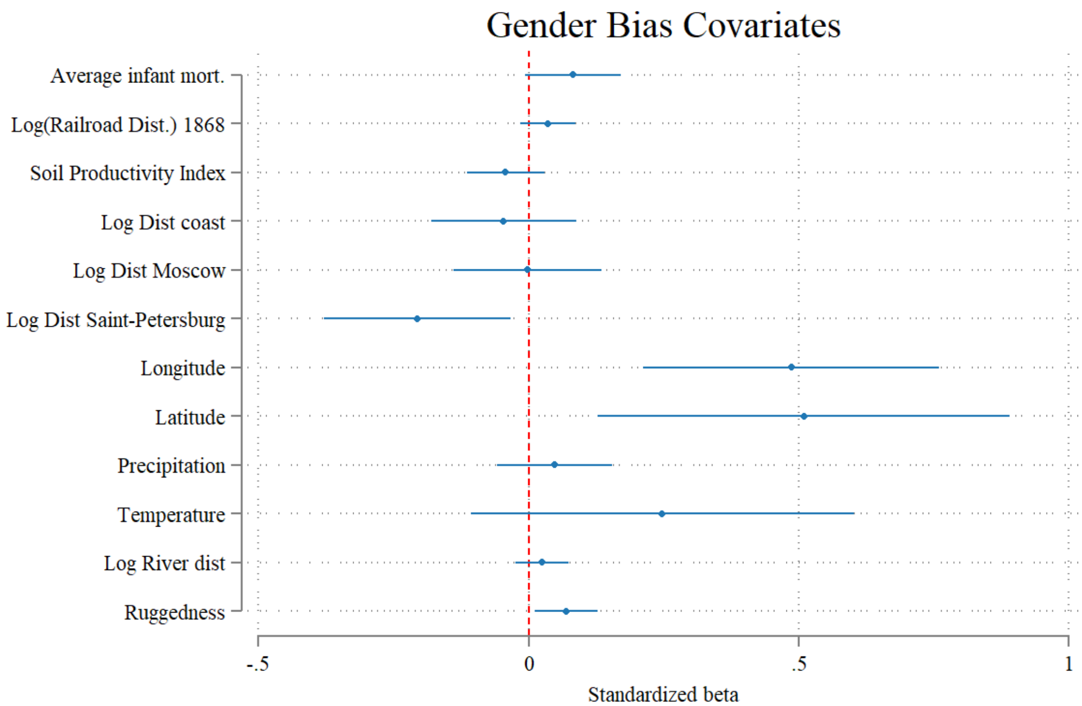
Note – This figure shows residual scatter plots after regressing indicators of women's socio-economic status on the measure of gender bias: (a) average female age at marriage (our current sample includes only 128 observations in the provinces affected by famine); (b) female labor force participation; (c) female employment rate in high-skill professions (scientists, doctors, teachers, law, and public administration). Other controls include literacy rate, latitude, longitude, exogenous soil productivity, average temperature and precipitation (GAEZ), ruggedness, distances to the railroad, to the nearest navigable river, coastline and capitals (Moscow and Saint Petersburg), and province dummies.

Figure 4. The geographic impact of the 1891-92 famine.



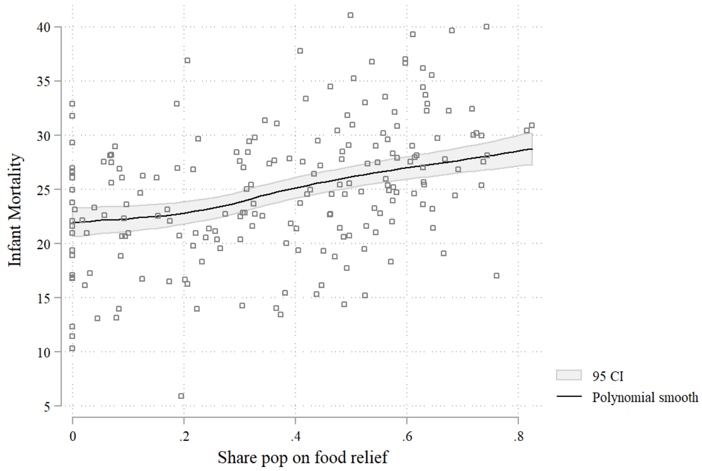
Note – This figure shows the spatial distribution of the share of the district population receiving food relief at the district ("uezd") level (European part of the Russian Empire).

Figure 5. Female negative bias district-level covariates

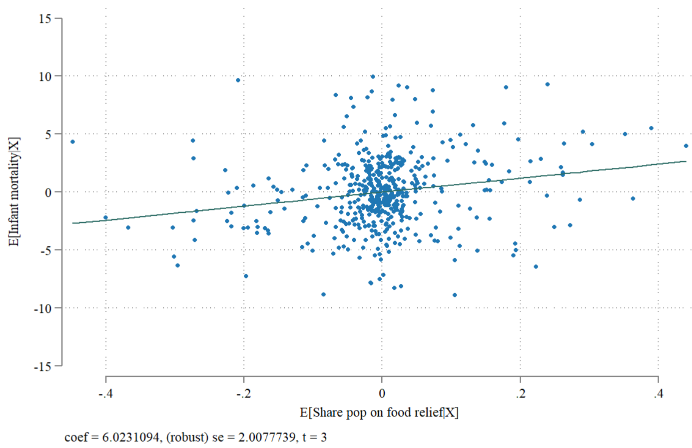


Note – This figure plots standardized coefficients after regressing the folklore-based gender bias measure on the set of district-level controls: average infant mortality rate (excluding famine years), latitude, longitude, exogenous soil productivity, average temperature and precipitation (GAEZ), ruggedness, distances to the railroad, to the nearest navigable river, coastline and capitals (Moscow and Saint Petersburg), and province dummies.

Figure 6. 1891 Famine and infant mortality



(a)



(b)

Note – This figure shows (a) unconditional and (b) conditional relationship between famine intensity and the 1891 infant mortality rate. A residual scatterplot is obtained after regressing 1891 infant mortality on famine intensity – a share of the district's population on food relief. Other controls include latitude, longitude, exogenous soil productivity, average temperature and precipitation (GAEZ), ruggedness, distances to the railroad, to the nearest navigable river, coastline and capitals (Moscow and Saint Petersburg), literacy rate and province dummies.

Table 1. 1891 Famine effect on the cohort size

	(1)	(2)
	Dep variable: Cohort size	
Famine intensity × Year < 1892	-0.146***	
	(0.036)	
Famine intensity predicted × Year < 1892		-0.188***
		(0.045)
Outcome mean / s.d	1.005 / 0.261	1.005 / 0.261
Famine intensity mean / s.d	0.145 / 0.232	0.145 / 0.232
Observations	5,006	5,006
R-squared	0.716	0.720

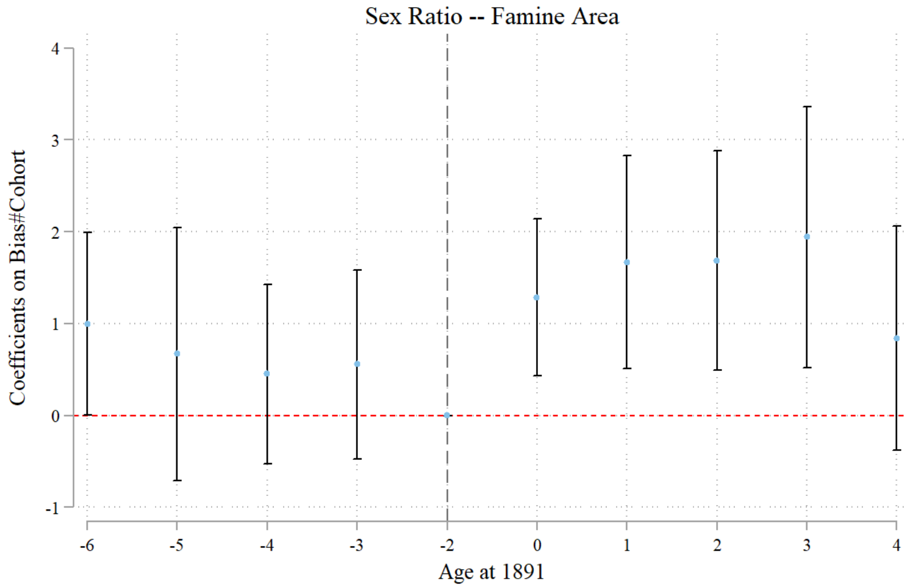
Note – This table shows the effect of the 1891-92 Famine on the size of the cohort (normalized by the average size of the cohorts born in 1887-1897). We apply a simple difference-in-difference approach by regressing cohort size on the treatment indicator (equals one for the cohorts born before 1892) and famine intensity measure alongside cohort and district fixed effects: $Cohort\ size_{it} = \gamma_i + \mu_t + \beta 1(Year < 1892)_t \times Famine_{i,1891} + \varepsilon_{it}$. *** p<0.01, ** p<0.05, * p<0.1

Table 2. Effect of famine and gender bias on sex ratios

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: M / F Ratio					
Famine intensity × Year < 1892	0.017**	-0.008	-0.069	1.763	1.317	1.284
	(0.007)	(0.059)	(0.062)	(1.069)	(1.841)	(1.882)
Bias × Famine × Year < 1892		0.318	1.020	1.631***	1.955***	1.842**
		(0.747)	(0.756)	(0.576)	(0.678)	(0.664)
Sex ratio at birth	0.101***	0.100***	0.116***	0.096***	0.113***	0.182**
	(0.031)	(0.031)	(0.033)	(0.031)	(0.033)	(0.070)
Cohort size	0.022*	0.023*	0.047	0.026**	0.050	0.047*
	(0.012)	(0.012)	(0.030)	(0.012)	(0.030)	(0.026)
Cohort FE	✓	✓	✓	✓	✓	✓
District FE	✓	✓	✓	✓	✓	✓
Province × Cohort FE			✓		✓	✓
Controls× Famine × Year < 1892				✓	✓	✓
Famine provinces only						✓
Outcome mean / s.d	0.985 / 0.053	0.985 / 0.053	0.985 / 0.053	0.985 / 0.053	0.985 / 0.053	0.984 / 0.054
Famine intensity mean / s.d	0.145 / 0.232	0.145 / 0.232	0.145 / 0.232	0.145 / 0.232	0.145 / 0.232	0.365 / 0.233
Bias mean / s.d	0.078 / 0.012	0.078 / 0.012	0.078 / 0.012	0.078 / 0.012	0.078 / 0.012	0.078 / 0.007
Observations	5,006	5,006	5,006	5,006	5,006	1,986
R-squared	0.265	0.265	0.357	0.271	0.361	0.359

Note – This table shows estimates of the joint effect of the 1891 Famine and gender bias on sex ratios. Famine intensity is the share of the district population receiving food relief from the government. *Year < 1892* is a binary indicator switching on for the cohorts, born before 1892. Bias is the measure of gender bias against women based on folklore data. Cohort size is normalized by the average size of the cohorts born in 1887-1897. Other controls include interaction of gender bias with the following controls latitude, longitude, exogenous soil productivity, average temperature and precipitation (GAEZ), ruggedness, distances to the railroad, to the nearest navigable river, coastline and capitals (Moscow and Saint Petersburg) The sample includes either all districts within the European part of the Russian Empire or only areas affected by the 1891 Famine. *** p<0.01, ** p<0.05, * p<0.1.

Figure 7. Effect of famine and gender bias on sex ratios (by cohort)



Note – This figure plots coefficient on the interaction term between the measure of gender bias and cohort indicators. The coefficients are normalized to the 1893 cohort (omitted category). 1892 cohort is excluded from the sample. The regression specification includes cohort dummies, district fixed effects, cohort-by-province dummies, sex ratio at birth, cohort size and interaction of cohort dummies with the following controls: latitude, longitude, exogenous soil productivity, average temperature and precipitation (GAEZ), ruggedness, distances to the railroad, to the nearest navigable river, coastline and capitals (Moscow and Saint Petersburg). The sample is limited to the districts with high famine intensity (> 75th percentile).

Table 3. Effect of famine and gender bias on sex ratios: accounting for the impact of economic factors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bias × Famine × Year < 1892	1.955***	1.999***	1.973***	1.857***	1.930***	2.029***	1.933***
	(0.678)	(0.678)	(0.674)	(0.669)	(0.699)	(0.660)	(0.676)
HS female employment × Famine × Year < 1892		-0.023					-0.001
		(0.060)					(0.058)
Female labor × Famine × Year < 1892			-0.118				-0.208*
			(0.106)				(0.120)
Indust employment × Famine × Year < 1892				0.141			0.164
				(0.124)			(0.125)
Urbanization × Famine × Year < 1892					0.017		0.006
					(0.074)		(0.068)
Share cattle producers × Famine × Year < 1892						-1.049	-0.992
						(0.771)	(0.817)
Cohort FE	✓	✓	✓	✓	✓	✓	✓
District FE	✓	✓	✓	✓	✓	✓	✓
Province × Cohort FE	✓	✓	✓	✓	✓	✓	✓
Controls× Famine × Year < 1892	✓	✓	✓	✓	✓	✓	✓
Observations	5,006	5,006	5,006	5,006	5,006	5,006	5,006
R-squared	0.361	0.362	0.362	0.362	0.361	0.362	0.362

Note – This table shows estimates of the joint effect of the 1891 Famine and gender bias on sex ratios. Famine intensity is the share of the district population receiving food relief from the government. *Year < 1892* is a binary indicator switching on for the cohorts, born before 1892. Bias is the measure of gender bias against women based on folklore data. Additional controls include the interaction of famine intensity with the indicators of women's economic status and general economic development, female employment rate in high skilled (HS) occupations, female labor force participation, industrial employment rate, urbanization rate, and share of workers involved in cattle breeding. Other controls include birth ratio, cohort size and interactions of famine intensity with latitude, longitude, exogenous soil productivity, average temperature and precipitation (GAEZ), ruggedness, distances to the railroad, to a nearest navigable river, coastline and capitals. The sample includes all districts within the European part of the Russian Empire. *** p<0.01, ** p<0.05, * p<0

Table 4. Effect of famine and gender bias on sex ratios: accounting for religion

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Religious groups and gender bias. Dependent variable: M / F Ratio					
Folklore bias × Famine intensity × Year < 1892	1.631***	1.193*	1.898***	1.863***	1.573***	1.565***
	(0.576)	(0.652)	(0.598)	(0.618)	(0.568)	(0.583)
Famine intensity × Share Muslims × Year < 1892		0.077				
		(0.052)				
Famine intensity × Share Catholics × Year < 1892			-1.302***			
			(0.437)			
Famine intensity × Share Protestants × Year < 1892				-0.355*		
				(0.180)		
Famine intensity × Share Jewish × Year < 1892					-3.829***	
					(1.325)	
Famine intensity × Share Old-Believers × Year < 1892						0.152
						(0.205)
Observations	5,006	5,006	5,006	5,006	5,006	5,006
R-squared	0.271	0.271	0.272	0.272	0.271	0.271
	Panel B: Religious groups without gender bias. Dependent variable: M / F Ratio					
Famine intensity × Share Muslims × Year < 1892		0.103***				
		(0.037)				
Famine intensity × Share Catholics × Year < 1892			-1.200***			
			(0.435)			
Famine intensity × Share Protestants × Year < 1892				-0.311*		
				(0.180)		
Famine intensity × Share Jewish × Year < 1892					-4.003***	
					(1.155)	
Famine intensity × Share Old-Believers × Year < 1892						0.196
						(0.188)
Observations		5,006	5,006	5,006	5,006	5,006
R-squared		0.271	0.271	0.271	0.271	0.270

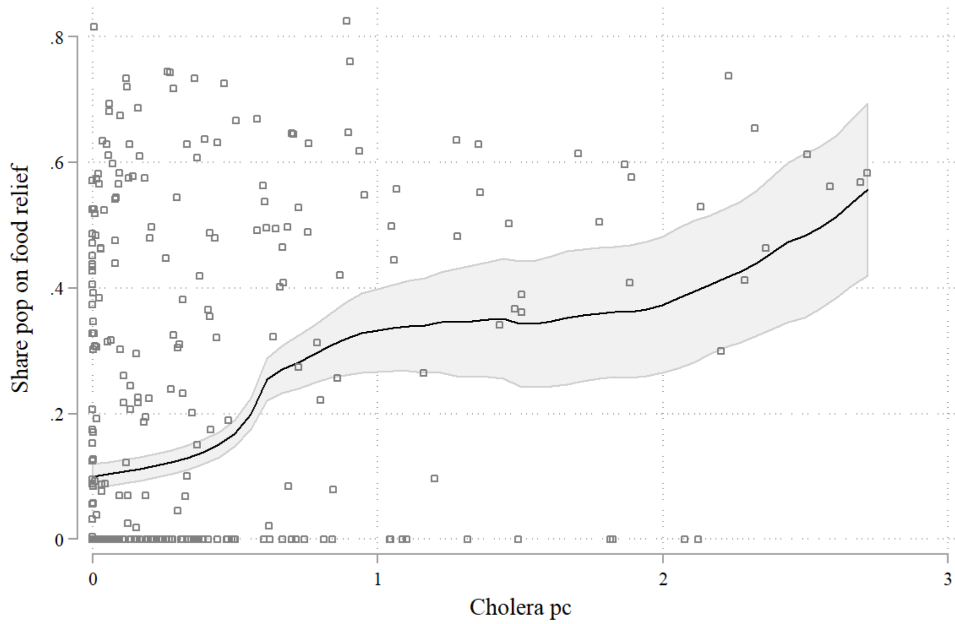
Note – This table shows the sensitivity of the coefficient on Bias × Famine × Year < 1892 to additional interactions of famine intensity with shares of religious minorities in population: Muslims, Catholics, Protestants and Old-Believers (subdivision within Orthodox Church). Regression specification corresponds to column 4 in Table 2. *** p<0.01, ** p<0.05, * p<0.1.

Table 5. Effect of famine and gender bias on sex ratios: predicted famine intensity

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: M / F Ratio					
Famine predicted × Year < 1892	0.018**	-0.007	-0.064	1.153	1.925	2.965*
	(0.008)	(0.058)	(0.064)	(1.084)	(1.658)	(1.505)
Bias × Famine pred × Year < 1892		0.322	1.046*	1.242**	1.645***	1.689***
		(0.735)	(0.601)	(0.597)	(0.562)	(0.567)
Birth ratio	0.101***	0.100***	0.116***	0.096***	0.113***	0.182**
	(0.031)	(0.031)	(0.033)	(0.031)	(0.033)	(0.069)
Cohort size	0.023*	0.023*	0.048	0.027**	0.051*	0.052*
	(0.012)	(0.012)	(0.030)	(0.013)	(0.030)	(0.025)
Cohort FE	✓	✓	✓	✓	✓	✓
District FE	✓	✓	✓	✓	✓	✓
Province × Cohort FE			✓		✓	✓
Controls× Famine × Year < 1892				✓	✓	✓
Famine provinces only						✓
Observations	5,006	5,006	5,006	5,006	5,006	1,986
R-squared	0.265	0.265	0.357	0.271	0.363	0.361

Note – This table replicates the findings of Table 2 using predicted famine intensity, based on climate data.

Figure 8. Cholera 1892 vs 1891 Famine



Note – This figure shows the relationship (local polynomial smooth) between 1891 Famine intensity and 1892 Cholera incidence (# of cases divided by district's population).

Table 6. Effect of famine, gender bias and cholera on sex ratios

	(1)	(2)	(3)	(4)	(5)
	Dependent variable: M / F Ratio				
Bias × Cholera cases pc	-0.135	-0.246	-0.351	-0.378	-0.441
	(0.274)	(0.363)	(0.482)	(0.387)	(0.540)
Bias × Famine × Year < 1892		1.751***	2.127***		
		(0.607)	(0.681)		
Bias × Famine pred × Year < 1892				1.351**	1.671***
				(0.615)	(0.571)
Birth ratio	0.105***	0.102***	0.117***	0.102***	0.116***
	(0.031)	(0.032)	(0.033)	(0.031)	(0.033)
Cohort size	0.027**	0.028**	0.044	0.028**	0.047
	(0.013)	(0.013)	(0.032)	(0.013)	(0.032)
Cohort FE	✓	✓	✓	✓	✓
District FE	✓	✓	✓	✓	✓
Controls × Famine × Year < 1892		✓	✓	✓	✓
Province × Cohort FE			✓		✓
Observations	4,982	4,982	4,982	4,982	4,982
R-squared	0.278	0.283	0.377	0.283	0.378

Note – This table shows the robustness of the main findings of Cholera exposure. Cholera cases pc denotes the number of cholera cases registered in each year between 1887 and 1897, normalized by 1890 population.

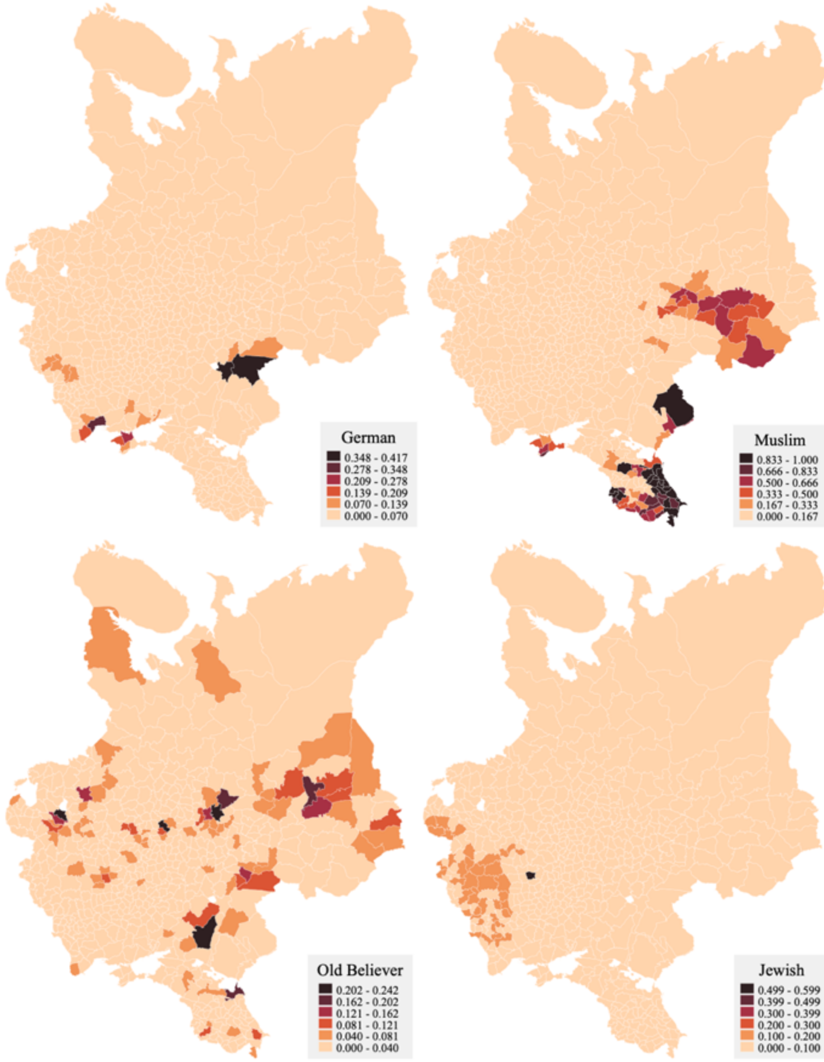
Online Appendix

Table A1. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Sex Ratio	5,006	0.985	0.053	0.473	1.554
Sex ratio at birth	5,006	1.056	0.038	0.455	1.541
Cohort size (normalized)	5,006	1.005	0.161	0.627	1.766
Female negative bias	501	.078	.012	.039	.132
Share pop starving	501	.145	.232	0	.825
Share pop starving, predicted	501	.136	.140	0	.598
Log railroad distance	501	3.52	1.41	-1.15	6.7
Log soil productivity index	501	8.26	.52	0	8.69
Log distance to coastline	501	6.00	.84	2.42	7.08
Log distance to Moscow	501	6.29	.67	2.14	7.38
Share female literate	501	0.12	0.16	0.02	0.83
Female labor force part.	501	0.12	0.07	0.03	0.55
Av. Precipitation	501	48.59	5.93	16.76	66.39
Av. Temperature	501	5.3	2.13	-3.96	11.63
Log distance to river	501	4.2	1.06	.089	6.58
Ruggedness	501	29.05	19.45	7.22	288.3
Mortality rate (age 0-1) 1891	501	20.91	6.72	5.91	41.08
Cholera cases per capita	4982	0.21	0.93	0	26.42

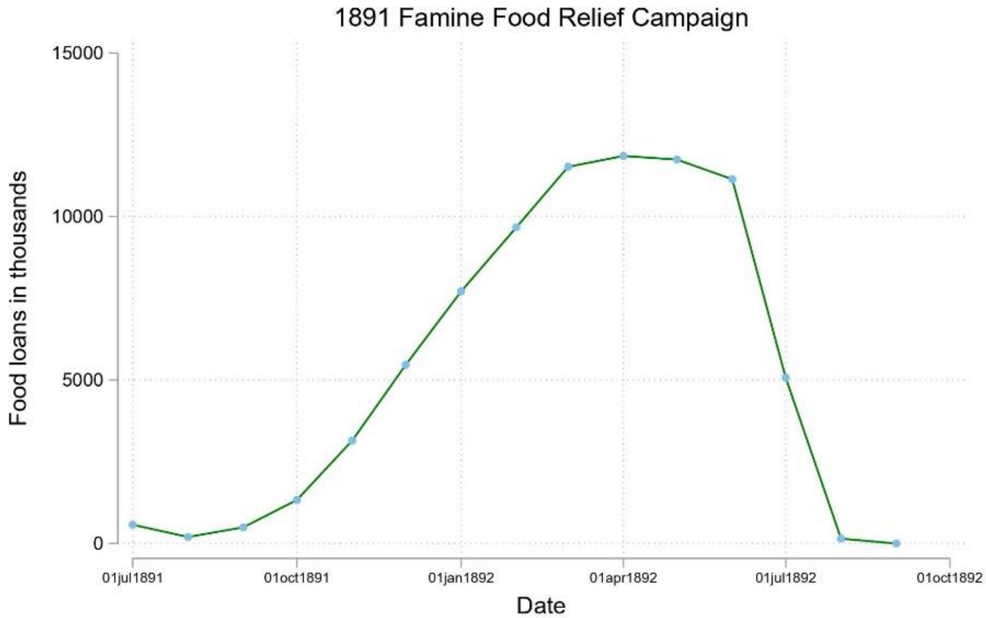
Note – Controls that vary by cohort and district include sex ratio, sex ratio at birth, cohort size, and cholera cases per capita. Other reported controls vary at the district level.

Figure A1. Ethnic and religious groups in 1897.



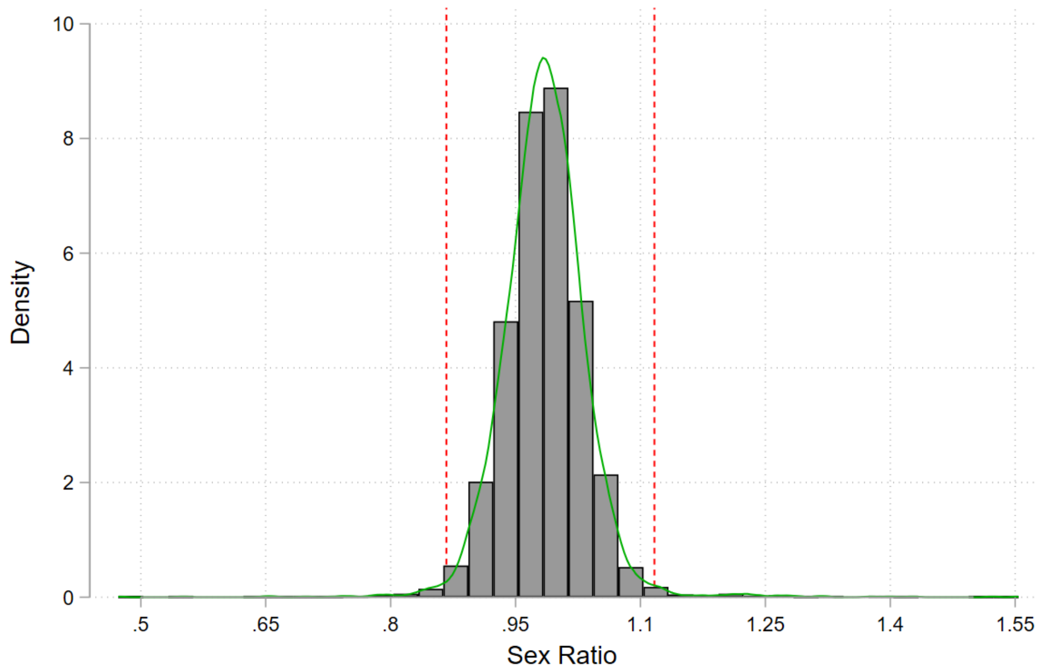
Note – This figure shows the spatial distribution of the ethnic and religious minorities in European Russia and the Caucasus based on the 1897 Census. Germans almost exclusively represented the Catholic and Protestant populations within the Volga basin.

Figure A2. Disbursement of state-sponsored food relief campaign over time



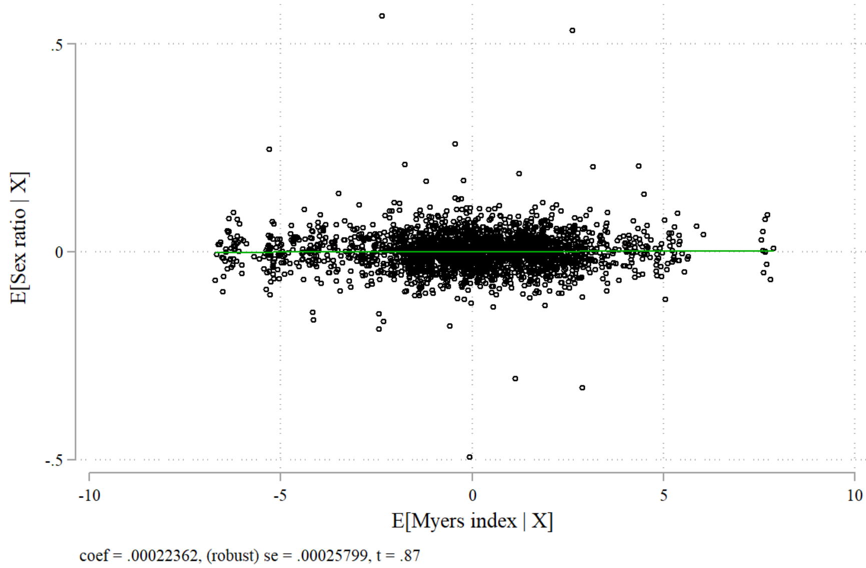
Source: Statisticheskie dannye po vydahe ssud na obsemenenie I prodovolstvie naseleniyu postraadavshemu ot neurozhaya v 1891-1892 gg. Reported by Whitecroft

Figure A3. Distribution of sex ratios



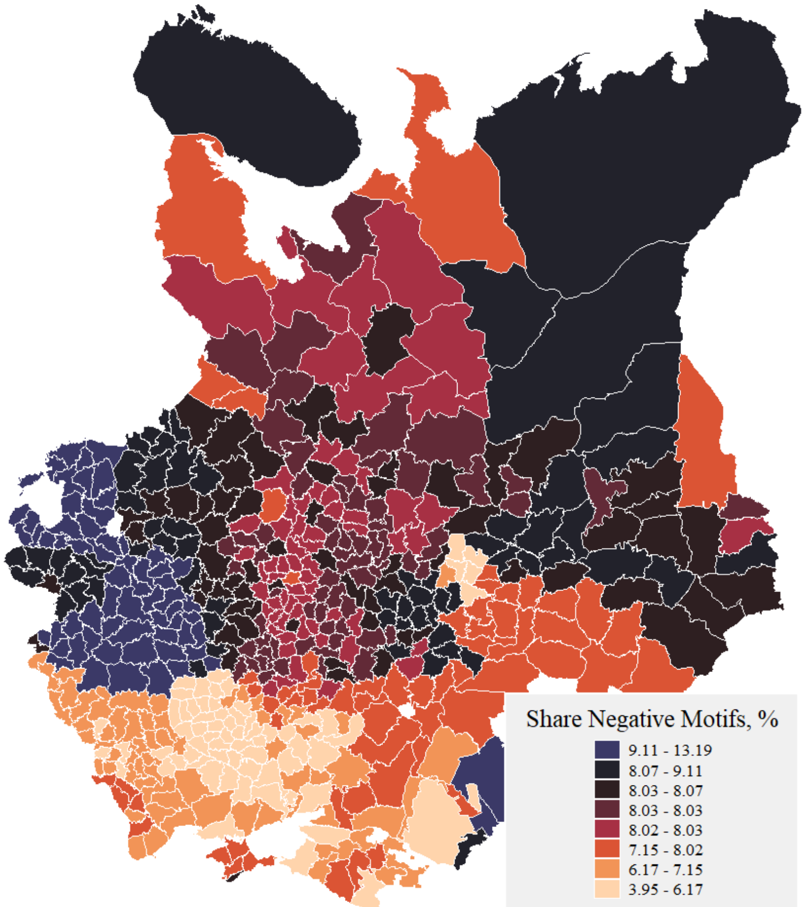
Note – This figure shows the distribution of sex ratios – the ratio between boys and girls among cohorts born between 1887 and 1897 (excluding 1892). Red lines indicate the 1st and 99th percentiles of the sample distribution. Source: Census 1897.

Figure A4. Age hyping (ages 15-74) and sex ratios



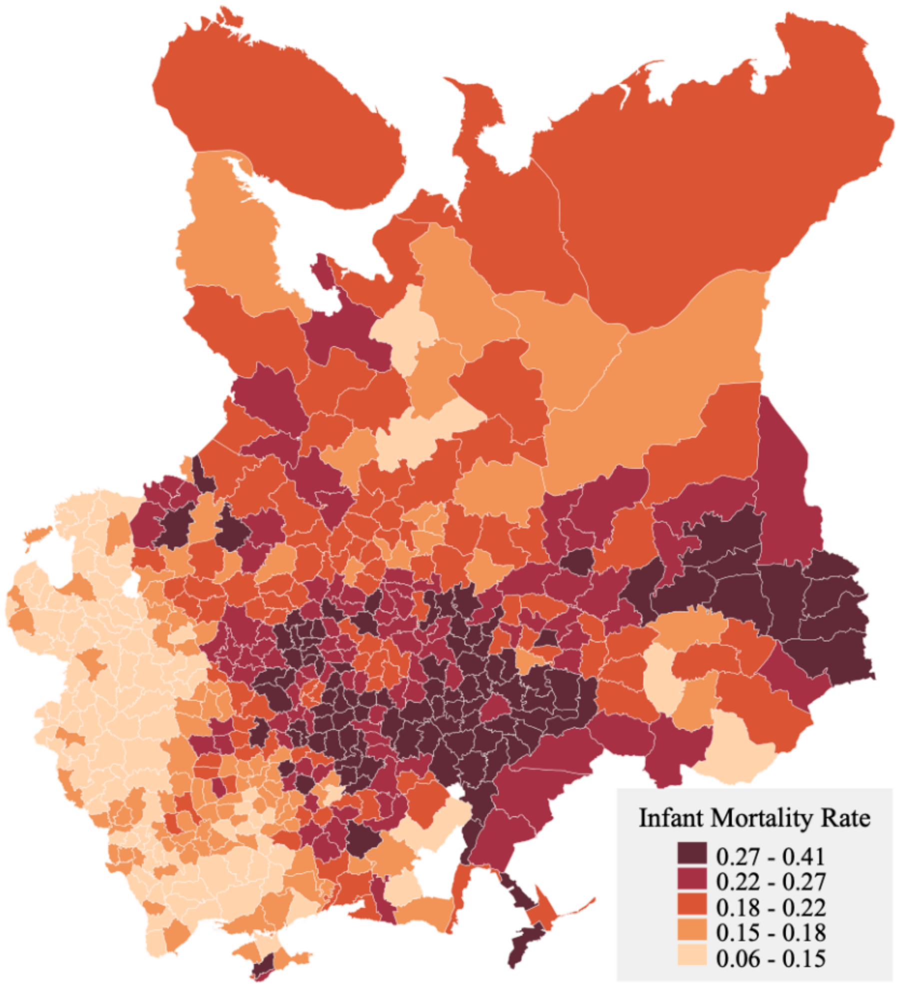
Note – This figure shows a conditional scatterplot obtained after regressing the sex ratio on the measure of age-hyping – Myers index for ages 15-74 (The index is constructed by Charnysh 2022 using Census 1897).

Figure A5. Distribution of the Female Negative Bias in the European part of the Russian Empire.



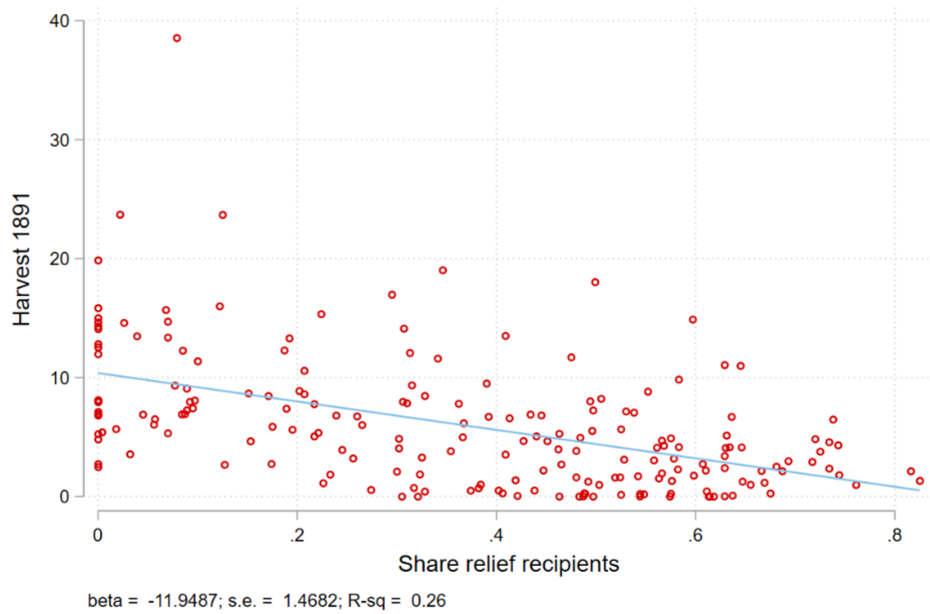
Note – This figure shows the spatial distribution of gender bias (Folklore) across districts in the European part of the Russian Empire and Caucasus.

Figure A6. Infant mortality rates, 1891



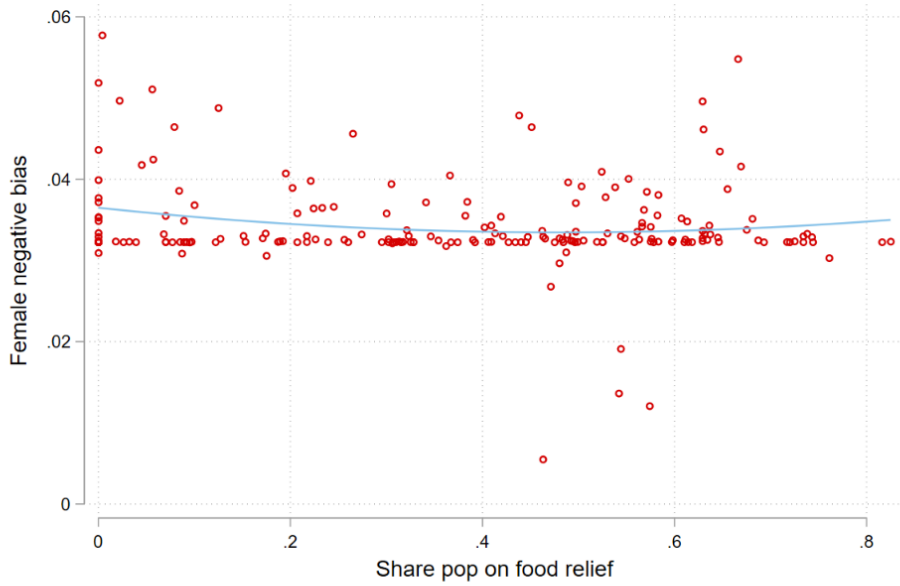
Note – This figure shows the spatial distribution of the 1891 infant mortality rate across districts in the European part of the Russian Empire.

Figure A7. Harvest pc 1891 and share of food relief recipients.



Note – This figure shows an unconditional relationship between the 1891 grain harvest and famine intensity – the share of the district's population receiving food relief from the government.

Figure A8. Female bias vs. Share of food relief recipients across districts



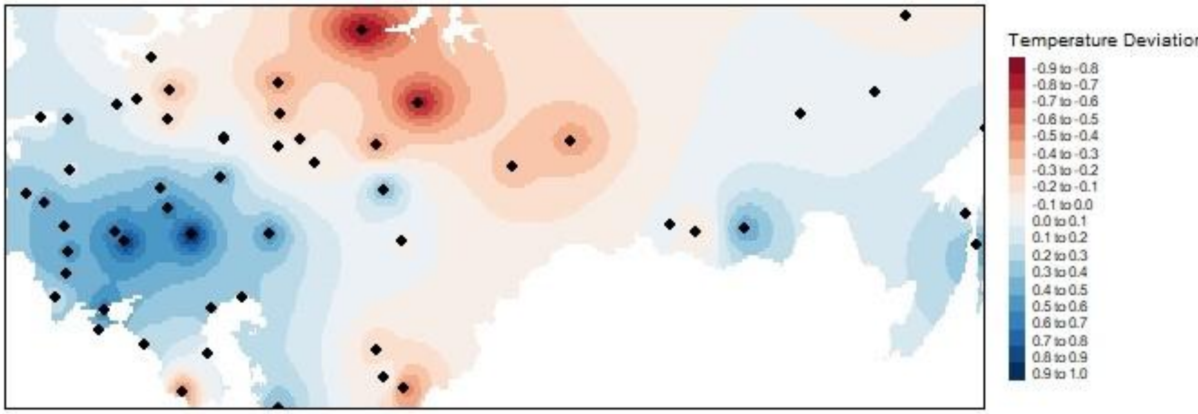
Note – This figure shows an unconditional relationship between Female negative bias and the share of the district population receiving food relief from the government.

Table A2. Climate shock as predictor of famine food releif

	OLS coefficient
January precipitation	-12.526
	(11.368)
February precipitation	2.799
	(18.218)
March precipitation	**-23.326*** **
	(8.003)
April precipitation	3.187
	(7.664)
May precipitation	5.575
	(9.065)
June precipitation	-9.279
	(12.339)
July precipitation	-1.011
	(7.682)
January temperature	-0.990
	(11.997)
February temperature	-9.318
	(6.820)
March temperature	-18.470
	(12.002)
April temperature	21.632
	(15.721)
May temperature	-7.029
	(17.802)
June temperature	1.922
	(12.211)
July temperature	**42.570*** **
	(11.396)
Soil productivity	-2.133
	(1.411)
Observations	576
R-squared	0.834

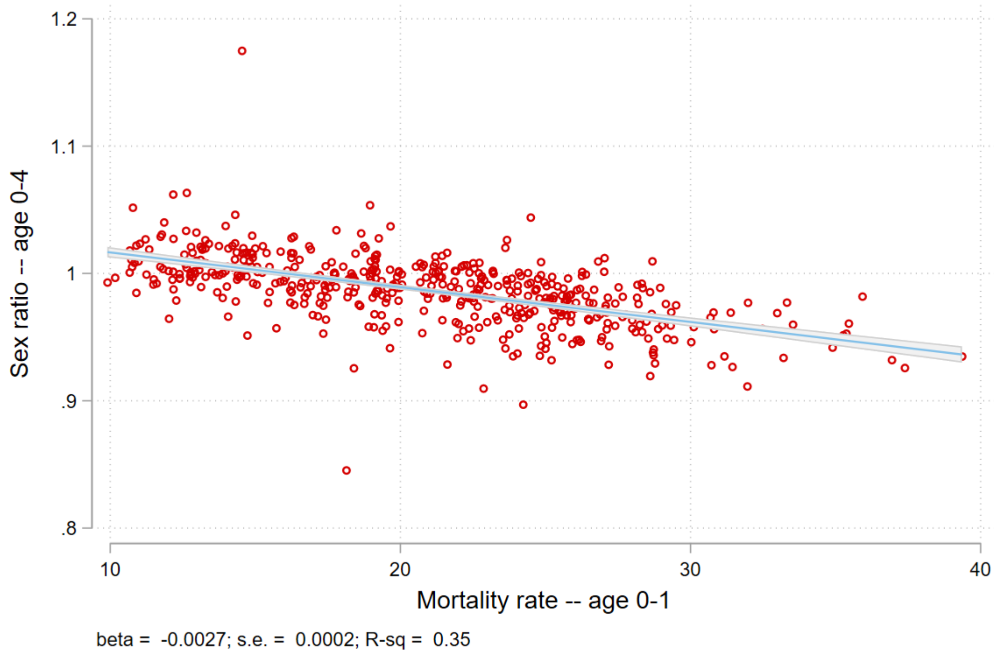
Note – This table shows estimates of the coefficient from the linear regression model based on climate observations. The monthly temperature and precipitation shocks are standardized deviations of 1891 levels from long-term mean values. Other controls include province dummies.

Figure A9. Deviation of temperature levels in July 1891 from that month historical mean values



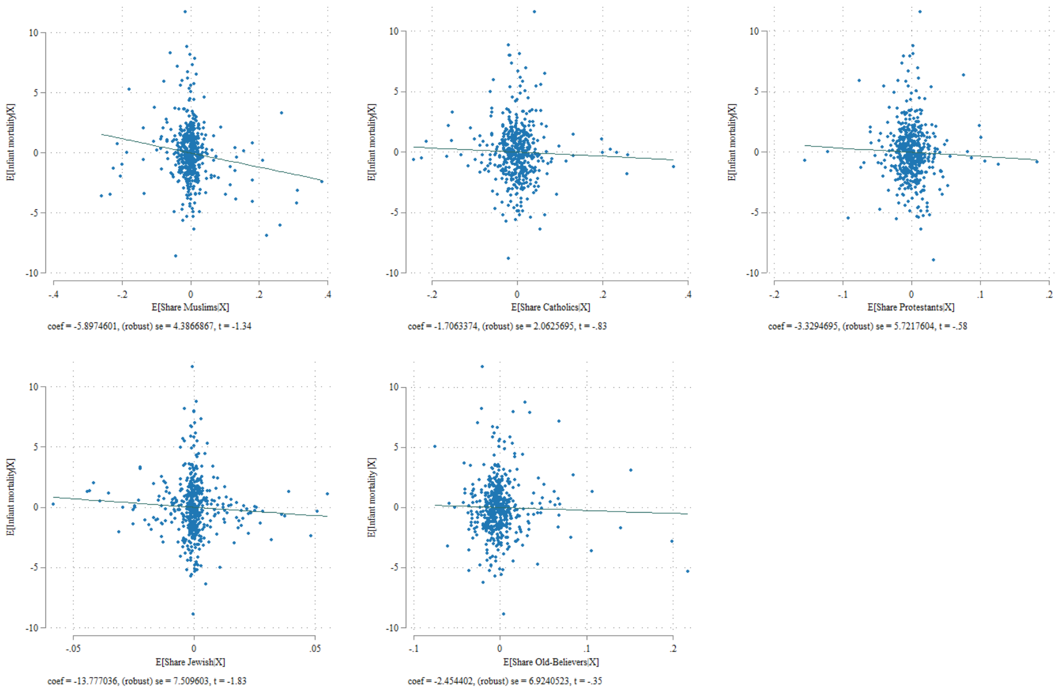
Note – This figure shows the spatial distribution of climate shock (temperature). Dots denote the location of climate stations.

Figure A10. Relationship between infant mortality and sex ratios



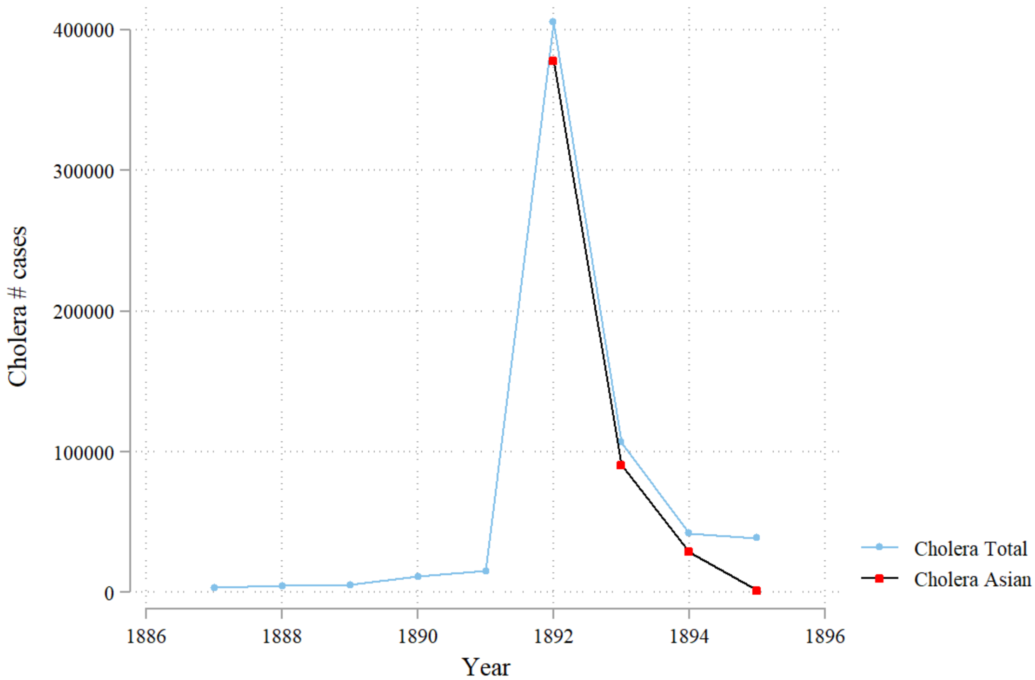
Note – This figure shows an unconditional relationship between sex ratios at age 0-4 (Source: Census 1897) and average infant mortality rate for the period between 1887 and 1897 excluding famine year (Source: Vital Statistics).

Figure A11. Religious minorities and infant mortality



Note – This figure plots conditional scatterplots of average infant mortality in 1887-1897 (excluding famine years) vs. shares of religious minorities in the population. Other controls include 1891 infant mortality rate, birth ratio, cohort size and interactions of famine intensity with latitude, longitude, exogenous soil productivity, average temperature and precipitation (GAEZ), ruggedness, distances to the railroad, to a nearest navigable river, coastline and capitals.

Figure A12. Cholera incidence in 1887-1895



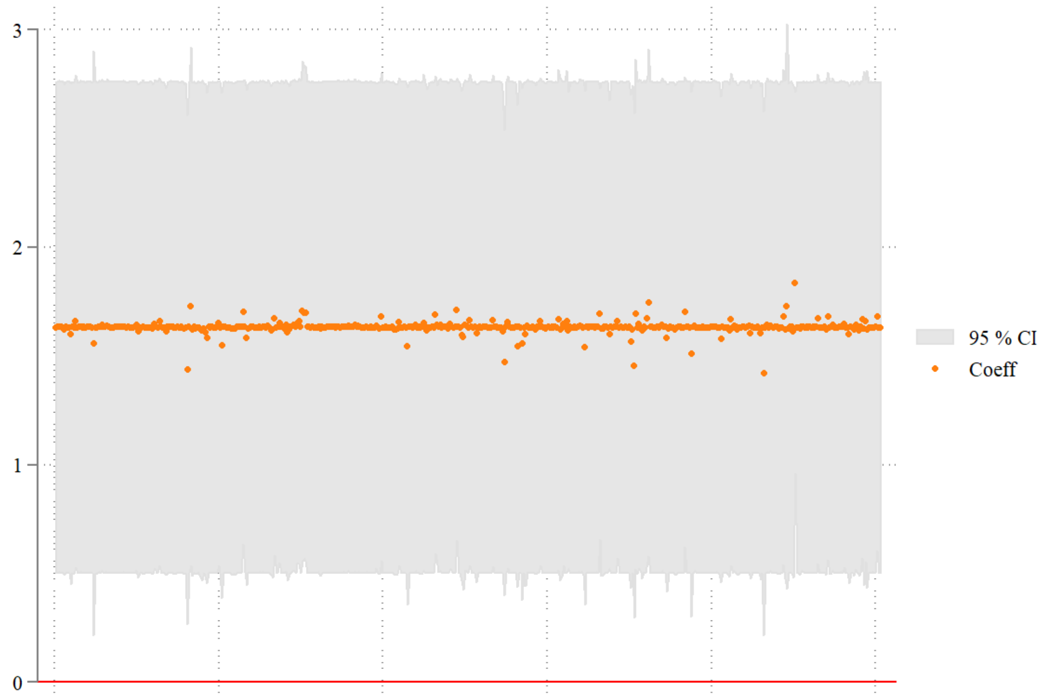
Note – This figure shows the incidence of Cholera over time in the Russian Empire. Source: Medical Department Report

Table A3. Alternative Standard Errors and Robustness to Outliers

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: M / F Ratio							
Bias × Famine × Year < 1892	1.631***	1.631***	1.631***	1.631**	0.865*	1.394**	1.766**	1.660***
	(0.576)	(0.587)	(0.633)	(0.644)	(0.451)	(0.560)	(0.800)	(0.561)
	Baseline	Conley Adj Spatial cut-off 500 km	Conley Adj Spatial cut-off 1000 km	Conley Adj Spatial cut-off 1500 km	Omit Cook's Distance outliers	Winsorize Sex ratio 1st/99th	Winsorize Bias 1st/99th	Winsorize Famine 1st/99^{th}
Observations	5,006	5,006	5,006	5,006	4,802	5,006	5,006	5,006
R-squared	0.271	0.271	0.271	0.271	0.441	0.335	0.271	0.271

Note – This table tests the robustness of the main findings to alternative standard errors (Conley Adjustment) and potential outliers. Regression specification corresponds to Table 2, column 4. *** p<0.01, ** p<0.05, * p<0.1.

Figure A13. Robustness to outliers



Note – This figure plots the distribution of the coefficients on *Bias* × *Famine intensity* × *Year < 1892* after excluding one of the districts from the sample. Regression specification corresponds to Table 2, column 4.

Table A4. Alternative outcome variable

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: % Boys in cohort					
Famine intensity × Year < 1892	0.405**	-0.119	-1.601	38.020	24.793	24.116
	(0.159)	(1.492)	(1.525)	(26.466)	(45.812)	(46.804)
Bias × Famine × Year < 1892		6.700	23.916	40.121***	49.262***	46.395**
		(18.882)	(18.689)	(14.513)	(16.804)	(16.511)
Sex ratio at birth	2.633***	2.628***	3.001***	2.531***	2.930***	4.733**
	(0.804)	(0.801)	(0.847)	(0.806)	(0.849)	(1.787)
Cohort size	0.597*	0.599*	1.198	0.684**	1.261	1.232
	(0.322)	(0.322)	(0.783)	(0.320)	(0.787)	(0.757)
Cohort FE	✓	✓	✓	✓	✓	✓
District FE	✓	✓	✓	✓	✓	✓
Province × Cohort FE			✓		✓	✓
Controls× Famine × Year < 1892				✓	✓	✓
Famine provinces only						✓
Observations	5,006	5,006	5,006	5,006	5,006	1,986
R-squared	0.266	0.266	0.355	0.271	0.359	0.353

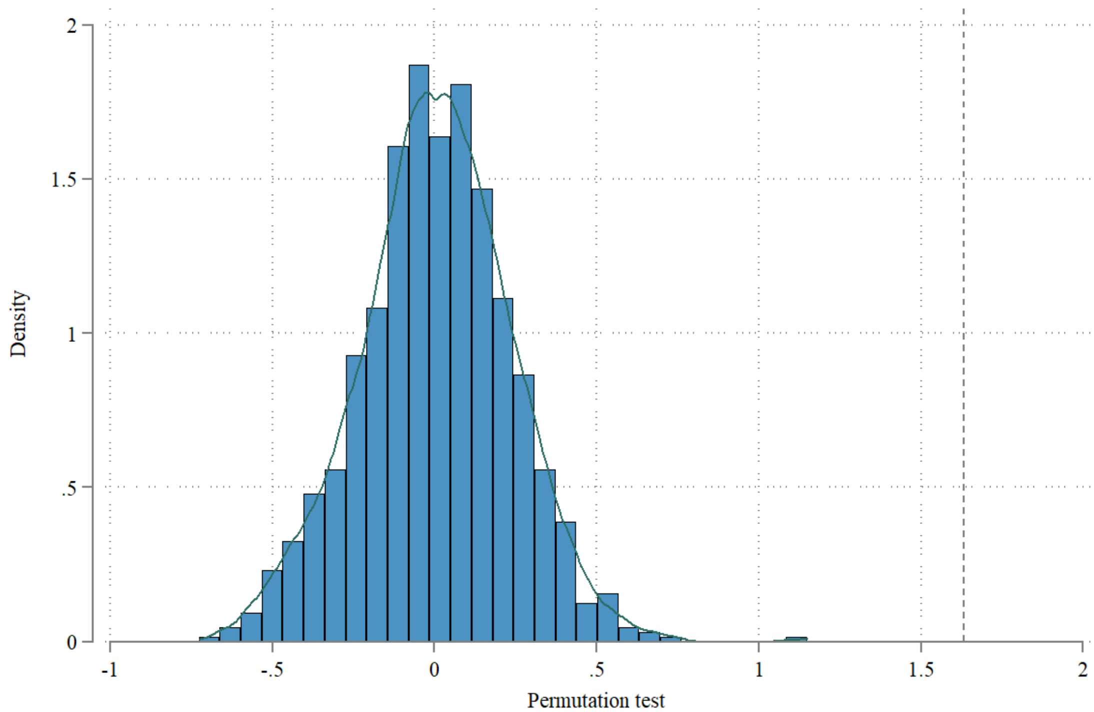
Note – This table replicates the findings of Table 2 with an alternative outcome variable – % of boys per cohort born in 1887-1897.

Table A5. Effect of famine and gender bias on sex ratios: by group of motifs

	(1)	(2)	(3)	(4)	(5)
	Dependent variable: M / F Ratio				
Submissive × Famine intensity × Year < 1892	2.633***	1.685**	1.780**	1.448**	1.430**
	(0.838)	(0.663)	(0.672)	(0.574)	(0.654)
Domestic affairs × Famine intensity × Year < 1892	-5.493				
	(4.622)				
Violent × Famine intensity × Year < 1892		0.277			
		(1.255)			
Physically active × Famine intensity × Year < 1892			4.249		
			(4.791)		
Sexual × Famine intensity × Year < 1892				6.658*	
				(3.959)	
Other × Famine intensity × Year < 1892					1.452
					(1.647)
Observations	5,006	5,006	5,006	5,006	5,006
R-squared	0.271	0.271	0.271	0.271	0.271

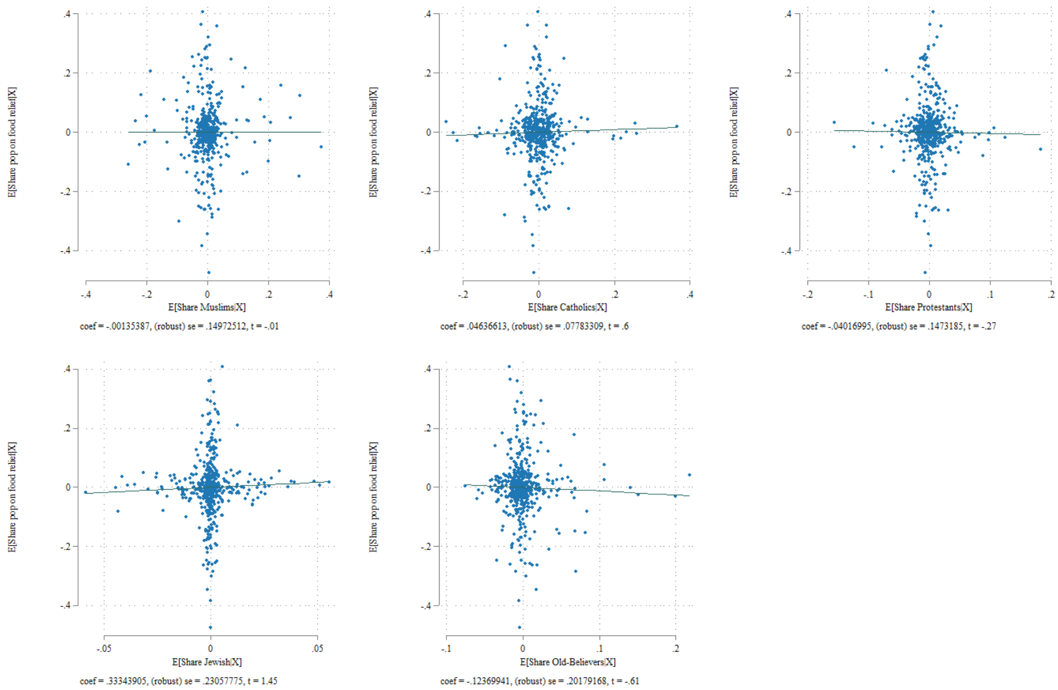
Note – This table demonstrates the interaction effect between famine and different groups of motifs depicting women as 1) submissive and stupid, 2) involved in domestic affairs, 3) violent, 4) physically active, 5) sexual, and 6) other. Regression specification corresponds to column 4 in Table 2. *** p<0.01, ** p<0.05, * p<0.1.

Figure A14. Permutation test



Note – This figure shows the distribution of the estimated coefficients from the regressions with false treatment (1000 iterations). The distribution of gender motifs is randomly reshuffled across ethnic groups in the original Folklore dataset. We then link it to the 1897 Census to compute a population-weighted average of the bias measure at the district level. The vertical line represents the coefficient value on interaction *Bias*Famine*Year < 1892* from the true model. The test indicates that the randomly generated predictors does not deliver the same or stronger magnitude estimate as the true model. Regression specification corresponds to Table 2, column 4.

Figure A15. Famine intensity and shares of main religious minorities in the population



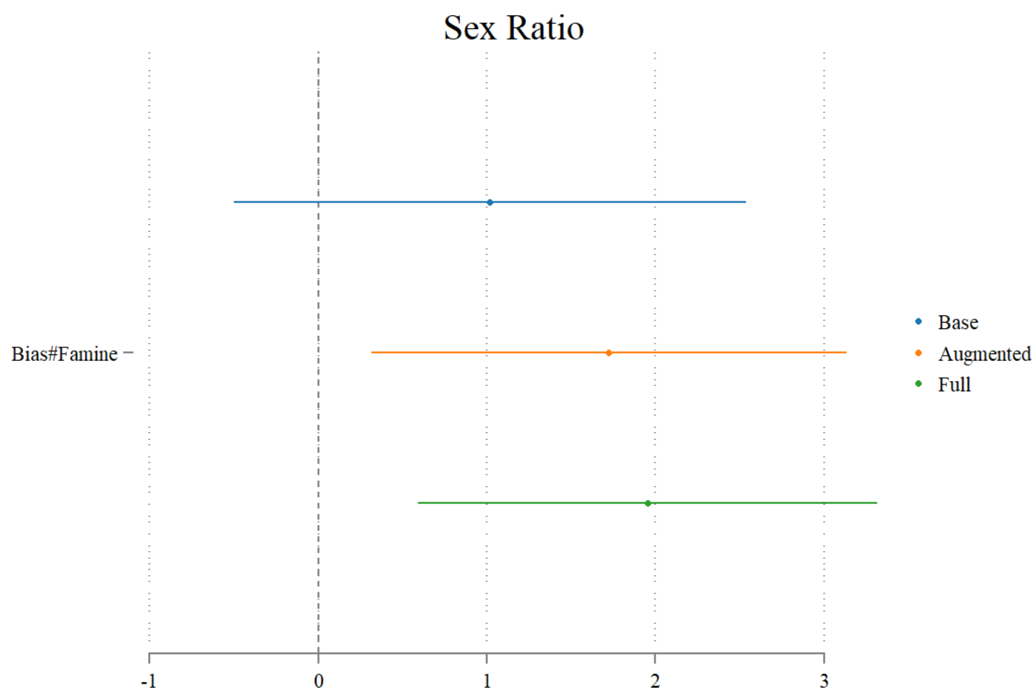
Note – This figure plots conditional scatterplots of famine intensity vs. shares of religious minorities in the population. Other controls include 1891 infant mortality rate, birth ratio, cohort size and interactions of famine intensity with latitude, longitude, exogenous soil productivity, average temperature and precipitation (GAEZ), ruggedness, distances to the railroad, to a nearest navigable river, coastline and capitals.

Table A6. The joint effect of famine intensity and average mortality in non-famine years on sex ratios

	(1)	(2)	(3)	(4)
	Dependent variable: M / F Ratio			
Famine intensity × Year < 1892	0.072***	1.763	1.317	1.284
	(0.023)	(1.069)	(1.841)	(1.882)
Infant mortality × Famine intensity × Year < 1892	-0.002**	-0.002**	-0.003**	-0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
Birth Ratio	0.101***	0.096***	0.113***	0.182**
	(0.031)	(0.031)	(0.033)	(0.070)
Cohort Size	0.021*	0.026**	0.050	0.047*
	(0.012)	(0.012)	(0.030)	(0.026)
Cohort FE	✓	✓	✓	✓
District FE	✓	✓	✓	✓
Province × Cohort FE			✓	✓
Controls× Famine × Year < 1892				✓
Famine provinces only				
Observations	5,006	5,006	5,006	1,986
R-squared	0.266	0.271	0.361	0.359

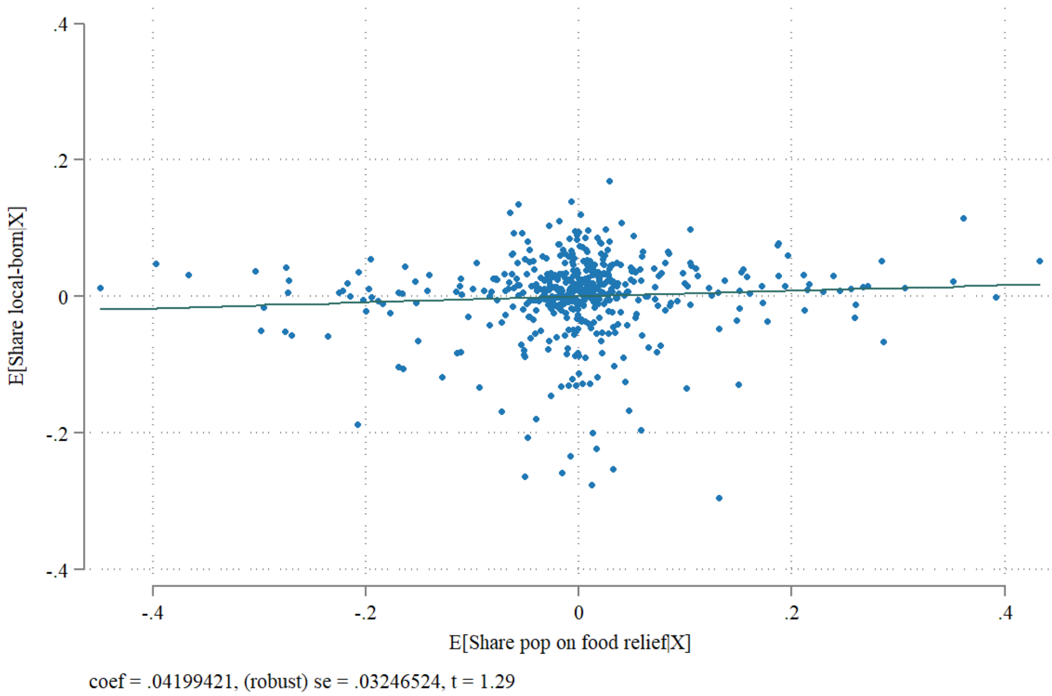
Note – This table demonstrates the interaction effect between famine intensity and average infant mortality on M/F ratio. Other controls correspond to Table 2. *** p<0.01, ** p<0.05, * p<0.1.

Figure A16. Coefficient on Bias × Famine intensity × Year < 1892 in different regression specifications



Note – This figure plots regression coefficients on the interaction term Bias × Famine intensity × Year < 1892 in the models 1) without additional interactions (base) 2) + Av. infant mort (1887-1897) × Famine intensity × Year < 1892 (augmented) 3) + Av. infant mort (1887-1897) × Famine intensity × Year < 1892 + other controls (see Figure 3) interacted with Famine intensity × Year < 1892 (full). The controls included in all models are cohort indicators, district and cohort-by-province indicators.

Figure A17. Famine intensity and Share of local residents in the population in 1897



Note – This figure shows the plots the share of population receiving a food assistance from the government in 1891-1892 vs. the share of local-born residents in the district population by 1897. The controls include latitude, longitude, exogenous soil productivity, average temperature and precipitation (GAEZ), ruggedness, distances to the railroad, to the nearest navigable river, coastline and capitals (Moscow and Saint Petersburg), literacy rate and province dummies.