# Migration, Climate Similarity, and the Consequences of Climate Mismatch*

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**Abstract**

This paper documents that climate similarity has shaped the geography of migration in the United States for more than 150 years, and that settling in less familiar climates is associated with worse immigrant well-being. Using historical and modern data on international and internal migration, we show that migrants disproportionately settle in destinations whose climates resemble those of their origins. The evidence is consistent with both the transferability of climate-specific skills and a direct amenity value of climatic familiarity. Migrants are willing to accept greater climate mismatch in exchange for better economic opportunities, although climate similarity continues to shape their destination choices. We then document that climate mismatch is associated with lower fertility, higher mortality among U.S.-born children, and shorter adult lives. The negative relationship between climate mismatch and longevity persists within neighborhoods and becomes larger within families. The longevity association also persists into the second generation, whereas the fertility and the child-mortality associations do not.

**Keywords:** Migration, climate similarity, fertility, mortality
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# 1 Introduction

Migrants tend to cluster geographically, leaving persistent settlement patterns that shape regional identities and the cultural geography of countries (Fischer 1989; Bazzi et al. 2023; Fouka and Serlin 2026). What explains the emergence of these distinctive settlement geographies? Well-studied determinants of migrant location choices include differences in economic opportunities across destinations (Borjas 2001; Cadena and Kovak 2016), co-ethnic networks (Munshi 2003; Stuart and Taylor 2021), geographic frictions such as distance and transportation costs (Schwartz 1973; Steckel 1983), political preferences (Bishop and Cushing 2009), and cultural sorting (Bazzi et al. 2020; Fouka and Serlin 2024).

Many historical accounts also point to climate matching, namely the tendency of migrants to settle in destinations whose climate resembles that of their origins. In 1925, U.S. President Calvin Coolidge observed that "the newcomers from Europe commonly sought climatic conditions [in the United States] like those in which they had been raised. So the Scandinavians are found chiefly in the northern parts of this country" (Coolidge 1926, p. 255). Similar arguments have been made about overseas European settlements (Fischer 1989; Crosby 2004) and U.S. internal migration during the 19$^{\text{th}}$ century (Steckel 1983).[1] Historical observers also believed that climate similarity influenced settlers' well-being. Writing in 1622, Sir Ferdinando Gorges argued that New England was particularly suitable for English settlers because they would "prosper kindly no where else" than in a climate resembling their own. Similar concerns appeared throughout the colonial period, when English migrants to North America and the West Indies expressed "profound anxiety" about the health consequences of climates that differed from England's temperate environment (Kupperman 1984).

Despite the prominence of these ideas in historical accounts, there is little systematic evidence on whether climate similarity shapes migration patterns and the potential consequences of climate mismatch for migrants. This paper addresses both questions. In the first part, we study international and internal migration in the United States from 1850 to 2019, combining linked census records, full-count cross-sections, and modern administrative data. We ask whether migrants disproportionately settle in destinations whose climates resemble those of their origins. In the second part, we examine whether climate mismatch is associated with fertility, child survival, and longevity among immigrants.

We begin by estimating gravity models in which migration flows depend on bilateral physical distance and origin- and destination-specific factors (Anderson and Van Wincoop 2003). We augment the baseline gravity model with climate distance, defined as the absolute difference in average annual temperature and precipitation between origin and destination. For international migration,

1. Steckel (1983) noted that a "farmer contemplating a move sought, other things being equal, a location that maximized the return on previous investments in human capital; namely, a place where the climate, soil, and terrain were familiar."

we combine historical linked census records following Norwegian migrants from their municipalities of origin to their U.S. counties of residence between 1865 and 1920 with repeated cross-sections covering both the Age of Mass Migration (1880–1920) and the modern immigration era (1970–2010). For internal migration, we use linked individual census records from 1850 to 1940 and modern administrative records of county-to-county migration from 2011 to 2019. Applying the same empirical approach to these settings allows us to compare climate matching across periods, geographic scales, and migration contexts.

We find that migrants disproportionately choose destinations whose temperatures resemble those of their origins. Reducing temperature distance between origin and destination by 1°C increases migration flows by approximately 2% to 37%, depending on the context. To benchmark these magnitudes, a 1°C reduction in temperature distance generates a predicted migration response equivalent to reducing physical distance by approximately 37 to 272 kilometers. In the modern samples, this response is comparable to that generated by a 4% increase in destination wages for international migration and a 5–17% increase for internal migration. In the modern international sample, it is also equivalent to increasing the existing destination diaspora by approximately 3–21%.

Precipitation similarity also predicts migration flows, but the estimates are less stable across settings and robustness checks. This is consistent with evidence that temperature is a more systematic predictor of human and economic outcomes, whereas precipitation effects tend to be context specific (Carleton and Hsiang 2016). We therefore use overall temperature distance as our preferred measure of climate similarity, while continuing to control for precipitation distance throughout. Temperature is salient, easy to observe, and correlated with many features relevant for productivity, comfort, and cultural familiarity.

One concern with our results is that climate distance may proxy for geography or other persistent origin–destination characteristics. This concern is especially relevant for internal migration because climate is spatially correlated and domestic moves are often short distance, so climate similarity is tied to geographic proximity. We address this by controlling flexibly for physical distance and a large set of bilateral covariates. A more demanding test exploits 20$^{\text{th}}$-century shifts in climate distance within origin–destination pairs, thereby absorbing all time-invariant bilateral factors, including geography, migrant networks, institutions, and culture. Temperature distance continues to predict migration in these within-pair specifications, suggesting that persistent bilateral relationships cannot account for climate matching.

Our data and empirical setting allow us to trace the evolution of climate matching over more than 150 years. For both internal and international migration, the relationship between climate similarity and migration gradually weakens over the study period, although it remains visible today. This decline is consistent with climate-specific human capital becoming less important as the economy industrialized and employment shifted away from climate-exposed sectors. We also examine whether the diffusion of air conditioning may have contributed to this decline. Because we do not observe

local air-conditioning adoption, this exercise is necessarily suggestive. We compare periods before and after its widespread adoption and find that after 1970 summer-temperature distance became less predictive of migration to the hottest parts of the U.S., particularly among non-farm workers. Because agricultural production still depends directly on local climate, this contrast suggests that air conditioning reduced the discomfort associated with climate mismatch. The pattern is therefore consistent with migrants valuing climate similarity as an amenity.

The linked historical samples contain rich demographic and economic information measured before the move, which allows us to examine how climate matching varies across migrants. Across most observable demographic and socioeconomic characteristics, climate matching varies relatively little. Two exceptions stand out. First, the relationship between climate similarity and migration is strongest among farmers and rural households, consistent with a role for climate-specific human capital (Steckel 1983; Bazzi et al. 2016). Yet climate distance continues to predict migration among workers in occupations and sectors with little direct exposure to climate. Second, climate matching is substantially weaker among both foreign-born and Black Americans. For foreign-born migrants, the country-of-origin climate remains the more relevant reference point, making the climate of their initial U.S. county of residence less salient. For Black migrants, weaker matching is consistent with the geographic gradient of the Great Migration, which drew migrants away from climatically familiar parts of the South toward greater economic opportunities in the North (Boustan 2016).

We also study how climate matching responds to economic opportunities at destination. We consider five distinct settings: railroad expansion, access to Homestead land, frontier settlement, local labor-demand growth, and New Deal spending. Across all five settings, stronger destination-side opportunities draw relatively more migrants from climatically distant origins. This attenuation is similar for farmers and non-farmers in most settings, despite stronger baseline climate matching among farmers. Yet climate similarity continues to predict migration in every case, even where economic opportunities are substantial. Because each of these forces changed the attractiveness of destination locations along multiple margins, we do not interpret any single exercise as evidence of a specific mechanism. The results instead show that economic opportunities can encourage migrants to accept greater climate mismatch.

The second part of the paper examines whether climate mismatch is associated with migrants' well-being. We focus on international immigrants to the United States, drawing on historical censuses to measure fertility and child survival in the early 20$^{\text{th}}$ century, and on Social Security administrative records and linked birth–infant death files from the National Center for Health Statistics to examine adult longevity and infant mortality at the turn of the 21$^{\text{st}}$ century. Because we lack plausibly exogenous variation in climate mismatch, it is possible that migrants who settle in more mismatched locations differ systematically in ways that also affect their demographic outcomes. Two features of our analysis limit the scope for selection. First, in the historical census analyses, we directly control for the prevalence of agricultural employment within each immigrant community, one of

the main dimensions along which climate matching varies in the linked samples. Second, when comparable controls are unavailable, as in the adult-longevity analysis, we instead exploit much finer comparisons—among immigrants who lived in the same neighborhood and among siblings from the same family who died in different counties. These comparisons do not fully eliminate concerns about selection on unobservables, so we interpret the evidence as descriptive rather than causal.

To study fertility and child survival, we use the full-count 1900 and 1910 U.S. censuses, which asked women to report the number of children ever born and the number surviving. Among foreign-born women aged 18–45 who married after arriving in the United States, a 5°C decrease in temperature distance—roughly the difference between Chicago and Washington, DC—is associated with 0.058 more U.S.-born children per woman, approximately 1.8% of the sample mean. The same decrease in temperature distance is associated with a 0.8 percentage point decline in the share of children who died, or about 5.1% of the mean. Both relationships are stable across origin countries, destination states, alternative samples, and controls for the socioeconomic composition of immigrant communities, including literacy, labor-force participation, rural residence, husbands' occupational income scores, and intermarriage. However, they disappear among U.S.-born women with immigrant parents, consistent with a role for physiological adaptation and for climate-specific norms and behaviors that adjust across generations. At the same time, the child-survival relationship remains in the modern era: among infants of foreign-born mothers, a 5°C decrease in temperature distance is associated with 0.135 fewer deaths per 1,000 births, or about 2.9% of the mean, between 2005 and 2019.

Next, we examine whether the negative association between climate mismatch and immigrant well-being extends into adulthood. Using administrative death records for immigrants who died between 1988 and 2005, we find that a 5°C decrease in temperature distance is associated with approximately 22 additional days of life, relative to an average age at death of about 76 years. The relationship persists among immigrants who lived in the same neighborhood and becomes nearly twice as large when comparing siblings from the same family who died in different counties. This pattern is consistent with positive selection across families into greater climate mismatch and suggests that comparisons among unrelated immigrants may, if anything, attenuate the negative association with longevity. We find a similar relationship among the immigrant generation of the Age of Mass Migration, using mortality records from 1959–1963. Moreover, in the three states that recorded parental birthplace, the association persists among the U.S.-born children of immigrants.

Three non-mutually exclusive mechanisms could explain the relationship between climate mismatch and immigrant well-being. First, economic resources could contribute if climate mismatch reduces immigrants' income, but are unlikely to explain the full pattern. The historical fertility and child-survival estimates are virtually unchanged after controlling for socioeconomic characteristics, while the within-family longevity estimates rule out channels operating solely through shared family

background. Moreover, the relationships persist into the modern era, when agricultural employment is negligible and technology has reduced the importance of climate-specific skills. Second, physiological adaptation may contribute to the effects of climate mismatch, if migrants remain imperfectly adapted to unfamiliar environments after moving. The disappearance of the fertility and child-survival relationships among U.S.-born women with immigrant parents is consistent with mechanisms tied to migrants' own climatic exposure. Physiological adaptation alone, however, cannot explain the persistence of the longevity relationship into the second generation. Third, migrants may carry climate-specific behaviors and knowledge that transfer imperfectly across environments and adjust only gradually after migration. The speed of adjustment may depend on the feedback from these practices: behaviors with salient and immediate consequences may adjust more quickly than behaviors whose effects are diffuse or delayed. This mechanism can therefore account for the contrasting patterns across generations: the disappearance of the fertility and child-survival associations, but the persistence of the longevity association.

Our paper contributes to the literature on the formation and persistence of immigrant settlement patterns. Historians have long argued that the distinctive regional geography of the United States reflects the origins and settlement patterns of the groups that populated different parts of the country (Zelinsky 1973; Fischer 1989; Woodard 2011), while a growing body of work in economics documents the emergence and persistence of distinctive local communities and regional cultures (Grosjean 2014; Bazzi et al. 2020; Bazzi et al. 2023). These studies often take the initial distribution of groups across space as given. We show that climate similarity systematically shaped settlement patterns by repeatedly directing migrants toward climatically familiar destinations, contributing to the persistent settlement geographies studied in these literatures.

Our results also speak to the literature on migration and location choice introduced above, and more specifically to work estimating the amenity value of climate. Using hedonic approaches, the climate-amenity literature typically finds that individuals prefer milder temperatures and avoid climatic extremes (Albouy et al. 2016; Sinha et al. 2021), generally treating the value of a destination's climate as common across individuals. A notable exception is Albouy et al. (2021), who show that immigrants tend to move to cities with characteristics resembling those of their countries of origin. We complement this work in several ways. First, we document that climate similarity systematically predicts migration across historical and contemporary settings and at different geographic scales. Second, we identify which migrants place greater weight on climatic similarity and show that economic opportunities and technological change can attenuate, though not eliminate, climate matching. Third, we provide descriptive evidence on the consequences of climate mismatch for immigrant well-being.

In documenting the relationship between climate mismatch and immigrant well-being across more than a century, we complement Bazzi et al. (2016), who show that Indonesian transmigrants assigned to more agroclimatically mismatched destinations were less productive. Our findings also

connect research on immigrant assimilation (Abramitzky et al. 2014; Abramitzky and Boustan 2022; Fouka et al. 2022) and on the determinants of mortality in the early 20$^{th}$ century U.S. (Alsan and Goldin 2019; Ager et al. 2024) to research on the effects of places on health and longevity (Chetty et al. 2016; Deryugina and Molitor 2020; Finkelstein et al. 2021) and to the growing literature on climate and mortality (Deschênes and Moretti 2009; Deschênes and Greenstone 2011; Barreca et al. 2016; Carleton et al. 2022). Existing work in economics typically studies the effects of the climate or temperature exposure individuals experience at destination. Physiology and epidemiology studies show that the response to thermal stress depends on how adapted individuals and populations are to local climatic conditions (Périard et al. 2015; Daanen et al. 2018; Tobías et al. 2021), and that the mortality advantage typically enjoyed by immigrants is smaller among those who move to colder climates (Shor and Roelfs 2019). Our results show that the consequences of climate exposure depend not only on conditions at destination, but also on how those conditions compare with the climate to which migrants are accustomed.

Finally, our findings have broader implications for empirical and quantitative approaches to migration. First, since Altonji and Card (1991) and Card (2001), a large empirical literature has used the historical geographic distribution of immigrant groups to predict where subsequent migrants from the same origins settle (Boustan 2010; Tabellini 2020; Bazzi et al. 2023).[2] These designs take initial origin-specific settlement shares as given and typically set aside the underlying causes of the migrant distribution. Our finding that climate similarity systematically shapes migration provides a partial microfoundation for those historical settlement patterns. This is in line with Hunt (1992), who showed that climatic variation helped shape the flow of repatriates from Algeria to France.

A second implication relates to quantitative models of migration and climate adaptation. Recent work studies the global consequences of climate change using spatial general-equilibrium models in which individuals adjust across locations and occupations (Cruz and Rossi-Hansberg 2024; Desmet and Rossi-Hansberg 2024; Bilal and Rossi-Hansberg 2025). These models treat local climate as a destination-level amenity or productivity shifter that enters identically for every migrant, whereas our results show that migrants care about climate distance from their origin. As warming alters the climatic similarity between origins and potential destinations, it will shift bilateral migration incentives. We do not quantify this channel here, but our findings suggest that spatial adaptation models should allow migration costs and climate amenities to vary by origin–destination pair.

2. For formal discussions of shift–share research designs, see Jaeger et al. (2018), Adão et al. (2019), Goldsmith-Pinkham et al. (2020), and Borusyak et al. (2022).

# 2 Climate Matching in Migration

## 2.1 Data and Measurement

This section describes the main data sources and variables used to study the relationship between climate distance and migration. Table B.1 provides the complete list.

**International migration.** Our analysis covers the two major waves of U.S. immigration (Abramitzky and Boustan 2017). During the Age of Mass Migration (1850–1920), over 30 million Europeans moved to the United States, initially from Northern and Western Europe and later increasingly from Southern and Eastern Europe as transportation costs fell (Hatton and Williamson 1998; Abramitzky and Boustan 2017). Immigrants tended to concentrate in distinct regions—Scandinavians and Germans in the Midwest; Italians in the Northeast, Mid-Atlantic, and California. Immigration was overwhelmingly European during this period (Figure A.1, Panel A), and few migrants settled in the U.S. South, with notable exceptions like Mexicans in Texas (Figure A.2, Panel A). Canadians tended to settle in northern border states. After World War I, restrictive quota laws sharply curtailed inflows, and the immigrant share of the U.S. population fell from 14% in 1920 to 5% by 1960 (Figure A.1, Panel B). The 1965 Immigration and Nationality Act reversed these restrictions and ushered in a new era (King 2002): by 2010, immigrants came predominantly from Latin America and Asia rather than Europe, and their settlement patterns had shifted toward the South and West (Figure A.2, Panel B).[3]

We construct two complementary measures of migration to the United States. First, to study subnational migration flows, we link the 1865, 1900, and 1910 Norwegian full-count Censuses to the 1880, 1910, and 1920 U.S. full-count Censuses and measure flows from municipalities in Norway to U.S. counties over the three periods 1865–1880, 1900–1910, and 1910–1920. Second, to study aggregate immigrant flows from foreign countries of origin to U.S. counties, we use U.S. full-count Census data from 1880 to 1920 (Ruggles et al. 2021), together with microdata from the U.S. Census and the American Community Survey (ACS) from 1970 to 2010.[4] For this aggregate country-of-origin sample, we collapse the data to the country-of-origin by U.S. county-of-residence by decade level. For all census years from 1900 onward, we identify immigrants using the year-of-arrival question and restrict the sample to individuals who arrived in the previous decade. Because the year-of-arrival question is not available in the 1880 Census, the 1880 observation includes all foreign-born individuals and therefore measures immigrant stocks rather than decadal arrival flows. Our results are unchanged when excluding 1880. For the aggregate country-of-origin sample, we follow the harmonization approach of Burchardi et al. (2019), who standardize countries and counties to their 1990 boundaries. For compatibility with modern administrative data, we adapt this procedure to map all counties to their 2010 definitions.[5]

3. See Table A.1 for the top-10 immigrant-sending countries during the two immigration eras.
4. The 1890 Census was destroyed in a fire. We therefore exclude the 1890 Census year from the analysis.
5. A small number of county–year observations (58) display immigrant population shares above one. These cases

**Internal migration.** As for international immigration, we consider both historical and modern internal migration. For the historical period, we focus on 1850 to 1940. This period was characterized by the westward expansion of white settlement (Steckel 1983; Bazzi et al. 2020), the diffusion of railroads (Fogel 1964; Donaldson and Hornbeck 2016), and the country's transition from a rural to an urban and industrial economy (Eckert et al. 2023). As a result of this process, the population center of gravity shifted from the East to the Midwest (Figure A.3).[6]

We measure historical internal migration using linked individual Census records from 1850 to 1940 available through the Census Tree Project (Price et al. 2021; Buckles et al. 2025).[7] Harmonized addresses for over 94% of the sample are obtained from the Census Place Project (Berkes et al. 2023). For the modern period, we use IRS Change-of-Address Tables (available for 2011–2022). Our baseline analysis uses 2011–2019 annual county-to-county flows, which draw upon year-to-year address changes reported on individual income tax returns.[8] To avoid any distortions created by the COVID-19 pandemic, we further exclude post-2019 observations (though results are robust to including 2020 and 2021).

**Climate.** We use mean annual temperature, measured in degrees Celsius, and monthly precipitation, measured in millimeters, from TerraClimate (Abatzoglou et al. 2018), a global gridded dataset widely used in climate research, to characterize local climate. We define climate using 1960–2000 long-run normals, capturing the persistent climatic environment migrants would expect to face, and assign these values at the finest geographic level available in the migration data.[9] For U.S. counties, we aggregate TerraClimate gridcells to county boundaries using gridcell-decade population from Klein Goldewijk et al. (2017) as weights. For the Norway–U.S. analysis, we similarly construct origin climate at the Norwegian municipality level, allowing us to measure climate distance at a comparable subnational scale. For all other international origins, historical censuses identify only country of birth, so we construct country-level climate by aggregating gridcells within

occur only in the historical 1880–1920 period and almost exclusively in counties with very small populations, likely reflecting enumeration errors or inconsistencies in the boundary-adjustment procedure. We set these observations to missing, although results are unchanged if we retain them, either using the raw values or after winsorizing.

6. Internal migration patterns changed in the 1930s, due to the Great Depression (Rosenbloom 2002; Fishback et al. 2006) and environmental shocks like the Dust Bowl (Hornbeck 2012, 2023).

7. Since 1890 is not available, we measure migration from 1880 to 1900. Our baseline results include all individuals aged 15 and older in the pre-migration census year in the linked sample, but the estimates are robust to restricting the sample to men. As discussed below, results are also robust to using linked samples from Abramitzky et al. (2020) and to relying on the 1940 full count Census to measure migration between 1935 and 1940.

8. See IRS Statistics of Income (SOI) Division Tax Stats—Migration Data, https://www.irs.gov/statistics/soi-tax-stats-migration-data. The dataset is available for filing years 1991 through 2022, but we focus on migration flows measured after 2011 when several changes to the underlying construction of the data were implemented. These include (i) incorporating all tax returns filed and processed within the full calendar year (rather than only those processed by early fall), (ii) improving year-to-year matching by using the TINs of primary, secondary, and dependent filers, and (iii) revising tabulations and expanding available breakdowns.

9. TerraClimate begins in 1958 and therefore does not measure climate contemporaneously with historical migration. This limitation is unlikely to be consequential because the cross-sectional variation in climate distance is highly stable during the 20$^{th}$ century. As a robustness check, we also use climate data from the Climatic Research Unit (Harris et al. 2020), which extend back to 1901.

national boundaries, weighted by population in each decade.[10] This approach maximizes spatial precision given the geographic information available in each migration dataset. Climate distance is then defined as the absolute difference in these long-run normals between origin and destination.

Figure A.4 displays the spatial distribution of average temperature across U.S. counties. Figure A.5 shows the temperature distance between each U.S. county and four major immigrant-sending countries. Figure A.6 plots temperature distances between each U.S. county and selected counties in the Mississippi Delta (Panel A) and the Northeast (Panel B).

## 2.2 Main Results

We begin by documenting a strong positive relationship between climate similarity and migration. Using information from the 1880 full-count U.S. Census, Figure 1 shows that the temperature in immigrants' county of residence is positively correlated with the temperature in their country of birth. That is, immigrants from warmer countries settled in warmer parts of the United States, while immigrants from colder countries settled in colder parts of the United States.

**Empirical strategy.** We formalize this motivating evidence by estimating gravity models common in the trade literature (Anderson and Van Wincoop 2003). In this framework, origin-destination flows are a function of origin-specific factors, destination-specific factors, and bilateral distances. Our central innovation is to augment the standard gravity model with climate distance, measured as the origin-destination absolute difference in average temperature ($\text{Dist}_{od}^{\text{Temp}}$) and precipitation ($\text{Dist}_{od}^{\text{Prec}}$), alongside physical distance ($\text{Dist}_{od}^{\text{Physical}}$). Because many origin-destination pairs record zero flows, we estimate all regressions using Poisson Pseudo-Maximum Likelihood (PPML).

Our baseline specification is:

$$M_{odt} = \exp\left[\alpha_{ot} + \gamma_{dt} + \beta^T \text{Dist}_{od}^{\text{Temp}} + \beta^P \text{Dist}_{od}^{\text{Prec}} + \theta \text{Dist}_{od}^{\text{Physical}}\right] \epsilon_{odt}, \tag{1}$$

where $M_{odt}$ is the number of migrants from origin $o$ to U.S. destination county $d$ in period $t$. Origins are Norwegian municipalities in the Norway–U.S. sample, countries in the international samples, and U.S. counties in the internal samples; $t$ indexes matched census cohorts, census decades, or calendar years, respectively. The fixed effects $\alpha_{ot}$ and $\gamma_{dt}$ absorb origin- and destination-period factors. Thus, $\beta^T$ is identified from variation in temperature distance across origin–destination pairs within a period, conditional on precipitation and physical distance. Standard errors are clustered by Norwegian province × U.S. destination state in the Norway–U.S. sample, by country of origin × U.S. destination state in the international samples, and by U.S. state of origin × U.S. state of destination in the internal samples.

One identification concern is that climate distance may proxy for geographic distance. Table A.2

10. We verify robustness to using climate averages over gridcells within a 25 km radius of each country's capital city.

shows that this concern is limited in the international setting: flexible polynomial functions of physical distance explain at most 1.6% of the variation in temperature distance between country–county pairs. The relationship is stronger for county pairs within the contiguous United States, where physical distance explains up to 19.9% of the variation in temperature distance, but most variation in climatic similarity remains independent of physical distance. Figures A.4–A.6 illustrate the point visually: while latitude drives some temperature variation, other geographic features such as mountains and coastlines generate substantial climate heterogeneity across both nearby and distant locations. We return to this concern in the robustness discussion below and in Appendix C.2.

**Baseline estimates.** We present the results from equation (1) in Table 1, separately for Norwegian (column 1), international (columns 2–3) and internal (columns 4–5) migration. Across all three settings, migration declines with temperature distance: flows are systematically larger between origins and destinations with more similar temperatures, consistent with Figure 1. Geographic distance also strongly reduces migration, in line with well-established spatial frictions (Schwartz 1973; Bryan and Morten 2019). The coefficient on precipitation distance is generally negative as well, although less stable across specifications and robustness checks. This contrast motivates our focus on temperature distance as the preferred measure of climate similarity.

One interpretation for the stronger temperature—rather than precipitation—results is that temperature acts as a sufficient statistic for the climate conditions migrants expect: it is easily observable, salient, and correlated with other features that could shape migrants' productivity, comfort, and cultural familiarity. The weaker, less stable relationship between precipitation distance and migration also aligns with findings in the environmental economics literature, which generally identifies temperature as a more consistent predictor of human and economic outcomes. It is relatively difficult to mitigate temperature's direct effects on agricultural productivity, labor supply, and health, while precipitation effects tend to be more context-specific and mediated by factors such as irrigation, water storage, and soil (e.g., Schlenker et al. 2005; Carleton and Hsiang 2016; Proctor et al. 2022; Taylor 2026). Our subsequent analysis thus focuses on temperature distance, while continuing to control for precipitation distance in all specifications.

The implied magnitudes for Norwegian immigration (column 1), historical international migration (column 2), and historical and modern internal migration (columns 4 and 5) are large and broadly comparable: reducing temperature distance by 1°C increases migration by 8.1%, 19.0%, 36.6%, and 26.7%, respectively.[11] Results for modern international migration (column 3) are instead substantially smaller in absolute value and somewhat less precisely estimated: reducing temperature distance by 1°C increases migration by 1.9%. Depending on the specification, these effects are equivalent to reducing physical distance by 37 to 272 kilometers.

For the modern samples, we can also benchmark these magnitudes in wage-equivalent terms. Com-

11. The implied magnitude can be calculated as $100\times(e^{-\beta^T}-1)$, where $\beta^T$ is the estimated coefficient on temperature distance from (1). Since $\beta^T < 0$, this gives the percentage increase in migration associated with a 1°C reduction in temperature distance.

bining our estimates with a migration elasticity to real wages of 0.5 for international migration (Caliendo et al. 2021), a 1°C reduction in temperature distance generates the same predicted response as an approximately 3.9% increase in destination wages. Internal-migration elasticities of 1.5–4.5 (Tombe and Zhu 2019; Morten and Oliveira 2024) imply a wage-equivalent increase of approximately 5.4–17.1%. Although these comparisons rely on elasticities estimated in different settings, they indicate that climate similarity predicts migration responses comparable to substantial differences in geographic distance and economic opportunities. Finally, climate matching is also quantitatively comparable to the pull of established migrant networks (Munshi 2020). For international migration, Beine et al. (2011) estimate that a 10% increase in the destination diaspora raises immigration by 1–6%. Using these estimates as a benchmark, the predicted response to a 1°C reduction in temperature distance is equivalent to increasing the destination diaspora by approximately 3.2–20.9% for modern international migration.

**Summary of robustness checks.** The results are robust to a wide range of specifications and checks. In Appendix C.1, we first assess the sensitivity of the estimates to the sequential inclusion of additional controls and fixed effects (Tables C.1–C.5). We also show robustness to excluding continents and the 1880 census, or measuring climate with capital-city temperatures (Table C.6); and clustering standard errors at higher levels (Table C.7).

In Appendix C.2, we address the concern that climate distance may proxy for geographic distance, particularly in the internal migration setting where climate and space are more strongly correlated. We replicate the internal migration analysis under a series of increasingly demanding spatial specifications: (i) estimating regressions separately by direction of movement (Table C.8); (ii) excluding short-range and within-state moves, as well as potentially idiosyncratic states such as California and Florida (Table C.9); and (iii) allowing for nonlinear effects of geographic distance (Table C.10). Across these exercises, the historical internal migration results remain robust, with the exception of north–south moves. For modern internal migration, the estimated effects are generally smaller but continue to hold, except when focusing on vertical movements or when allowing for flexible polynomial controls for geographic distance.

In Appendix C.3, we further show that results are robust to controlling for origin–destination differences in a wide range of geographic characteristics—including elevation, coastal access, ruggedness, latitude, longitude, and soil quality—and, for Norway, bilateral differences in socioeconomic characteristics, elevation, and ruggedness (Tables C.11–C.19). For historical internal migration, the findings are also unchanged when we control for a rich set of bilateral economic and demographic characteristics (Figure C.1) and when we use time-varying travel-cost proxies (Table C.20). In Appendix C.4, we assess robustness to alternative climate definitions, such as measures of seasonal variability (Tables C.21–C.22) and alternative temperature statistics, including seasonal extreme temperatures (Tables C.23–C.24). Finally, Appendix C.5 assesses the robustness of the linked-sample estimates. The Norway–U.S. migration results are robust to alternative linking procedures

(Table C.25) and to excluding high-flow U.S. destinations, high-outflow Norwegian municipalities, large municipality–county flows, and Minnesota (Table C.26). The historical internal migration results hold under alternative sample restrictions and when using the linked samples from Abramitzky et al. (2020) or the 1940 full-count U.S. Census (Table C.27).

### 2.3 Exploiting Long-Run Changes in Climate

In Table 1, we exploited cross-sectional variation in bilateral climate distances computed from the average climatology of each location over the period 1960–2000. We now leverage variation that arises from *changes* in average climate occurring differentially across space. Specifically, we test whether, over the 20$^{\text{th}}$ century, the *change* in climate distance across space predicts the *change* in international and internal migration patterns.[12] We focus on two periods: a historical window in the early 20$^{\text{th}}$ century and a modern window in the early 21$^{\text{st}}$ century.[13]

Figure A.7 illustrates how climate distance between each U.S. county and the four countries shown in Figure A.5 has changed over time. The maps reveal substantial spatial variation in relative climate convergence and divergence. Faster warming in colder origin countries such as Norway and Germany reduces temperature distance to warmer U.S. regions, generating widespread decreases in climate distance (green shading) across the U.S. Southeast. For Mexico, by contrast, it is the colder northern regions that have become more similar, while the Southeast has grown more dissimilar. Figure A.8 presents analogous maps for two selected U.S. counties—one in the Delta (Panel A) and one in the Northeast (Panel B)—relative to all other U.S. counties.

We augment the gravity model in equation (1) by adding origin-by-destination fixed effects to absorb any pair-specific (time-invariant) factor. To allow the change in climate distance to be correlated with geographic distance, we further control for the interaction between geographic distance and period fixed effects. Formally, we estimate:

$$M_{od\tau} = \exp\left[\alpha_{o\tau} + \gamma_{d\tau} + \gamma_{od} + \beta^{T}\text{Dist}_{od\tau}^{\text{Temp}} + \beta^{P}\text{Dist}_{od\tau}^{\text{Prec}} + \theta_{\tau}\text{Dist}_{od}^{\text{Physical}}\right]\epsilon_{od\tau}, \tag{2}$$

where everything is as before, but $\tau$ refers to the period (historical or modern), $\gamma_{od}$ are origin-by-destination fixed effects, and $\theta_{\tau}\text{Dist}_{od}^{\text{Physical}}$ are period dummies interacted with geographic distance.

We present results in Table 2. In columns 1 and 2, we examine international migration, considering different time windows to measure migration flows (1900 and 2010; average over 1900–1920 and over 1990–2010, respectively). In columns 3 and 4, we focus on internal migration, using the 1900–1910 linked sample (resp., the 1900 to 1940 averages from the linked sample) and the 2018–2019 IRS migration data (resp., the average over the 2011–2019 period). The coefficient on temperature

12. While anthropogenic emissions have driven the overall warming of the climate since about 1980, such spatiotemporal variation is a normal part of the climate system, influenced by multi-decadal oceanic circulation patterns (e.g., North Atlantic Oscillation), solar variability, volcanic activity, and land use change.

13. The climate over the historical and modern periods is measured over 1901–1930 and 1991–2020, respectively.

distance is statistically significant at the 1% level in all specifications. Magnitudes are broadly consistent with those in Table 1—if anything somewhat larger for internal migration. A 1°C decrease in temperature distance over time—comparable to the average global temperature increase over the last century—increases migration by 35.9%–58.9%.

These patterns reduce concerns that the results in Table 1 may be driven by time-invariant origin-destination characteristics, such as shared language, cultural proximity, economic linkages, or historical migration patterns. By including origin-by-destination fixed effects, the specification absorbs all stable bilateral factors, allowing us to isolate the effects of changes in climate distance on changes in migration flows. The model in equation (2) also addresses the possibility that the observed effects are simply picking up the persistence of ethnic networks. Since networks tend to be persistent over time, any influence they exert that does not vary across periods is captured by the fixed effects.

# 3 Forces Shaping Climate Matching

## 3.1 Climate Matching over Time

One advantage of our setting is that it spans more than 150 years of migration history. This allows us to examine how the relationship between climate similarity and migration evolved over time. Figure 2 reports estimates from regressions analogous to equation (1), estimated separately for each historical period. We present results for Norwegian, international, and internal migration in Panels A, B, and C, respectively.[14] The figure documents that climate matching is remarkably persistent. In every period and across all settings, migrants systematically sort toward destinations whose climates resemble those of their places of origin. At the same time, the strength of climate matching declines over time. The attenuation is particularly pronounced for international migration, where temperature distance is a much stronger predictor of settlement during the Age of Mass Migration than in recent decades. Internal migration displays a similar, though more gradual, decline. Despite this attenuation, climate similarity remains an economically and statistically significant determinant of migration even in the most recent years.

The gradual decline in climate matching is consistent with economic development reducing the importance of local climatic conditions for migration decisions. As the U.S. economy industrialized, workers shifted away from agriculture and other climate-exposed sectors, reducing the value of local climate knowledge that may be difficult to transfer across environments (Steckel 1983; Bazzi et al. 2016). Technological progress also increasingly shielded households and workplaces from outdoor temperatures, making climatic differences across destinations less consequential. At the

14. Temperature distance is standardized to have mean zero and standard deviation equal to one within each subsample to facilitate comparisons across estimates. As a result, the coefficients are not directly comparable to those reported in Tables 1 and 2, where temperature distance is measured in degrees Celsius. Because the Norwegian linked samples end in 1920, they span a much shorter period than the other datasets and are therefore included primarily for comparison.

same time, the persistence of climate matching into the 21st century suggests that occupational exposure alone cannot account for the pattern and that migrants may also place direct value on living in a familiar climate. We return to these two mechanisms in the next subsection.

We focus on a key development which may have been instrumental to this shift: the diffusion of air conditioning after 1970. Because we do not observe local air-conditioning adoption, we test this mechanism indirectly by asking whether, after its widespread diffusion, hot destinations became more attractive to migrants from cooler climates and climate matching weakened along the summer-temperature dimension. Table A.3 implements this test by replicating the international migration analysis separately for the historical (1880–1920) and modern (1970–2010) immigration eras. We distinguish between January and July temperature distance and interact each measure with an indicator equal to one for destinations whose average July temperature lies above the national median ("South").[15]

Consistent with Figure 2, the overall effect of temperature distance remains negative in both periods (columns 1 and 4) but is substantially smaller in the modern era. Columns 2 and 5 distinguish between winter and summer temperatures. January temperature distance has the larger effect during the historical period, whereas July temperature distance becomes relatively more important in the modern period. Columns 3 and 6 allow the effects of January and July temperature distance to differ between hotter and cooler destinations. During 1880–1920, both winter and summer mismatch deterred migration to the hotter parts of the United States, with the larger and more precisely estimated interaction for January (column 3). During the modern period, after the widespread adoption of air conditioning, the interaction between July temperature distance and the South dummy switches sign and becomes positive, while the January interaction remains negative (column 6). The sign reversal is specific to summer heat, which is the pattern air conditioning would produce. Thus, although July temperature distance continues to reduce migration overall, its effect in hotter destinations is substantially attenuated.

If this attenuation reflects air conditioning's role in insulating from outdoor heat, it should be concentrated among workers whose climatic exposure is mediated by indoor environments. Columns 7 and 8 support this interpretation. The interaction between July temperature distance and the South dummy is positive and statistically significant for non-farmers, but small and statistically insignificant for farmers. Because agricultural production remains directly exposed to local weather conditions, this pattern is consistent with air conditioning reducing the direct costs of living in climatically unfamiliar destinations while leaving climate-sensitive production largely unaffected.

15. Ideally, we would replicate this exercise for internal migration as well. Unfortunately, comparable county-to-county migration data are not available for the 1970–2000 period, when air conditioning diffused rapidly across the United States.

### 3.2 Who Matches on Climate?

Having established how climate matching evolved over time, we now ask whether it varies across individuals. We rely on the linked historical samples of internal migrants, which span nearly a century and contain rich information on migrants' demographic and economic characteristics measured before migration. This allows us to study selection into climate matching based on pre-migration characteristics.

First, we ask whether climate matching is stronger among workers whose skills and livelihoods are more climate dependent. Figure 3, Panel A, reports estimates of equation (1) separately by industry.[16] The coefficient on temperature distance is largest for workers employed in agriculture, but remains economically and statistically significant in every industry, including services, where production is less exposed to local climatic conditions. Panel B documents a similar pattern when occupations are classified according to whether they are performed primarily indoors or outdoors and whether they are climate intensive.[17] Stronger matching among farmers and workers in climate-intensive occupations is consistent with climate-specific human capital being more difficult to transfer across environments. Yet climate matching remains substantial even among workers in indoor occupations and in service industries, indicating that occupational exposure alone cannot explain the pattern and that migrants value climatically familiar environments directly.

Second, we examine whether climate matching varies with a broader set of demographic and economic characteristics. In Figure A.9, the first coefficient reproduces the baseline estimate, while the remaining coefficients report estimates for different subsamples. Consistent with the occupational evidence, the clearest difference is between rural and urban households, with substantially stronger climate matching among rural migrants. Point estimates also suggest somewhat stronger matching among low-skilled and illiterate migrants, non-farmers with below-median occupational income scores, and households with children.[18] However, differences by sex, marital status, family structure, age, and homeownership are generally modest and not statistically significant. Thus, outside the dimensions most closely related to rural residence, climate matching varies relatively little across the demographic and socioeconomic characteristics we observe.

Finally, we explore heterogeneity by nativity and race. Climate matching is substantially weaker among foreign-born migrants. One possible interpretation is that, for these movers, the climate of their initial U.S. county is a less relevant reference point than the climate of their country of origin. Relative to U.S.-born whites, climate matching is also substantially weaker among Black migrants. This pattern is consistent with the distinctive geography of the Great Migration (Boustan 2016).

16. Throughout Section 3.2, we standardize temperature distance to have zero mean and standard deviation equal to one.

17. Industries (resp., occupations) are defined using the Census *IND1950* (resp., *OCC1950*) codes. Following Eckert and Peters (2025), we classify agriculture as codes 105 (agriculture), 116 (forestry), and 126 (fishery).

18. Similar to Medici (2024), we classify workers as high and low skilled using the mapping from 3-digit occupational codes (*OCC1950*) to skill groups from Katz and Margo (2014). For occupational income scores, we restrict attention to non-farmers because these scores provide limited variation within agricultural occupations.

Climatically similar destinations were concentrated in the South, where economic opportunities were more limited and racial discrimination and violence were severe. Moving toward the economic opportunities of the North therefore often required moving to less familiar climates. Weaker climate matching among Black migrants may therefore reflect the unusually high economic and social costs of choosing climatically familiar destinations, rather than a weaker preference for climatic familiarity itself.

### 3.3 Trading Off Climate Similarity and Economic Opportunities

We next examine how climate matching responds to variation in economic opportunities across destinations. We augment equation (1) by interacting temperature distance with economic pull factors.[19] A positive interaction indicates weaker climate matching in destinations with better economic opportunities. Origin-by-decade and destination-by-decade fixed effects absorb changes in overall out-migration and the direct effects of destination-side shocks, respectively. We focus on the linked historical samples of internal migrants and present the results in Table 3.

We consider two broad classes of pull factors. The first captures expansions in access to land and markets. Column 1 considers railroad access between 1860 and 1920 (Atack 2016), defining treatment as whether the destination became connected during the previous decade and restricting origins to counties already connected in the baseline decade.[20] Column 2 turns to the Homestead Act, defining exposure as whether the destination is in the top 20% of share of land patented nationally and restricting origins to counties that were never homesteaded.[21] Column 3 considers the westward expansion of the frontier between 1860 and 1890, with frontier status defined as in Bazzi et al. (2020).[22] The second class captures increases in local labor demand or public resources. Column 4 uses a Bartik-predicted measure of labor-demand growth.[23] Column 5 considers New Deal spending from Fishback et al. (2003). Because New Deal generosity may be correlated with the severity of the Great Depression, this specification also interacts temperature distance with the 1929–1933 decline in retail sales (Fishback et al. 2003; Feigenbaum 2015).

Across all five settings, stronger destination-side opportunities draw relatively more migrants from climatically distant origins. The attenuation is most pronounced for forces that expanded access to land and markets. Across the railroad, Homestead, and frontier exercises, a 1°C decrease in temper-

19. The regressions also interact each pull factor with precipitation and geographic distance.

20. The railroad database of Atack (2016) ends in 1911, so connection status in 1920 reflects the 1911 network.

21. The Homestead Act was the largest federal land-distribution program in U.S. history. Beginning in 1862, the Act offered settlers up to 160 acres of public land at little cost, provided that they resided on and cultivated it for five years (Smith 2026). We focus on 1870–1920, when the vast majority of Homestead patents were granted. Using alternative thresholds to define Homestead counties leaves results unchanged.

22. Although frontier expansion began earlier, we first observe destinations in 1860. We therefore focus on 1860–1890, when the frontier was still expanding and before its closure in 1890 (Turner 1893). Because linked data are unavailable for 1890, we assign the 1880–1900 migration sample to the 1890 frontier definition.

23. We construct the Bartik by interacting counties' initial industry shares with national industry growth, calculated leaving out the state, and apply a recentering procedure (Borusyak and Hull 2023).

ature distance increases migration by 41.8–49.3% toward unexposed destinations, compared with 17.2–31.9% toward exposed destinations. The Bartik and New Deal exercises yield the same qualitative pattern, although the attenuation associated with the Bartik shock is quantitatively modest. We next ask whether this response differs for farmers, who exhibit stronger climate matching at baseline (Figure 3). Because several of these opportunities—particularly railroad access, Homestead land, and the frontier—may have been especially valuable to farmers, it is not obvious whether the attenuation should be stronger or weaker for this group.

In Table A.4, we replicate the analysis in Table 3 separately for farmers (Panel B) and non-farmers (Panel C).[24] Consistent with Section 3.2, temperature distance predicts migration more strongly among farmers, although the coefficient remains large and statistically significant among non-farmers. The pull-factor interactions are similar between farmers and non-farmers and remain significant among both groups. New Deal spending is the exception (column 5): the interaction is twice as large for farmers as for non-farmers. Because this difference appears in only one setting, we interpret it cautiously.

These exercises should not be interpreted as isolating a single economic mechanism. Railroad expansion changed transportation costs and market access; Homestead and frontier counties differed in access to land and potentially land quality, living conditions, and migrant networks; and New Deal spending operated through several channels beyond local labor demand. We therefore interpret the results as broad evidence that economic forces can induce migrants to accept greater climate mismatch. The similar attenuation among farmers and non-farmers in most settings further suggests that this response was not confined to workers whose livelihoods were directly exposed to climate.

# 4 Climate Mismatch and Immigrant Well-Being

Section 2 showed that migrants systematically sort toward destinations whose climates resemble those of their origins. Yet climate matching is likely to be imperfect in practice. First, as documented in Section 3.3, destination-side economic opportunities induced migrants to accept greater climate mismatch. Second, migrants often had limited information about destination climates.[25] Focusing on international immigrants to the United States across settings spanning 1900 to 2019, we study whether the resulting mismatch is associated with three dimensions of well-being: fer-

24. To ease comparisons across samples, regressors are standardized to have mean zero and standard deviation equal to one within each subsample. Panel A reports the estimates for the full sample, corresponding to those in Table 3.

25. For example, English colonists expected North American climates to resemble those of corresponding European latitudes and were unprepared for the continent's harsh extremes (Kupperman 1982). Centuries later, without long-term precipitation records, homesteaders in the Great Plains discounted evidence of the region's drier climate (Libecap and Hansen 2002). Organized colonization also led to mismatch. In the 1840s, promotional accounts and Adelsverein land grants brought thousands of migrants from northern Germany to the much hotter Texas Hill Country, where chain migration sustained German enclaves for generations (Biesele 1930; Jordan 1966).

tility, child survival, and longevity.[26] We begin by outlining the main mechanisms through which climate mismatch may affect these outcomes (Section 4.1), before presenting the empirical evidence (Sections 4.2–4.4).

Because migrants choose where to settle, climate mismatch may be correlated with unobserved characteristics that also affect demographic outcomes. The implications for our estimates are *ex-ante* ambiguous. On the one hand, migrants with fewer resources may be less able to sort toward climatically familiar destinations, potentially generating a negative relationship between mismatch and well-being. On the other hand, more educated or higher-skilled migrants may face stronger economic incentives to accept climate mismatch if their employment opportunities are less tied to local climatic conditions, attenuating the negative relationship between mismatch and well-being. Selective return or onward migration could generate similar attenuation if migrants who suffered most from climatic mismatch were more likely to leave the destination.[27]

We mitigate concerns about selection in two ways. First, guided by the heterogeneity documented in Section 3.2, the fertility and child-survival specifications directly account for differences in agricultural employment across immigrant communities. Farm status and rural residence are among the few observable dimensions along which climate matching differs substantially, while differences across most other demographic and socioeconomic characteristics are modest. Agricultural composition therefore represents a salient observable source of differential sorting in these analyses.[28] Second, where individual socioeconomic information is more limited, as in the longevity data, we tighten the comparison substantially by comparing immigrants who lived in the same neighborhood and, separately, siblings from the same household who died in different counties. These checks assuage concerns about selection on observables and shared neighborhood- and family-level factors. They cannot rule out selection on characteristics that vary within families, however, so we interpret the evidence as descriptive rather than causal.

### 4.1 How Climate Mismatch May Affect Well-Being

A first channel linking climate mismatch to immigrant well-being is *economic*. Immigrants who settle in climatically unfamiliar places may earn less over their lifetimes if climate-specific human capital transfers imperfectly across environments (Bazzi et al. 2016)—a friction consistent with the stronger climate matching among farmers and workers in climate-intensive occupations documented in Section 3.2. Lower lifetime resources are, in turn, robustly associated with worse health and

26. Unlike child survival and adult longevity, where higher levels are unambiguously better, the relationship between fertility and welfare is less clear. Some people may prefer fewer children, and smaller family size may have associated socioeconomic benefits.

27. For instance, Abramitzky et al. (2019) document that among Norwegian immigrants to the U.S. during the Age of Mass Migration, those who returned to Norway were negatively selected.

28. Section 3.2 also documents weaker climate matching among foreign-born and Black internal migrants. These patterns are unlikely to confound the analysis here: our samples consist of international immigrants, so there is no variation in nativity status, while the weaker matching among Black migrants reflects the distinctive incentives of the Great Migration, which is outside the setting studied in this section.

shorter lives: a large literature documents a steep socioeconomic gradient in health that emerges in childhood (Case et al. 2002; Currie 2009) and extends to adult mortality (Cutler et al. 2006; Chetty et al. 2016).

A second channel is *physiological*. Physiological responses to temperature depend partly on the climate to which individuals are accustomed. The temperature at which mortality is minimized varies systematically across populations according to local climatic conditions (Heutel et al. 2021; Tobías et al. 2021), suggesting that previous climate exposure shapes the health effects of a given climate. Acclimatization develops with exposure and decays afterwards (Périard et al. 2015; Daanen et al. 2018), whereas any heritable component of climate adaptation changes across generations (Hancock et al. 2008; Daanen and Van Marken Lichtenbelt 2016). Immigrants may therefore remain imperfectly adapted to a new climatic environment after migration to the extent that adaptation is inherited rather than acquired.

These physiological mechanisms provide potential links to each of the outcomes we study. Heat exposure during pregnancy is linked to preterm delivery and low birth weight (Chersich et al. 2020; Lakhoo et al. 2025). Climate mismatch could therefore reduce the number of live births even if desired family size were unchanged.[29] Infants may be particularly vulnerable to climate mismatch: they regulate body temperature less effectively than adults, depend on caregivers to manage environmental conditions, and are more likely to experience adverse health effects from temperature exposure (Lakhoo et al. 2022). For adult longevity, by contrast, a persistent physiological effect of the origin climate would require adaptation that survives prolonged exposure to the destination environment or is transmitted across generations. The evidence for such persistence is limited: acquired heat adaptation decays with exposure, and only cold adaptation shows a heritable component (Taylor 2014; Daanen and Van Marken Lichtenbelt 2016).

A third channel operates through *climate-specific behaviors and knowledge*. Everyday practices can embody locally adapted knowledge accumulated over generations and transmitted through social learning (Boyd and Richerson 1985; Henrich 2016; Giuliano and Nunn 2021). Because such practices may adjust slowly, migrants can arrive with habits suited to the climatic and epidemiological conditions of their origins rather than their destinations (Nunn 2021). Even perceived thermal comfort reflects prior climatic exposure and adapts only gradually after migration (de Dear and Brager 1998; Luo et al. 2018). Climate mismatch may also carry psychological costs: discrepancies between internalized norms and the surrounding environment can reduce well-being (Fulmer et al. 2010; Stephens et al. 2012). These effects could in turn diminish longevity, given the association of social isolation and depression with mortality (Cuijpers et al. 2014; Holt-Lunstad et al. 2015).

Behavioral channels may have been especially important for child survival. Infant mortality in the early 20$^{\text{th}}$ century was high and strongly seasonal, with deaths concentrated in summer gastroin-

29. Thermal stress also reduces the probability of conception (Barreca et al. 2018) and increases the probability of stillbirth (Chersich et al. 2020).

testinal epidemics and winter respiratory diseases (Cheney 1984; Anderson et al. 2020; Eriksson et al. 2026). The timing of the dangerous season varied with climate, and survival depended partly on childcare practices—including breastfeeding, infant feeding, hygiene, and the handling of milk and water—adapted to the local seasonal cycle.[30] Preston and Haines (1991) argue that differences in these behaviors, rather than income alone, accounted for substantial variation in child mortality across immigrant groups during this period. Contemporary public-health accounts illustrate the potential consequences of transferring practices across climates. S. Josephine Baker, the first director of New York City's Bureau of Child Hygiene, recalled teaching immigrant mothers to abandon habits such as swaddling-bands, overdressing, and guarding against ventilation and "night air," which were ill suited to New York summers (Baker 1939, pp. 86, 117–118).[31] Behavioral responses could also affect fertility. Couples may postpone or limit childbearing in unfamiliar environments if adaptation raises the perceived costs or risks of family formation (Sobotka et al. 2011). In adulthood, practices involving clothing, diet, daily routines, and responses to seasonal risks may likewise transfer imperfectly across climates.

These three channels are not mutually exclusive, and our data do not allow us to estimate their relative importance. They do, however, have different observable implications. If climate mismatch affects well-being primarily through economic resources, its association with demographic outcomes should weaken once we account for observable socioeconomic differences across immigrant communities and as climate-specific skills become less important for production in the modern economy. Physiological maladaptation should be strongest among immigrants with greater direct exposure to the origin climate and should attenuate across generations, although inherited adaptation could generate some persistence. Culturally transmitted norms and practices, by contrast, may persist within families across generations. Practices that generate salient feedback, such as those affecting fertility and infant survival, may nevertheless adjust more quickly than practices whose consequences for adult health are diffuse or delayed. We use these predictions to interpret the evidence on fertility, child survival, and adult longevity below.

### 4.2 Fertility

**Baseline estimates.** To examine the relationship between climate mismatch and immigrant fertility, we use the full-count 1900 and 1910 U.S. censuses, which asked women to report the total number of children ever born.[32] To isolate births that occurred in the U.S., we restrict the sample

30. The Philadelphia Board of Health, for instance, distributed pamphlets on the "management of infants in the hot season," advising mothers to breastfeed through the child's second summer, avoid weaning during hot weather, and boil cow's milk and keep it on ice (Cheney 1984).

31. See Meckel (1990) on the broader infant-welfare movement.

32. The question was asked to ever-married women in 1910, but to both ever-married and never-married women in 1900. See Table B.1 for more details on this and the other variables used in the remainder of Section 4.

to foreign-born women aged 18–45 who married after arriving in the country.[33] The outcome is the number of U.S.-born children per foreign-born woman within each country-of-origin, U.S. county-of-residence, and census-year cell. We estimate:

$$Y_{odt} = \alpha_{ot} + \gamma_{dt} + \beta^T \text{Dist}_{od}^{\text{Temp}} + \beta^P \text{Dist}_{od}^{\text{Prec}} + \theta \, \text{Dist}_{od}^{\text{Physical}} + X'_{odt}\delta + \varepsilon_{odt}. \tag{3}$$

Temperature, precipitation, and geographic distances are defined as in Section 2.2; $\alpha_{ot}$ and $\gamma_{dt}$ denote country-of-origin-by-census-year and county-of-residence-by-census-year fixed effects; and $X_{odt}$ includes the 1880 immigrant stock from country $o$ in county $d$, as well as average years since migration, age, marriage duration, and the share of men working in agriculture in each origin-destination-year cell. The specification therefore compares immigrants from different origin countries living in the same county and census year, while accounting for historical enclave size and observable demographic composition. Controlling for agricultural employment directly addresses the concern that the stronger climate matching among farmers documented in Section 3.2 could confound the relationship between climate mismatch and immigrant outcomes. Standard errors are clustered at the country-of-origin-by-U.S.-state-of-residence level.

Table 4, Panel A, reports the results. Column 1 presents a specification with country-of-origin, county-of-residence, and census-year fixed effects. Column 2 interacts census-year fixed effects with origin and destination fixed effects. Columns 3 and 4 add origin-destination-year cell controls and the 1880 immigrant stock, respectively. Across all specifications, the coefficient on temperature distance is negative, statistically significant at the 1% level, and stable. In the preferred specification (column 4), a 5°C decrease in temperature distance is associated with 0.058 more U.S.-born children per foreign-born woman, or about 1.8% of the sample mean of 3.3 children per woman. This association reflects both a higher probability of having at least one child and more children among mothers. Columns 1 and 2 of Table A.5 show that a 5°C decrease in temperature distance increases the probability of having at least one child by 1.4 percentage points, or 1.6% relative to the sample mean, and the number of children among mothers by 1.0%, relative to a mean of 3.8.

**Interpretation and robustness.** We first consider whether the results partly reflect differences in marriage rates. Although our preferred specification already controls for the 1880 immigrant stock, climate mismatch may still be associated with lower marriage rates if immigrants in more climatically unfamiliar destinations face thinner marriage markets. At a time when nonmarital births were rare, this could mechanically reduce fertility (Teele and Schmidt 1970; Ventura and Bachrach 2000). To examine this possibility, we turn to a complementary outcome: the number of coresident U.S.-born children up to age 15 per foreign-born woman. Unlike children ever born, this measure is observed at the same time as marital status and can be constructed throughout 1880–

33. This restriction is possible because the 1900 and 1910 censuses record year of arrival, marital status, and the duration of the current marriage. Because nonmarital births were rare during this period (Teele and Schmidt 1970; Ventura and Bachrach 2000), the restriction excludes relatively few births. As a robustness check, we also replicate the analysis restricting the sample to women who arrived in the U.S. before age 15.

1920. Because it counts only surviving children, though, it reflects both fertility and child survival. Columns 3–5 of Table A.5 first show that this alternative measure yields a relationship similar to the 1900–1910 estimates. Columns 6–8 then restrict the same analysis to married women. The estimates remain virtually unchanged, suggesting that differences in marriage rates do not account for the relationship between fertility and climate mismatch.

We next examine whether the way we account for immigrant networks affects the results. Our baseline specification controls for the 1880 immigrant stock to reduce concerns that climate mismatch affects outcomes through the size of immigrant communities. Because our sample spans several decades, however, these initial networks may have had different effects over time. The second estimate from the left in Figure A.10, Panel A, therefore interacts the 1880 immigrant stock with census-year fixed effects. The coefficient is very similar to the baseline estimate, reported as the first point in the figure. A separate concern is that observable socioeconomic differences account for the relationship between fertility and climate mismatch. Our preferred specification already controls for agricultural employment. Figure A.10, Panel A, adds further origin-destination-year characteristics, including women's literacy, English proficiency, labor-force participation, and rural residence;[34] husbands' occupational income scores; and intermarriage with U.S.-born whites, who had lower fertility than immigrants during this period (Morgan et al. 1994). The coefficient is unchanged, even when all controls enter simultaneously, suggesting that observable socioeconomic characteristics are unlikely to explain the results. The estimates are also stable when sequentially excluding the ten largest origin countries and destination states (Panels B–C) and across maternal age groups (Panel D), although the estimate is smaller for mothers aged 18–24 and imprecise for mothers aged 35–45.[35]

Finally, we use differences in women's exposure to the origin climate to distinguish between mechanisms that require direct climatic experience and those that may persist across generations. As discussed in Section 4.1, if direct climatic exposure drives the fertility relationship, results should weaken as time spent in the origin climate declines. Restricting the sample to women who arrived in the United States before age 15 leaves the estimate essentially unchanged (Table A.6, column 2). By contrast, the relationship disappears among second-generation women, who were born and raised in the United States and never directly experienced their parents' origin climate (column 3).[36] This pattern is consistent with physiological adaptation to the destination climate occurring across generations. It is also consistent with climate-specific fertility norms and practices adjusting within immigrant families, so that behaviors carried by the first generation no longer shape fertility among their U.S.-born children.

34. Controlling for the share of immigrant women living in rural areas accounts for the fact that fertility was historically higher in rural areas (Grabill et al. 1958).

35. This imprecision is unsurprising given the relatively small number of births to mothers at these ages.

36. We define second-generation immigrants as individuals born in the U.S. with both parents born in the same country of origin.

### 4.3 Child Mortality

**Baseline estimates.** Table 4, Panel B, examines whether climate mismatch is associated with higher mortality among the U.S.-born children of immigrants, using the same 1900–1910 census data as in Section 4.2. Because these censuses report both the number of children ever born and the number dying, we can calculate the average share of children who died in each cell. Focusing on foreign-born women aged 18–45 who married after arriving in the United States, and restricting to cells with at least five children ever born, we estimate equation (3) using this child-mortality rate as the outcome. Across specifications, the coefficient on temperature distance is positive, stable, and statistically significant at the 1% level. This indicates that a larger share of U.S.-born children died when their parents settled in climatically less familiar locations. In the preferred specification (column 4), a 5°C decrease in temperature distance is associated with a 0.8 percentage point decrease in the child mortality rate, corresponding to approximately 5.1% of the sample mean death rate of 15.6%.

**Interpretation and robustness.** We first examine whether observable socioeconomic differences can account for the relationship.[37] Figure A.11, Panel A, interacts the 1880 immigrant stock with census year fixed effects, and progressively adds the same origin-destination-year controls considered for fertility in Section 4.2. The coefficient is unchanged, including when all controls enter simultaneously. As with fertility, observable socioeconomic differences therefore appear unlikely to be the main driver of the results. This echoes Preston and Haines (1991), who argue that income differences explained little of the variation in child mortality across immigrant groups in this period.

The remaining panels of Figure A.11 show that the estimates are robust to sequentially excluding the ten largest origin countries and destination states (Panels B–C), and remain stable across maternal age groups, although smaller and no longer statistically significant for mothers aged 30–45 (Panel D). Because younger mothers mechanically have younger children on average, the persistence of the relationship among these mothers suggests that the baseline result is not driven simply by longer cumulative mortality exposure among older children. Figure A.12 addresses this issue more directly by applying the Brass/Trussell method (Brass 1964; Trussell 1975; United Nations 1983; Preston and Haines 1991; Dribe et al. 2020) to convert the census measures into estimates of the probability of dying before ages one, two, three, and five.[38] The relationship with temperature distance remains positive at all four ages, although the estimate for mortality before age one is less precise.[39] These results indicate that the baseline relationship is not driven by differences across cells in children's duration of exposure to mortality risk. Figure A.13 also shows that the results are robust to alternative samples and outcome definitions. Including cells with at least one

37. Dribe et al. (2020) study child mortality across immigrant groups in the 1900 and 1910 censuses and show that differences in socioeconomic characteristics, residential context, and assimilation account for a substantial share of raw mortality differences across origins.

38. Appendix D provides details on the construction of these mortality estimates.

39. The age-one estimate is based on children of mothers aged 15–19 and should be interpreted cautiously because mortality estimates for this group are less reliable (United Nations 1983).

birth or restricting the sample to cells with at least 10 births produces similar, although somewhat weaker and less precise, estimates. Averaging mothers' individual child-mortality shares within origin-destination-year cells, rather than taking the ratio of cell totals, or controlling separately for the number of births strengthens the relationship.

Next, we ask whether the relationship persists as mothers' direct exposure to the origin climate declines. The estimate is essentially unchanged among first-generation women who arrived in the United States before age 15, but becomes quantitatively small and statistically insignificant among second-generation women (Table A.6, columns 5 and 6). This pattern mirrors the fertility results and is consistent with mechanisms that weaken across generations, including physiological adaptation and the adjustment of climate-specific norms and practices acquired in the origin environment. For child survival, behavioral adjustment may be particularly rapid because infant illness or death provides relatively immediate and salient feedback about feeding, hygiene, and other care practices, inducing families to change behaviors poorly suited to the destination climate.

**Modern era.** Finally, we ask whether the relationship between climate mismatch and child mortality persists in the modern era. Using CDC linked birth–infant death records from 2005 to 2019, we calculate infant mortality rates per 1,000 live births among U.S. births to foreign-born mothers.[40] We estimate equation (3) replacing census year with calendar year and report the results in Table 5. Across columns, we progressively include: country-of-origin, county, and year fixed effects (column 1); origin-by-year and county-by-year fixed effects (column 2); average maternal age, the share of mothers married, and the average number of prior births (column 3); and the log of 2000 immigrant stock (column 4).[41]

Across all specifications, the coefficient on temperature distance is positive and relatively stable; it is statistically significant at the 10% level in columns 1, 2, and 4. In column 4, a 5°C decrease in temperature distance is associated with 0.135 fewer infant deaths per 1,000 births, about 2.9% of the sample mean. The lower precision relative to the historical analysis may partly reflect the much lower incidence of mortality in the modern sample. The baseline historical outcome includes deaths beyond infancy and is therefore not directly comparable to the modern measure. Figure A.14 shows that the results are robust to sequentially excluding each world region of origin (Panel A), each of the ten largest countries of origin (Panel B), and each of the ten largest destination states (Panel C).[42] Table A.7 examines low birth weight (Panel A) and premature birth (Panel B), both predictors of infant mortality. Greater temperature distance is generally associated with worse outcomes, although these estimates are less stable than those for infant mortality and should be viewed as suggestive.

40. Infant deaths are defined as deaths occurring before age one. Although the data extend through 2021, we end the analysis in 2019 to avoid including the COVID-19 pandemic.

41. Maternal characteristics are calculated over 2005–2019 for each origin-destination cell. Controls differ from the historical analysis because of differences in context and data availability.

42. The only notable exception is Central and South America, whose exclusion reduces the coefficient by approximately one-third.

Together, these results suggest that the relationship between climate mismatch and infant health has weakened but not disappeared. Its persistence is notable given substantial improvements in housing, medicine, and climate control since the early 20$^{\text{th}}$ century. We cannot rule out economic differences across mothers, and the modern data provide fewer socioeconomic and demographic controls than the historical sample. However, the persistence of the relationship in the modern era, when agricultural employment is negligible, is consistent with a role for the non-economic channels discussed in Section 4.1.

### 4.4 Adult Longevity

**Baseline estimates.** We now ask whether immigrants who settled in less familiar climates died at younger ages. We use the Berkeley Unified Numident Mortality Database (BUNMD), which contains more than 49 million individual mortality records linked to Social Security administrative data (Goldstein et al. 2023). For foreign-born individuals who died in the United States between 1988 and 2005, the data report age at death, country of birth, and county of death. We restrict the sample to individuals 18 or older at death.

These records cover a later and more diverse immigrant population than the one studied in Sections 4.2 and 4.3. The average decedent died at age 76 and was therefore born in the 1910s or 1920s, too late to belong to the families observed in the 1900–1910 censuses. Reflecting broader changes in U.S. immigration over the 20$^{\text{th}}$ century (King 2002; Abramitzky and Boustan 2017), about 56% of immigrants in the sample were born outside Europe. The longevity analysis should therefore not be interpreted as following the same families over the life cycle, and magnitudes are not directly comparable across outcomes. We complement this analysis below with mortality records from 1959–1963, whose foreign-born decedents were born substantially earlier and are more closely connected to the cohorts studied above; in three states, these records also identify the U.S.-born children of immigrants, allowing us to extend the intergenerational analysis to longevity.

We estimate individual-level regressions of the form:

$$A_{iodb} = \alpha_{ob} + \gamma_{db} + \beta^{T}\text{Dist}_{od}^{\text{Temp}} + \beta^{P}\text{Dist}_{od}^{\text{Prec}} + \theta\,\text{Dist}_{od}^{\text{Physical}} + X'_{iodb}\delta + \varepsilon_{iodb}, \tag{4}$$

where $A_{iodb}$ is the age at death of individual $i$, born in country $o$ in year $b$ and dying in U.S. county $d$; $\alpha_{ob}$ and $\gamma_{db}$ denote country-of-origin-by-birth-year and county-of-death-by-birth-year fixed effects; and $X_{iodb}$ includes the log 1980 immigrant stock for each origin–destination pair, an indicator for being female, and the year of Social Security application, which we use as an imperfect proxy for year of migration. Standard errors are clustered at the country-of-origin-by-U.S.-state-of-death level.

Identification comes from comparing immigrants from different origin countries who were born in the same year and died in the same county, while accounting for differences in historical enclave

size. These comparisons also help address an important feature of the mortality data. Because the BUNMD records deaths only between 1988 and 2005, age at death is observed within a cohort-specific window—for example, between ages 73 and 90 for individuals born in 1915—an inherent feature of age-at-death analyses using BUNMD-type data (Goldstein et al. 2023). Importantly, all individuals born in the same year face the same observation window. The origin-by-birth-year and county-by-birth-year fixed effects therefore absorb differences in age at death associated with cohort composition and origin- or destination-specific mortality profiles, while the control for year of Social Security application accounts for differences in arrival timing within these comparisons.[43] The remaining concern is attenuation: truncation excludes the earliest and latest deaths within each cohort and compresses observed differences in longevity, tending to bias estimated relationships toward zero. This bias would therefore work against finding a negative relationship between climate mismatch and longevity.

Table 6 presents the results. Columns 1–4 progressively introduce the fixed effects and controls described above. Across specifications, the coefficient on temperature distance remains negative and statistically significant, and becomes larger in absolute value, from −0.008 in column 1 to −0.012 in column 4. The preferred estimate (column 4) implies that a 5°C decrease in temperature distance is associated with roughly 22 additional days of life, relative to a sample mean age at death of 76.3 years.[44] We benchmark these estimates against effects documented in the place-based and clinical literatures. Finkelstein et al. (2021) estimate that moving from a tenth- to a ninetieth-percentile U.S. location raises life expectancy at age 65 by 1.1 years, making the baseline association with a 5°C climate mismatch about 5.5% as large. Childhood vaccines against measles, rubella, and pertussis increase life expectancy in the target population by about three days (Wright and Weinstein 1998), while common cancer screening programs yield lifetime gains of at most roughly three months, and often substantially less (Bretthauer et al. 2023). Thus, the estimated longevity association is modest but comparable to other population-level health effects. Valued at $100,000 per life-year (Cutler 2004), the 22 days correspond to approximately $6,000, or 18% of the $33,000 median annual earnings of full-time, year-round foreign-born workers in 2009 (U.S. Census Bureau 2010).[45] This magnitude is close to the 20% increase in destination wages that generates the same predicted migration response as a 5°C reduction in climate distance in Section 2.2.

**Within-neighborhood and within-family comparisons.** In Sections 4.2 and 4.3, we could directly control for agricultural employment, an important observable dimension of selection into climate matching (Section 3.2). The BUNMD records do not contain comparable information on occupation or other individual socioeconomic characteristics. They do, however, allow us to

43. Because the mean of a truncated outcome is a nonlinear function of latent longevity, additive fixed effects do not eliminate the effects of truncation exactly.

44. These estimates are distinct from evidence that moving to warmer U.S. locations raises life expectancy (Deschênes and Moretti 2009), or that place effects shape longevity (Finkelstein et al. 2021). Both reflect the level of destination attributes, which the county-of-death-by-birth-year fixed effects absorb.

45. This calculation values a descriptive association, not a causal effect, and applying contemporary valuations to this population is necessarily approximate. A $10 million value of a statistical life yields a figure of the same order.

tighten the comparison substantially, first by comparing immigrants within the same neighborhood and then by comparing siblings from the same family. Column 5 of Table 6 replaces the county-of-death-by-cohort fixed effects with five-digit ZIP-code-by-cohort fixed effects, comparing immigrants from different origins who were born in the same year and lived in the same neighborhood.[46] Because income, social status, health care, and environmental conditions can vary substantially across neighborhoods within counties (Chyn and Katz 2021), this specification absorbs much finer-grained destination-level heterogeneity than the baseline. The coefficient remains similar to that reported in column 4, implying approximately 16 additional days of life for a 5°C decrease in temperature distance. The stability of the coefficient suggests that differences in neighborhood conditions within counties do not account for the baseline relationship.

In the rest of Table 6, we exploit the fact that siblings can be identified for a subset of individuals in the CenSoc/BUNMD data.[47] Column 6 re-estimates the baseline specification on the sibling subsample without household fixed effects. The coefficient is statistically significant and somewhat larger than in the full sample ($-0.018$).[48] Column 7 then adds household fixed effects, identifying the coefficient from siblings who died in different counties and therefore experienced different degrees of climate mismatch.[49] This comparison absorbs family characteristics shared by siblings, including parental resources, upbringing, and family health endowments. The coefficient remains statistically significant at the 1% level and nearly doubles in magnitude, from $-0.018$ to $-0.033$, implying approximately 60 additional days of life for a 5°C decrease in temperature distance.[50] This pattern is consistent with positive selection across families into greater climate mismatch, or with selective return migration among families that stood to suffer most from climatic unfamiliarity.

**Additional robustness.** Figure A.15 shows that the baseline estimate is stable when we exclude, one at a time, each world region of origin (Panel A), each of the ten largest countries of origin (Panel B), and each of the ten largest states of death (Panel C). We also address a measurement concern arising from the use of county of death to proxy for the destination climate. The mortality records do not reveal where immigrants spent most of their adult lives, and late-life relocation—for instance, toward warmer climates after retirement—could cause county of death to mismeasure long-run climate exposure. Table A.9 uses the state where each individual's Social Security number was issued as a proxy for arrival location to assess this possibility. Column 1 reproduces the baseline

46. The ZIP-code specification drops 181,490 observations, about 11% of the baseline sample, for which the five-digit ZIP code is missing.

47. CenSoc/BUNMD identifies sibling groups by matching individuals on their parents' full names as recorded in the Social Security Numident records, allowing for minor spelling variation using Jaro–Winkler string distance. The sibling subsample comprises 106,422 individuals in 50,269 sibling groups, or 6.5% of the baseline sample. The inclusion of controls and fixed effects reduces the estimation sample to 96,768 individuals in 48,913 sibling groups.

48. Relative to the full sample, the sibling subsample is older at death (79.7 versus 76.3 years) and, by construction, over-represents immigrants whose parents also appear in Social Security records.

49. 60.9% (38.5%) of families include at least two siblings who died in different counties (states). Among siblings who died in different counties, the average within-family difference in temperature distance is 4.4°C (standard deviation 4.6), and the average geographic distance between counties of death is 1,204 km.

50. Results are similar when we control for birth order or the signed age difference between siblings (Table A.8, columns 3–4).

specification on individuals with known social security issuance states for comparison. Columns 2 and 3 separately consider stayers, whose state of death coincides with the state of issuance, and movers, who died in a different state; the estimates remain similar in both samples. Column 4 instead measures climate mismatch using the arrival state rather than the county of death and again yields a similar estimate.

**Earlier cohorts and the second generation.** We next use the NCHS Multiple Cause-of-Death files to examine earlier immigrant cohorts and extend the analysis to the second generation. For 1959–1961, these records report decedents' country of birth, yielding roughly 700,000 foreign-born deaths with an origin composition much closer to that of the cohorts studied in Sections 4.2 and 4.3.[51] As before, we restrict the sample to individuals aged 18 or older at death. Table A.10 presents the results.

The truncation problem discussed above is more severe in the NCHS data because deaths are observed over only three years, substantially narrowing the range of ages observed within each birth cohort. We therefore interpret these estimates more cautiously, focusing on whether the relationship remains negative across specifications rather than on any particular magnitude. The short mortality window also creates a specification tradeoff. Because age at death is tied to birth year when death year varies only from 1959 to 1961, fine birth-cohort fixed effects absorb substantial variation in the outcome; omitting them, however, risks confounding the estimates with cohort composition across origins. Column 1 therefore estimates a parsimonious version of equation (4) with country-of-origin and county-of-death fixed effects, gender, and the log 1930 immigrant stock for each origin–destination pair.[52] The coefficient on temperature distance is negative, statistically significant, and quantitatively large. Columns 2 and 3 add 20-year and 10-year birth-cohort fixed effects. The coefficient falls from $-0.124$ to $-0.025$ and $-0.008$, respectively, but remains negative and statistically significant. Further interacting 20-year (column 4) and 10-year (column 5) birth cohort fixed effects with country and county fixed effects leaves results unchanged.

The NCHS records also permit an intergenerational comparison that is unavailable in the BUNMD. In California, Massachusetts, and Rhode Island, death certificates recorded parental birthplace, allowing us to identify U.S.-born decedents with foreign-born parents.[53] Column 1 of Table A.11 re-estimates the 20-year birth-cohort specification (column 2, Table A.10) for first-generation immigrants in these three states, for whom the coefficient remains negative and statistically significant. Columns 2–5 then consider the U.S.-born children of immigrants.[54] For individuals whose parents were born in different countries, columns 2 and 3 assign climate distance using the father's and

51. Mortality records come from the CDC/NCHS Multiple Cause-of-Death files, accessed through the NBER.

52. The NCHS data do not consistently record marital status or year of migration, so these controls are omitted.

53. The parental-nativity supplement yields 177,246 second-generation adult deaths over 1960–1963. NCHS reassigned the parental-nativity country codes in 1962 without documentation; we reconstruct the code list and validate it by comparing origin composition across 1961–1962. Records with unresolved codes are treated as missing. The inclusion of controls and fixed effects reduces the number of observations to about 162,000–176,600, depending on the second-generation origin definition used.

54. The decedent's own country of birth was last recorded in 1961.

mother's country of birth, respectively; column 4 uses the average of the two; and column 5 excludes these cases altogether. Across all four specifications, the coefficient remains negative and statistically significant, as in the first generation.

**Interpretation.** The mortality results are potentially consistent with each of the three mechanisms discussed in Section 4.1. We have limited leverage on the economic channel because the mortality records contain little individual-level socioeconomic information. However, the within-neighborhood estimates suggest that differences in local socioeconomic conditions do not account for the relationship, while the within-family comparisons rule out explanations operating solely through shared family resources or background. Physiological adaptation may contribute among first-generation immigrants, but the persistence of the longevity relationship into the second generation makes a mechanism operating solely through individuals' own climatic experience less likely.[55] This persistence contrasts with fertility and child survival, for which the relationships disappear in the second generation. It is consistent with the intergenerational transmission of health-related practices and knowledge whose consequences for longevity are diffuse or delayed, generating weaker feedback and slower adjustment across generations, although it is also consistent with the transmission of unobserved characteristics that led the parents to settle in climatically distant locations.

# 5 Conclusion

This paper provides evidence that, over more than 150 years of U.S. history, climate similarity has shaped the geography of migration, and that climate mismatch is associated with worse demographic outcomes among immigrants. We first show that both international and internal migrants disproportionately settle in destinations whose climates resemble those of their origins. Economic opportunities attenuate, but do not eliminate, climate matching, suggesting that migrants are willing to accept greater climate mismatch when opportunities are available at destination. We then document that immigrants who settle in more mismatched destinations have lower fertility, higher mortality among their U.S.-born children, and shorter adult lives. Economic mechanisms alone are unlikely to account for these patterns; our evidence points to a role for physiological adaptation and the persistence of behaviors and norms that become less well suited in unfamiliar climates.

Our results point to two directions for future research. First, climate matching offers a way to predict the spatial distribution of immigrant groups. These predicted settlement patterns could provide leverage for testing longstanding theories that American regional cultures reflect the origins of the populations that settled them (Zelinsky 1973; Fischer 1989; Woodard 2011). Climate matching may be informative for studying cultural persistence because origin-specific practices and norms are likely to remain better suited to climatically familiar destinations. This may in turn facilitate the transplantation and persistence of cultural traits after migration (Giuliano and Nunn

55. An inherited component of climate adaptation could generate persistence across generations.

2021; Nunn 2021).

Second, our findings have implications for adaptation to climate change. While migration may allow households to leave deteriorating conditions, it may expose migrants to environments that differ from those to which their physiology, practices, and knowledge are adapted. Constraints ranging from national borders to housing markets may limit migrants' ability to choose climatically familiar destinations. At the same time, climate change can generate mismatch without migration, as local conditions gradually diverge from those to which resident populations are accustomed. The historical relationships we document should not be interpreted as estimates of the welfare costs of future climate change: gradual climatic change allows greater scope for acclimatization and behavioral adjustment than a discrete move, and modern technologies may mitigate the consequences of mismatch. Nevertheless, our results suggest that climate mismatch may remain a cost of both migration and adaptation in place. Quantifying this margin, and incorporating it into models of spatial and in-place adaptation to climate change, is an important direction for future work.

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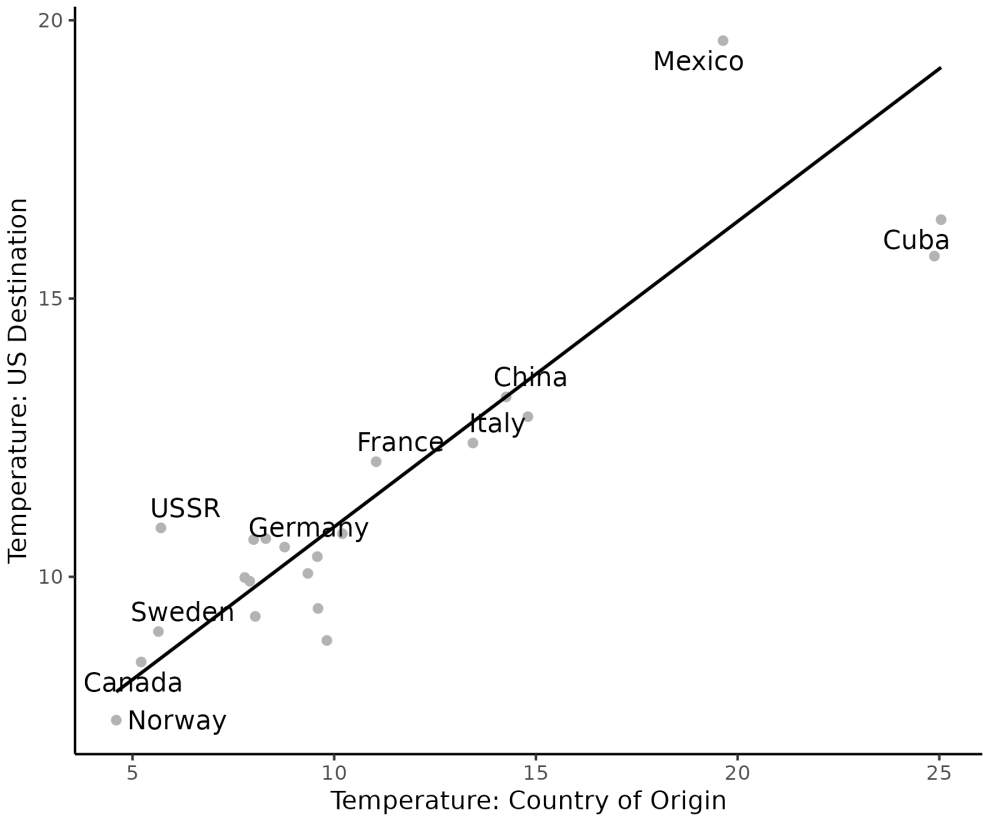
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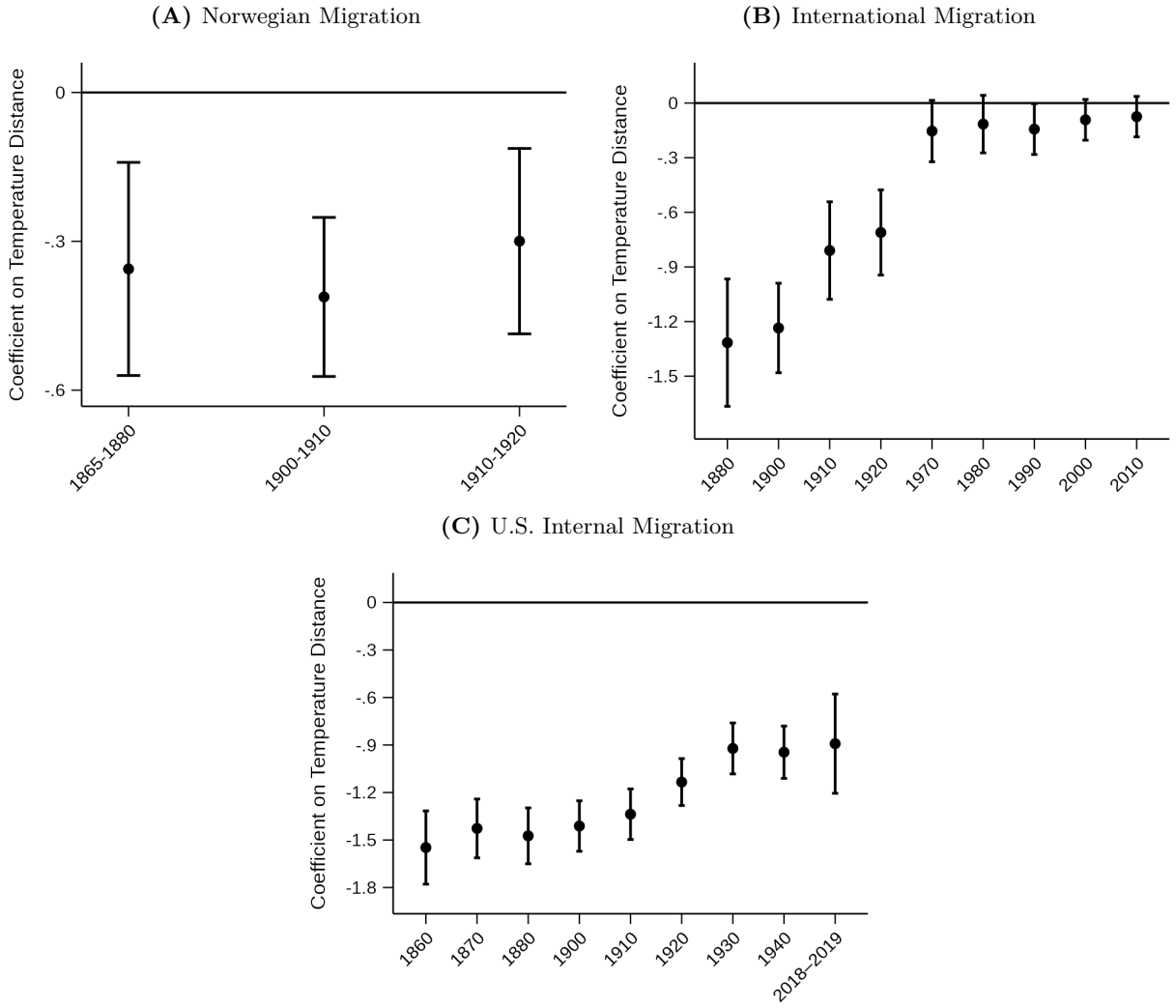
# Figures and Tables

**Figure 1.** Temperature Matching for Immigrants in the U.S. (1880)




*Notes:* The figure plots the relationship between temperature in immigrants' countries of origin (x-axis) and the weighted average temperature across U.S. counties in which immigrants from each origin resided in 1880 (y-axis), with weights given by each county's share of immigrants from that origin. The sample includes immigrants living in the contiguous United States in 1880 from countries accounting for at least 0.1% of the foreign-born population at the time. Country boundaries are harmonized to their 1990 definitions following Burchardi et al. (2019). Temperature, in degrees Celsius, is measured as mean annual temperature over the 1960–2000 period using TerraClimate data (Abatzoglou et al. 2018). Regressions are weighted by the number of individuals from each origin country residing in the United States. The estimated regression coefficient is 0.549, with a robust standard error of 0.082.

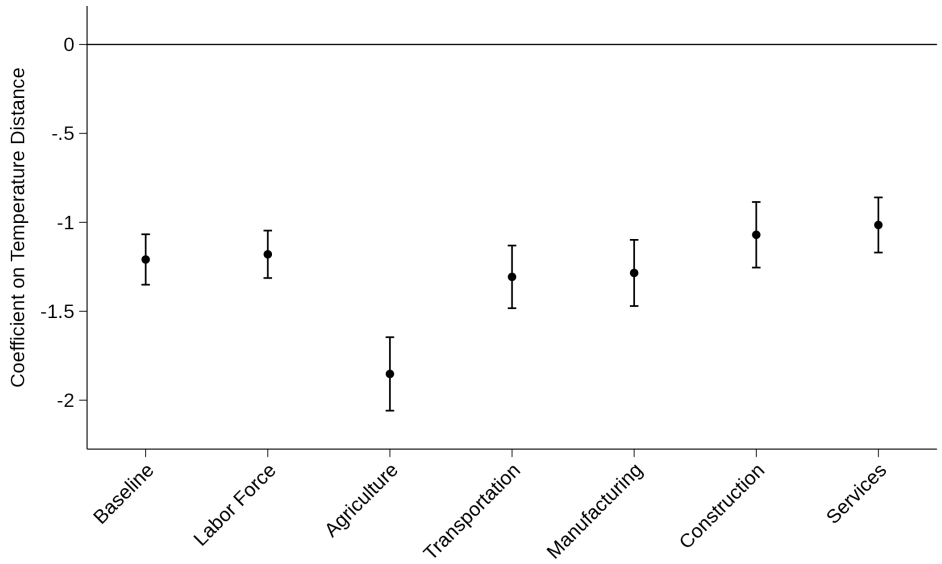
**Figure 2.** Climate Distance and Migration, by Period and Sample



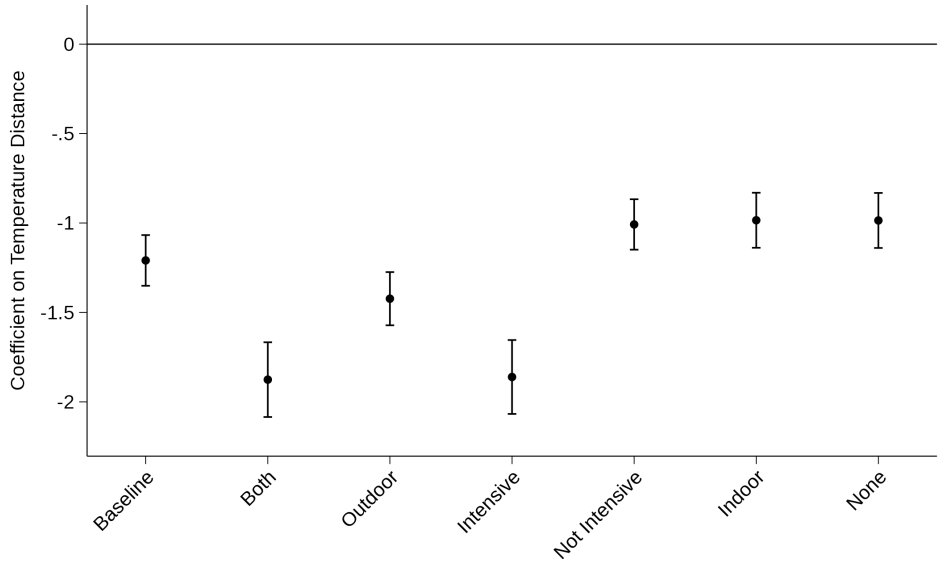

*Notes:* The figure plots the coefficient, with corresponding 95% confidence intervals, on the absolute difference in temperature between (A) Norwegian municipality of origin and U.S. destination county, (B) international country of birth and U.S. destination county, and (C) U.S. origin and destination counties for internal movers. Dots refer to the baseline specification, described in the notes of Table 1. The dependent variable is the number of immigrants over the corresponding period. Temperature distances are standardized within the relevant sample to have zero mean and standard deviation equal to one. Standard errors are clustered at the Norwegian province of origin by U.S. state of destination level in Panel A, at the country of origin by U.S. state of destination level in Panel B, and at the U.S. state of origin by U.S. state of destination level in Panel C.

**Figure 3.** Climate Distance and Migration: Heterogeneity in U.S. Internal Migration

**(A)** Heterogeneity by Industry




**(B)** Heterogeneity by Occupation




*Notes:* The figure plots the coefficient, with corresponding 95% confidence intervals, on the absolute difference in temperature between U.S. origin and destination counties for internal movers. The first dot in each panel shows the baseline specification from column 4 of Table 1. From the second dot onward, the number of migrants counts migrants aged 15–64 who are in the labor force in both the origin and destination census years (Labor Force) and who are also in the industry (Panel A, defined according to 3-digit IND1950 code from IPUMS) or occupation (Panel B, defined according to 3-digit OCC1950 code from IPUMS) reported on the x-axis in both census years. In Panel B, Both denotes occupations classified as both outdoor and climate intensive, and None denotes occupations classified as neither. Temperature distances are standardized within the relevant sample to have zero mean and standard deviation equal to one. Standard errors are clustered at the U.S. state of origin by U.S. state of destination level.

**Table 1.** Climate and Migration: Main Results

| Dep. Variable: | Number of Migrants | | | | |
|---|---|---|---|---|---|
| | Norway-U.S. 1865–1920 | Intl-U.S. 1880–1920 | Intl-U.S. 1970–2010 | Internal 1850–1940 | Internal 2011–2019 |
| | (1) | (2) | (3) | (4) | (5) |
| Temperature Distance | -0.078*** | -0.174*** | -0.019* | -0.312*** | -0.237*** |
| | (0.014) | (0.021) | (0.011) | (0.020) | (0.041) |
| Precipitation Distance | -0.001* | -0.002 | -0.008*** | -0.016*** | -0.030*** |
| | (0.001) | (0.004) | (0.002) | (0.002) | (0.006) |
| Distance (100 km) | -0.138*** | -0.064*** | -0.051*** | -0.210*** | -0.204*** |
| | (0.025) | (0.013) | (0.004) | (0.015) | (0.022) |
| Observations | 811,961 | 1,942,210 | 2,475,100 | 31,105,383 | 25,088,936 |
| Pseudo R-squared | 0.390 | 0.916 | 0.893 | 0.746 | 0.776 |
| Mean Temp. Dist. | 4.526 | 9.622 | 9.622 | 4.923 | 4.989 |
| SD Temp. Dist. | 3.790 | 5.752 | 5.685 | 3.578 | 3.632 |
| Mean Precip. Dist. | 53.36 | 52.67 | 53.92 | 31.01 | 31.06 |
| SD Precip. Dist. | 47.11 | 42.24 | 43.91 | 23.76 | 24.01 |
| Origin × Period FE | Yes | Yes | Yes | Yes | Yes |
| Destination × Period FE | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. Column 1 covers all Norwegian municipality–U.S. county pairs, linking the 1865, 1900, and 1910 Norwegian censuses to the 1880, 1910, and 1920 U.S. censuses, respectively, using the linking procedure of Abramitzky et al. (2021). The samples in columns 2–3 are international migration flows from the Burchardi et al. (2019) sample. The samples in columns 4–5 include county-pairs in the contiguous U.S. for each decade from 1850–1860 to 1930–1940 and for each calendar year from 2011–2012 to 2018–2019, respectively. In column 1, Number of Migrants is the count of Norwegian male immigrants aged at least 10 in the Norwegian census linked to the U.S. Census. In column 4, Number of Migrants is the number of individuals 15+ in the baseline year who moved from the origin to the destination county in the decade. In column 5, Number of Migrants is the number of people who changed address between origin and destination counties, based on IRS Migration data from individual income tax returns. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. In column 1, Origin $o$ refers to a Norwegian municipality. In columns 2–3 (resp., columns 4–5), Origin $o$ refers to the origin country (resp., the origin U.S. county). Destination $d$ refers to a U.S. county in all columns. In the fixed effects, period denotes the cohort in column 1, the decade in columns 2–4, and the year in column 5. Standard errors, reported in parentheses, are clustered at the U.S. state by Norwegian province level in column 1, at the country of origin by U.S. state of destination level in columns 2–3, and at the U.S. state of origin by U.S. state of destination level in columns 4–5. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table 2.** Climate Distance and Migration in the Long Run

| Dep. Variable: | Number of Migrants | | | |
|---|---|---|---|---|
| | Intl-U.S. | Intl-U.S. | Internal | Internal |
| | (1) | (2) | (3) | (4) |
| Temperature Distance | -0.326*** | -0.307*** | -0.463*** | -0.331*** |
| | (0.124) | (0.111) | (0.094) | (0.069) |
| Precipitation Distance | -0.021 | -0.016 | -0.038*** | -0.031*** |
| | (0.014) | (0.015) | (0.008) | (0.008) |
| Observations | 814,336 | 915,866 | 1,057,970 | 2,682,286 |
| Pseudo R-squared | 0.991 | 0.990 | 0.963 | 0.964 |
| Mean Temp. Dist. | 9.388 | 9.552 | 3.228 | 3.848 |
| SD Temp. Dist. | 5.831 | 5.855 | 2.875 | 3.233 |
| Mean Precip. Dist. | 50.62 | 51.75 | 22.07 | 24.97 |
| SD Precip. Dist. | 40.17 | 41.10 | 20.66 | 21.66 |
| Origin × Period FE | Yes | Yes | Yes | Yes |
| Destination × Period FE | Yes | Yes | Yes | Yes |
| Origin × Destination FE | Yes | Yes | Yes | Yes |
| Distance × Period FE | Yes | Yes | Yes | Yes |
| Migration Historical Period | 1900 | Avg. 1900–1920 | 1900–1910 | Avg. 1900–1940 |
| Migration Modern Period | 2010 | Avg. 1990–2010 | 2018–2019 | Avg. 2011–2019 |

*Notes:* PPML Estimates. The samples in columns 1–2 include U.S. county-country pairs for the two periods defined at the bottom of the table. The definition of countries of origin is fixed to 1990 boundaries and harmonized following the procedure in Burchardi et al. (2019). The samples in columns 3–4 include county-pairs in the contiguous U.S. for the two periods defined at the bottom of the table. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature (resp., mean monthly precipitation), measured in degrees Celsius (resp., monthly precipitation in millimeters), between the origin and the destination in the historical (1901–1930) and modern (1991–2020) periods. In columns 1–2 (resp., columns 3–4), Origin $o$ refers to the origin country (resp., the origin U.S. county). Destination $d$ refers to a U.S. county in all columns. All regressions also control for the absolute difference in precipitation between the origin and the destination in the historical and modern periods and the interaction between the modern period dummy and geographic distance, and include origin × period, destination × period, and origin × destination fixed effects. Standard errors, reported in parentheses, are clustered at the country (resp., U.S. state) of origin × U.S. state of destination level in columns 1–2 (resp., columns 3–4). Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table 3.** Internal Migration and Destination Pull Factors

| Dep. Variable: | Number of Migrants | | | | |
|---|---|---|---|---|---|
| | (1) Railroad | (2) Homestead | (3) Frontier | (4) Bartik | (5) New Deal[b] |
| Temp. Dist. × Pull Factor | 0.072*** | 0.209*** | 0.242*** | 0.015*** | 0.037*** |
| | (0.014) | (0.026) | (0.030) | (0.004) | (0.011) |
| Temperature Distance | -0.349*** | -0.368*** | -0.401*** | -0.311*** | -0.271*** |
| | (0.020) | (0.021) | (0.023) | (0.020) | (0.024) |
| Precipitation Distance | -0.018*** | -0.029*** | -0.028*** | -0.016*** | -0.015*** |
| | (0.003) | (0.004) | (0.004) | (0.002) | (0.002) |
| Distance (100 km) | -0.214*** | -0.213*** | -0.195*** | -0.211*** | -0.253*** |
| | (0.015) | (0.017) | (0.015) | (0.015) | (0.017) |
| Observations | 13,119,955 | 15,646,574 | 11,087,951 | 31,105,383 | 4,692,511 |
| Pseudo R-squared | 0.730 | 0.733 | 0.693 | 0.747 | 0.789 |
| Sample (Years) | 1860–1920 | 1870–1920 | 1860–1900 | 1860–1940 | 1930–1940 |
| Origin × Decade FE | Yes | Yes | Yes | Yes | Yes[a] |
| Destination × Decade FE | Yes | Yes | Yes | Yes | Yes[a] |

*Notes:* PPML Estimates. The sample includes all U.S. internal movers. Number of Migrants is the number of individuals who moved from the origin to the destination county. Sample (Years) lists the census year that ends each migration period (e.g., 1860 denotes 1850–1860); because there is no 1890 census, 1880–1900 is a single period, dated 1900. Each pull factor is interacted with all three distances (temperature, precipitation, geographic), not temperature alone; the precipitation and geographic interactions are included in every column but not reported. Column 1 uses Railroad: destinations newly connected at $t$, origins already rail-connected at $t-10$. Column 2 uses Homestead: destinations above the 80th-percentile homestead share, origins never above that threshold, 1870–1920. Column 3 uses Frontier: destinations newly on the frontier at $t$, origins that never entered the frontier between 1850 and 1890; the 1880–1900 period uses the 1890 frontier. Column 4 uses Bartik: a shift-share with 1850-fixed industry shares, recentered following Borusyak and Hull (2023), z-scored, with share-sum × year controls included for each of the three interacted distances and no origin restriction. Column 5 uses New Deal generosity: a single 1930–1940 cross-section, destination shock, z-scored, with no origin restriction. Standard errors, reported in parentheses, are clustered at the origin state × destination state level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

[a] Collapses to plain origin and destination fixed effects: only one decade (1930–1940) is in the sample for column 5.

[b] Column 5 enters Great Depression severity and New Deal generosity together in the same regression, each interacted with all three distances, to control for the severity of the Great Depression shock while identifying the New Deal effect off the same cross-section. Only the New Deal coefficient is reported, so that the table shows economic-opportunity pull factors only.

**Table 4.** Climate Distance, Children Ever Born, and Child Mortality (1900–1910)

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *Panel A: No. Children Ever Born per Woman* | | | | |
| Temperature Distance | -0.0147*** | -0.0157*** | -0.0179*** | -0.0115*** |
| | (0.0052) | (0.0051) | (0.0043) | (0.0042) |
| Precipitation Distance | -0.0018** | -0.0019** | -0.0009 | -0.0006 |
| | (0.0008) | (0.0008) | (0.0006) | (0.0006) |
| Distance (100 km) | -0.0038 | -0.0040 | 0.0010 | 0.0035 |
| | (0.0026) | (0.0027) | (0.0028) | (0.0028) |
| Observations | 47,957 | 47,658 | 45,606 | 45,606 |
| Adj. R-squared | 0.143 | 0.156 | 0.465 | 0.466 |
| Dep. Var. Mean | 3.259 | 3.256 | 3.266 | 3.266 |
| *Panel B: Share of Ever-Born Children Who Die* | | | | |
| Temperature Distance | 0.0016*** | 0.0016*** | 0.0014*** | 0.0016*** |
| | (0.0005) | (0.0005) | (0.0005) | (0.0005) |
| Precipitation Distance | -0.0003*** | -0.0003*** | -0.0003*** | -0.0003*** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Distance (100 km) | -0.0005 | -0.0005 | -0.0006* | -0.0005 |
| | (0.0003) | (0.0003) | (0.0003) | (0.0003) |
| Observations | 34,896 | 34,510 | 33,954 | 33,954 |
| Adj. R-squared | 0.100 | 0.108 | 0.113 | 0.114 |
| Dep. Var. Mean | 0.156 | 0.156 | 0.156 | 0.156 |
| Origin FE | Yes | | | |
| County FE | Yes | | | |
| Year FE | Yes | | | |
| Origin × Year FE | | Yes | Yes | Yes |
| County × Year FE | | Yes | Yes | Yes |
| *odt* Controls | | | Yes | Yes |
| Imm. Stock | | | | Yes |

*Notes:* OLS Estimates. The sample includes foreign-born women 18–45 married after arriving in the U.S., pooled 1900 and 1910 IPUMS USA full count. The unit of observation is the origin country × destination county × census year (*odt*) cell. In Panel A the dependent variable is the number of children ever born per woman, on *odt* cells with no minimum size. In Panel B it is the share of ever-born children who did not survive, on *odt* cells with at least 5 children ever born. Column 1 includes separate origin, county, and year fixed effects. Column 2 replaces these with origin × year and county × year interactions. Column 3 adds the *odt*-level controls (average years in the U.S., average age, average marriage duration, and the share of working-age (15–64) men in the labor force employed in agriculture in the *odt* cell). Column 4 adds the log 1880 immigrant stock from $o$ in $d$. Both panels use an identical specification. Standard errors, reported in parentheses, are clustered at the origin country × destination state level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table 5.** Climate Distance and Infant Mortality Rate

| Dep. Variable: | Infant Mortality Rate (per 1,000) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Temperature Distance | 0.027* | 0.030* | 0.026 | 0.027* |
| | (0.016) | (0.016) | (0.016) | (0.016) |
| Precipitation Distance | 0.000 | 0.001 | 0.001 | 0.001 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Distance (100 km) | -0.001 | -0.003 | -0.002 | -0.002 |
| | (0.006) | (0.006) | (0.006) | (0.006) |
| Observations | 186,734 | 175,497 | 175,497 | 175,497 |
| Adj. R-squared | 0.010 | 0.024 | 0.024 | 0.024 |
| Dep. Var. Mean | 4.692 | 4.660 | 4.660 | 4.660 |
| Country FE | Yes | | | |
| County FE | Yes | | | |
| Year FE | Yes | | | |
| Country × Year FE | | Yes | Yes | Yes |
| County × Year FE | | Yes | Yes | Yes |
| Mother Controls | | | Yes | Yes |
| Imm. Stock | | | | Yes |

*Notes:* OLS Estimates. The sample is an origin country × U.S. county × year panel covering 2005–2019 (selected to exclude the COVID years). Infant Mortality Rate is infant deaths per 1,000 live births. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 includes separate country, county, and year fixed effects, with the distance variables only. Column 2 replaces these with country × year and county × year fixed effects, again with the distance variables only. Column 3 adds the mother controls (average age, share married, and average prior live births), which are origin–destination constants held fixed across years. Column 4 adds the log 2000 immigrant stock $(o, d)$. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table 6.** Climate Distance and Age at Death

| Dep. Variable: | Age at Death | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Temperature Distance | -0.008** | -0.008** | -0.009*** | -0.012*** | -0.009*** | -0.018*** | -0.033*** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.006) | (0.012) |
| Precipitation Distance | -0.002*** | -0.002*** | -0.001** | -0.001** | -0.001*** | -0.004*** | -0.004* |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.000) | (0.001) | (0.002) |
| Distance (100 km) | -0.001 | -0.001 | -0.001 | -0.002* | -0.002 | 0.001 | 0.008 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.003) | (0.006) |
| Observations | 1,625,620 | 1,588,364 | 1,588,171 | 1,588,171 | 1,406,681 | 96,768 | 88,610 |
| Adj. R-squared | 0.875 | 0.869 | 0.870 | 0.870 | 0.846 | 0.617 | 0.614 |
| Dep. Var. Mean | 76.11 | 76.26 | 76.26 | 76.26 | 76.77 | 79.66 | 79.62 |
| Sample | All | All | All | All | All | Siblings | Siblings |
| County FE | Yes | | | | | | |
| Country FE | Yes | | | | | | |
| Birth Cohort FE | Yes | | | | | | |
| County × Cohort FE | | Yes | Yes | Yes | | Yes | Yes |
| Country × Cohort FE | | Yes | Yes | Yes | Yes | Yes | Yes |
| Individual Controls | | | Yes | Yes | Yes | Yes | Yes |
| Imm. Stock | | | | Yes | Yes | Yes | Yes |
| ZIP × Cohort FE | | | | | Yes | | |
| Household FE | | | | | | | Yes |

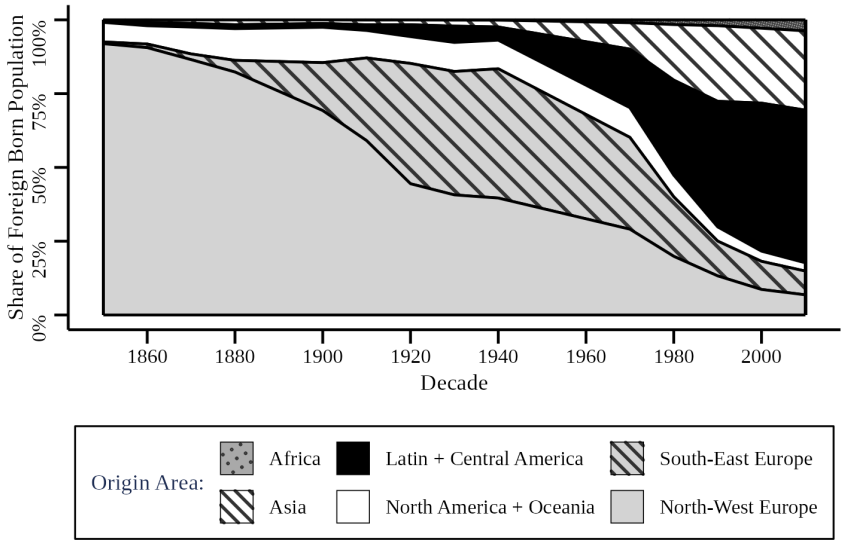
*Notes:* OLS Estimates. The sample includes BUNMD immigrants who died 1988–2005 at age 18 or older. Age at Death is the age in years at which the individual died. Column 1 includes separate country, county of death, and 1-year birth-cohort fixed effects. Column 2 replaces these with country × cohort and county × cohort interactions. Column 3 adds individual-level controls (gender, year of SS application). Column 4 adds the log 1980 immigrant stock $(o, d)$. Column 5 replaces county × cohort fixed effects with 5-digit ZIP code × cohort fixed effects, comparing immigrants who lived in the same neighborhood (column 4 remains the baseline). Column 6 re-estimates the baseline on the sibling subsample (individuals with at least one linked sibling), without household fixed effects, as a selection check. Column 7 adds household fixed effects to column 6. The *Sample* row indicates whether a column uses all decedents or only those with at least one linked sibling. In column 7 the coefficient is identified from sibling groups whose members died in different counties, since climate distance does not vary within a group that died in the same county. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of death level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

# Appendix

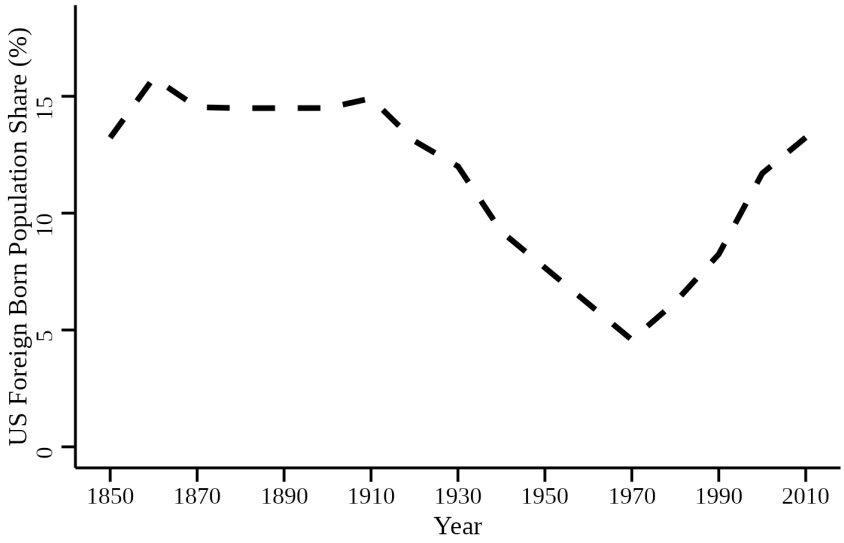
## A Additional Figures and Tables

**Figure A.1.** U.S. Foreign Born Population, 1850–2010

**(A)** U.S. Foreign Born Population by Origin



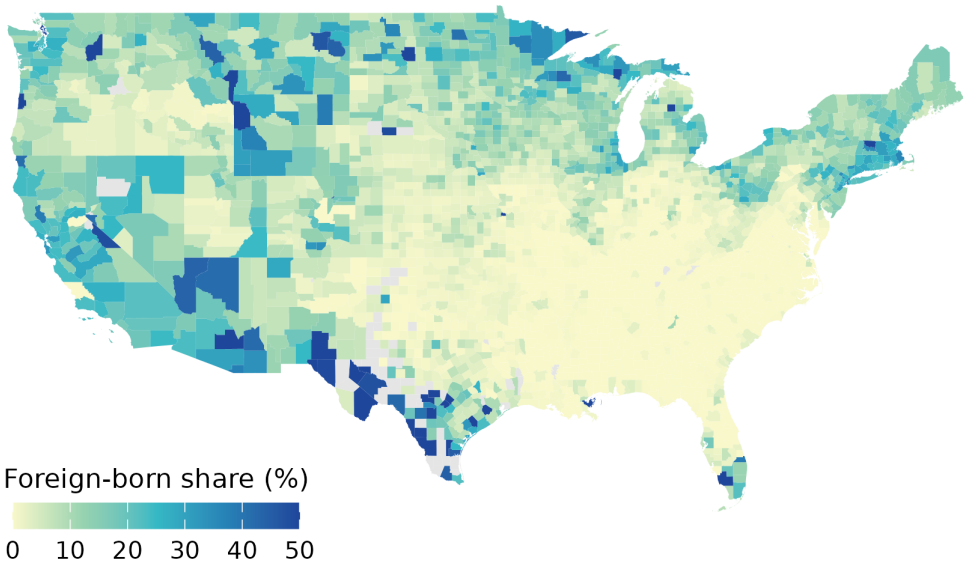

**(B)** U.S. Foreign Born Population Share



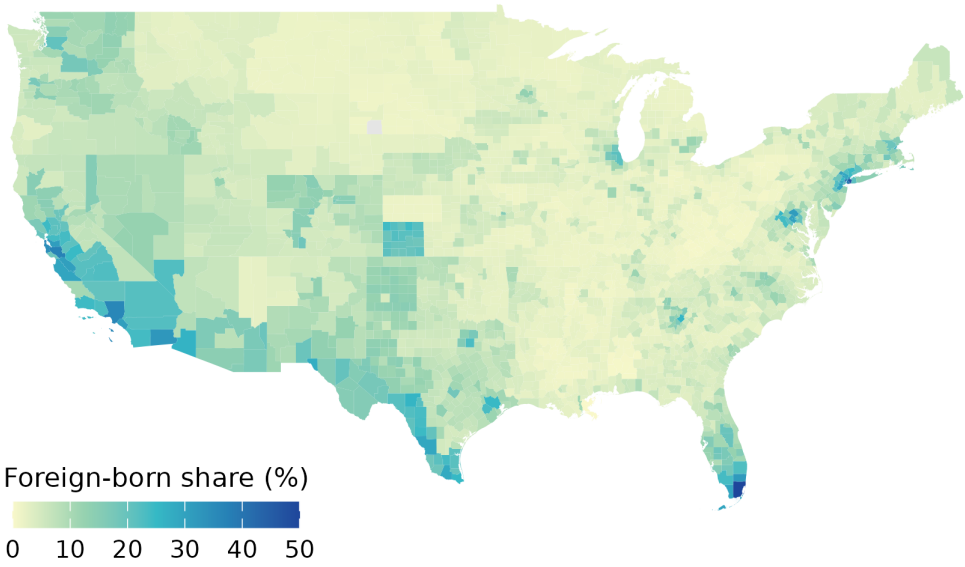

*Notes:* Panel A displays the U.S. foreign-born population share by origin region from 1850 to 2010. Panel B displays the immigrant population share from 1850–2010. Data for 1850 to 1940 come from full count U.S. Censuses (Ruggles et al. 2021). Data for 1970–2010 come from IPUMS micro-samples and from the American Community Survey (ACS).

**Figure A.2.** Immigrant Population Share

**(A)** 1920

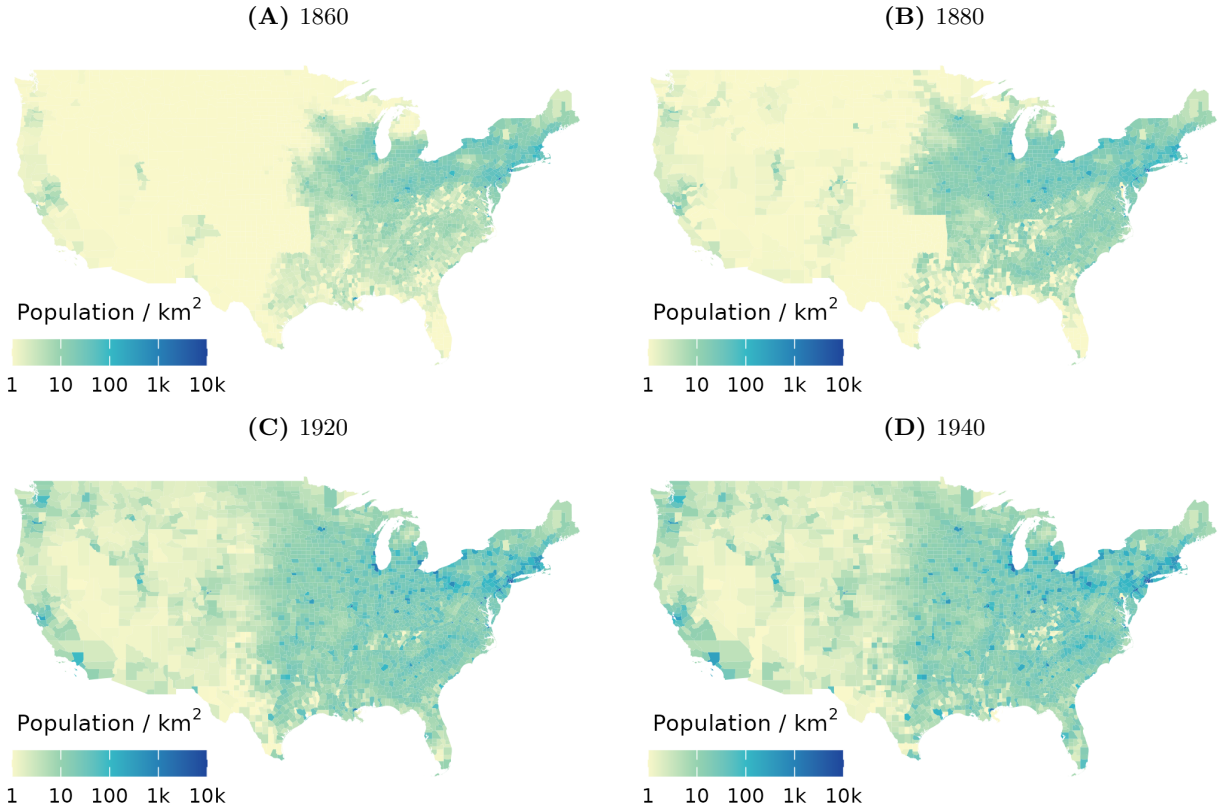



**(B)** 2010



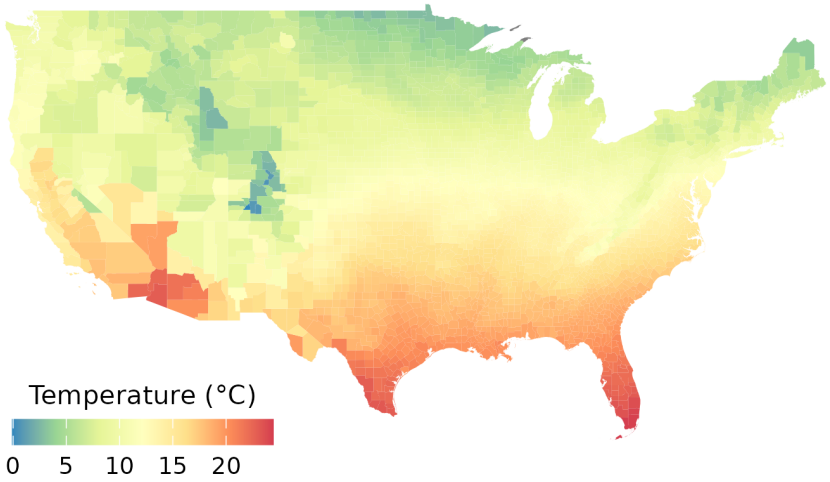

*Notes:* The figure displays the foreign-born population share (%) across U.S. counties in 1920 (Panel A) and 2010 (Panel B), using data from the full count U.S. Census and the American Community Survey (ACS), respectively.

**Figure A.3.** Distribution of U.S. Population, by Decade



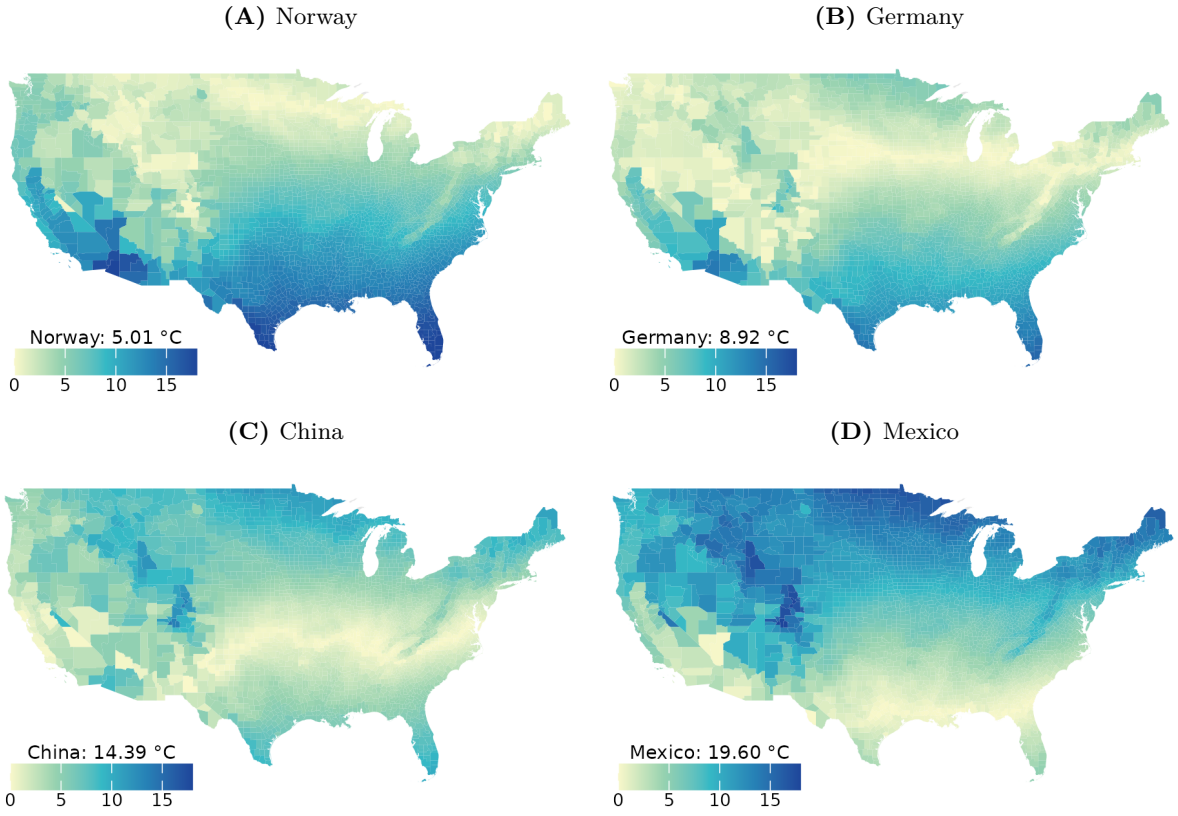

*Notes:* Each map plots county population density (individuals per square km) in a given decade, using data from full count U.S. Censuses (Ruggles et al. 2021).

**Figure A.4.** U.S. County Temperature (1960–2000)




*Notes:* The figure displays mean annual temperature in each U.S. county in degrees Celsius averaged over the period 1960–2000 using TerraClimate data (Abatzoglou et al. 2018).

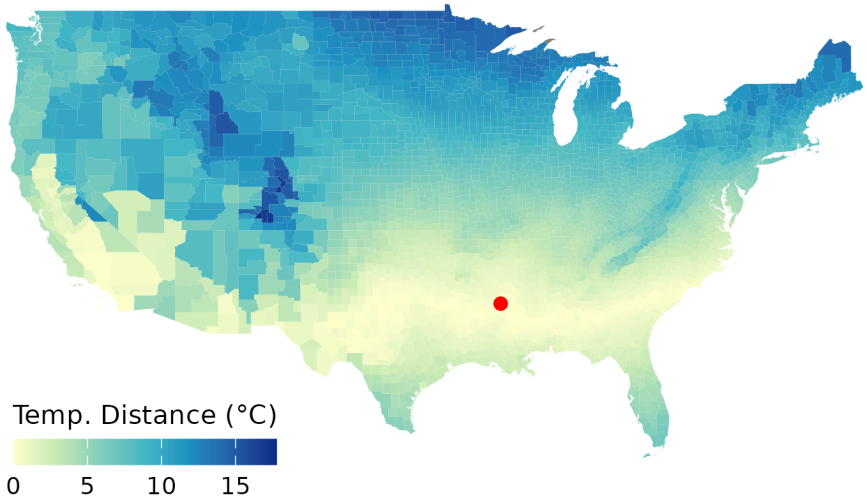
**Figure A.5.** Temperature Distance Between Selected Countries and U.S. Counties



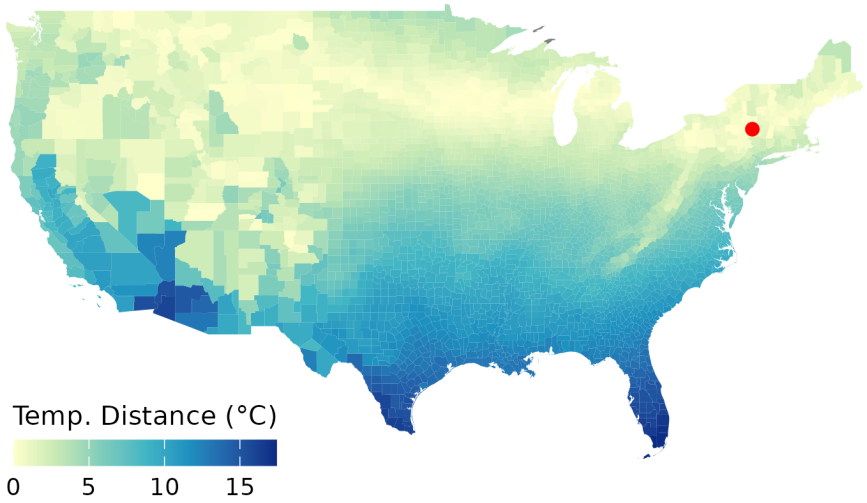

*Notes:* The figure shows the absolute difference in temperature between each U.S. county and four example countries (Norway, Germany, China, Mexico). Temperature is the mean annual temperature in degrees Celsius averaged over the period 1960–2000 using TerraClimate data (Abatzoglou et al. 2018).

**Figure A.6.** Temperature Distances Between U.S. Counties

**(A)** Relative to the Delta Region

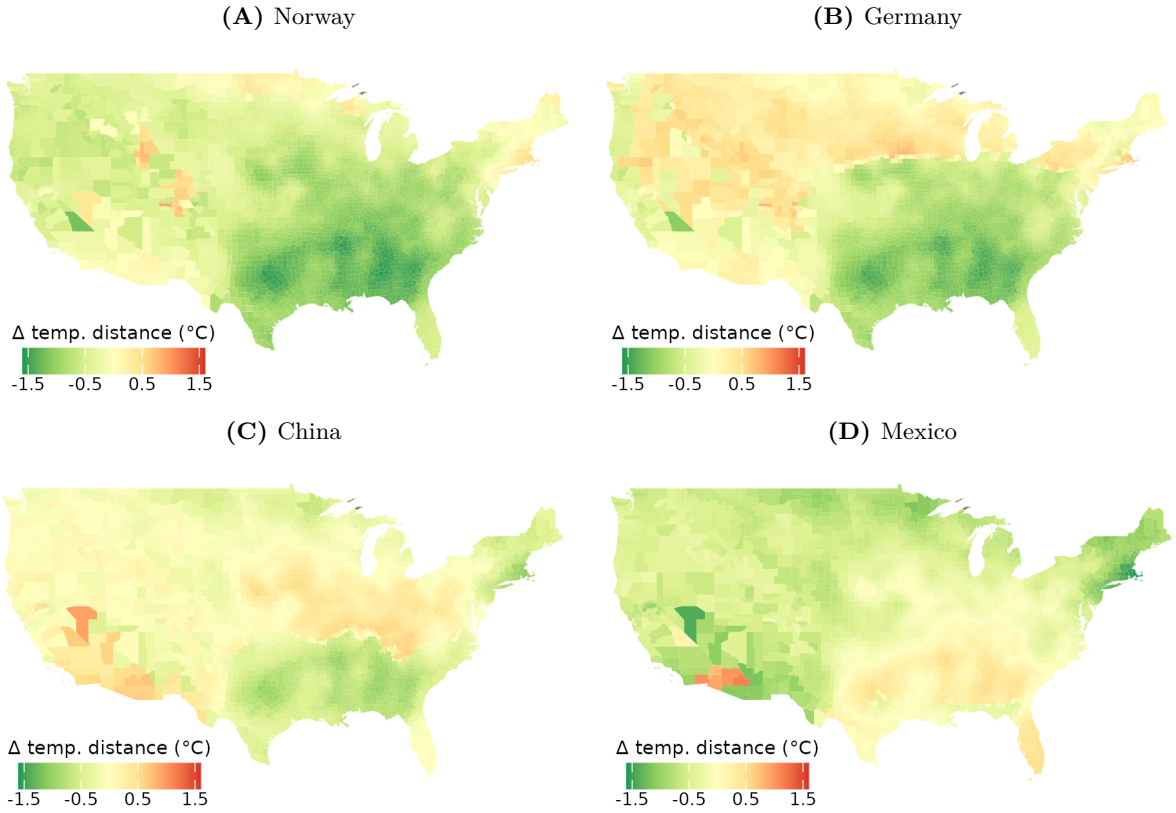



**(B)** Relative to the U.S. Northeast




*Notes:* The figure plots the absolute temperature difference between each U.S. county and the U.S. county indicated by the red dot. Temperature is defined as the annual mean in degrees Celsius averaged over the period 1960–2000 using TerraClimate data (Abatzoglou et al. 2018). For reference, temperature distance between the Delta region and New York City is 6°C.

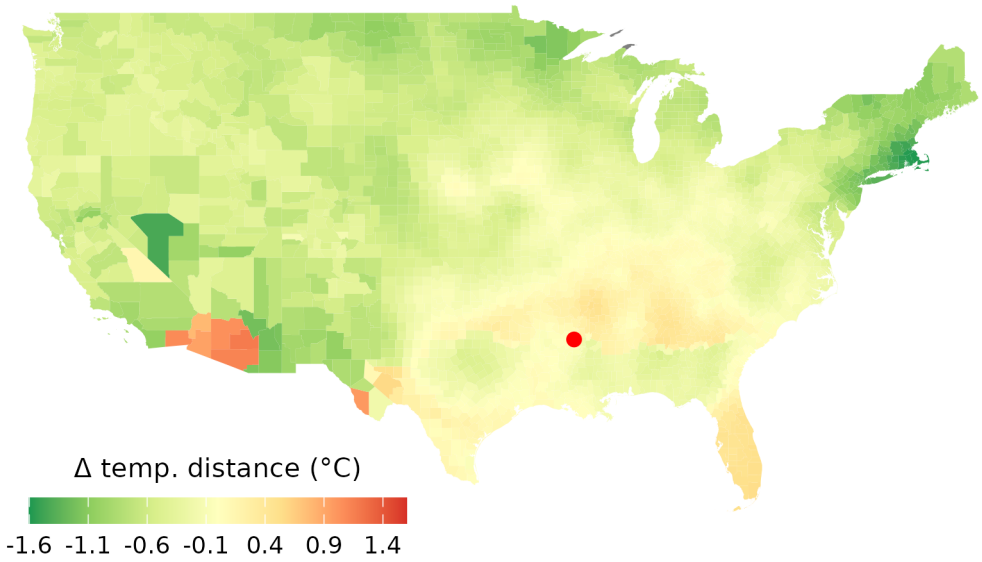
**Figure A.7.** Change in Temperature Distance Between Selected Countries and U.S. Counties



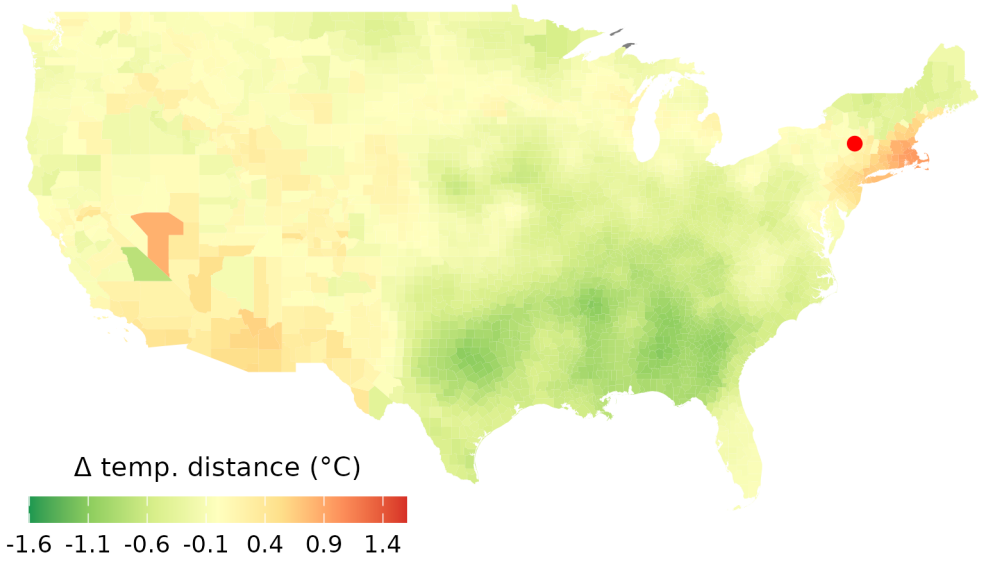

*Notes:* The figure plots the change in the absolute difference in temperature between each U.S. county and four example countries (Norway, Germany, China, Mexico). Temperature is the mean annual temperature in degrees Celsius. These averages are taken over the periods 1901–1930 and 1991–2020 using CRU climate data (Harris et al. 2020). Green areas represent climate convergence over time, and red areas climate divergence.

**Figure A.8.** Historical Change in Temperature Distance Between U.S. Counties

**(A)** Relative to the Delta Region

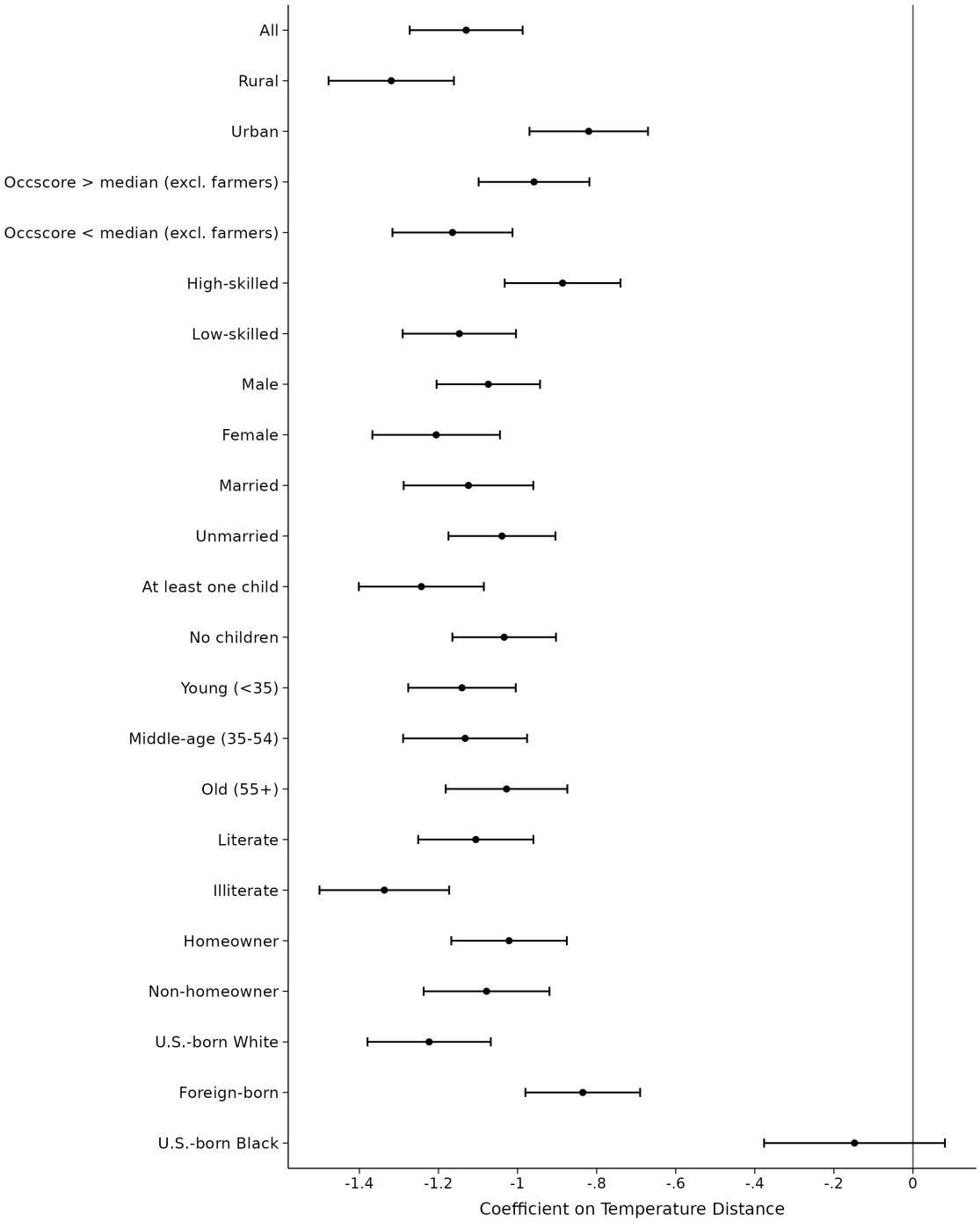



**(B)** Relative to the U.S. Northeast



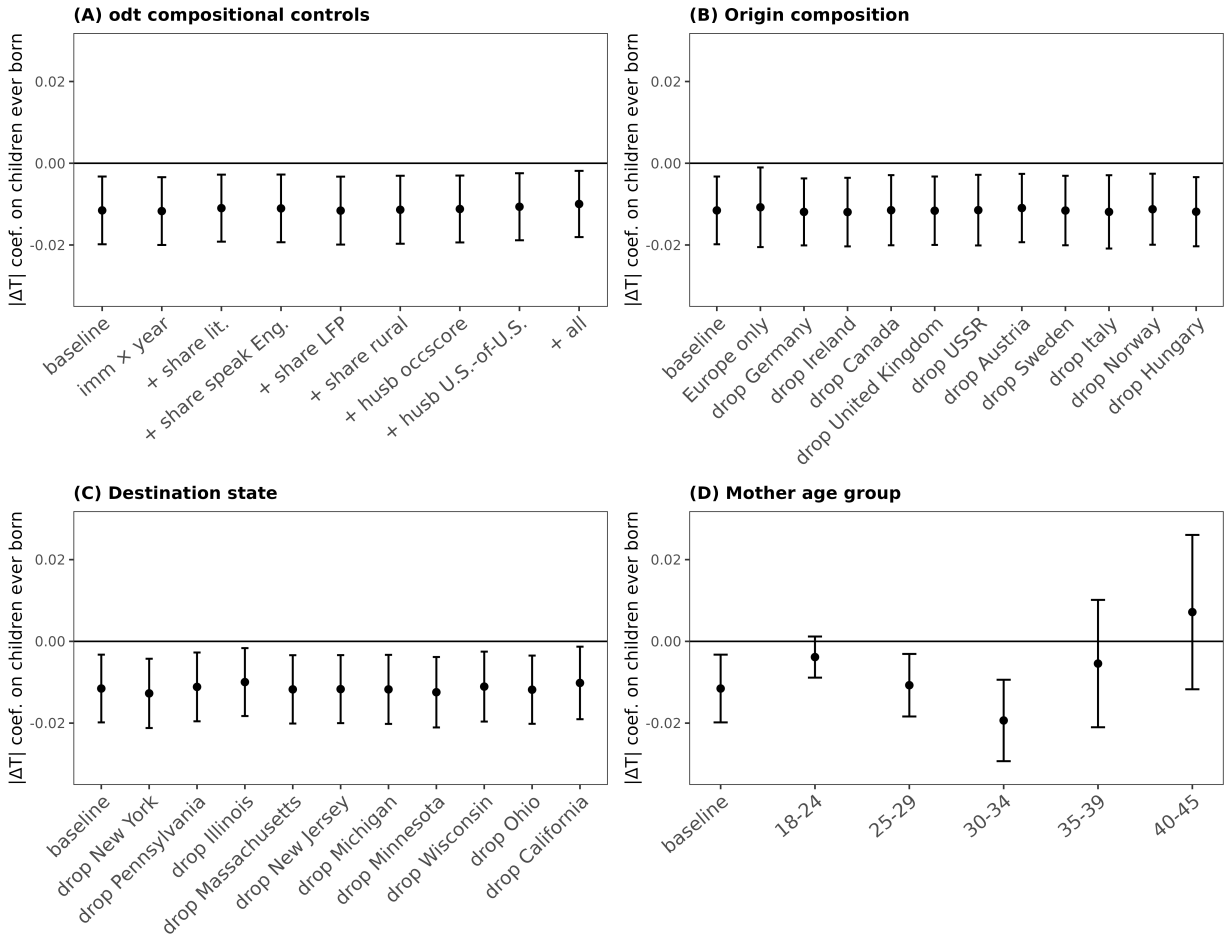

*Notes:* The figure plots the change in the absolute difference in temperature between each U.S. county and the U.S. county indicated by the red dot. Temperature is defined as the annual mean in degrees Celsius. These averages are taken over the period 1901–1930 and 1991–2020 using CRU data (Harris et al. 2020). To interpret the figure, note that in Panel A, the *distance* in temperature between the Delta region and New York City decreased by 1°C (from 7.2°C to 6.2°C); New York City today remains colder on average than the Delta region but the difference is smaller than it was 100 years ago. As a result New York City appears bright green on the map in Panel A, representing climate convergence.

**Figure A.9.** U.S. Internal Migration: Heterogeneity by Individual Characteristics



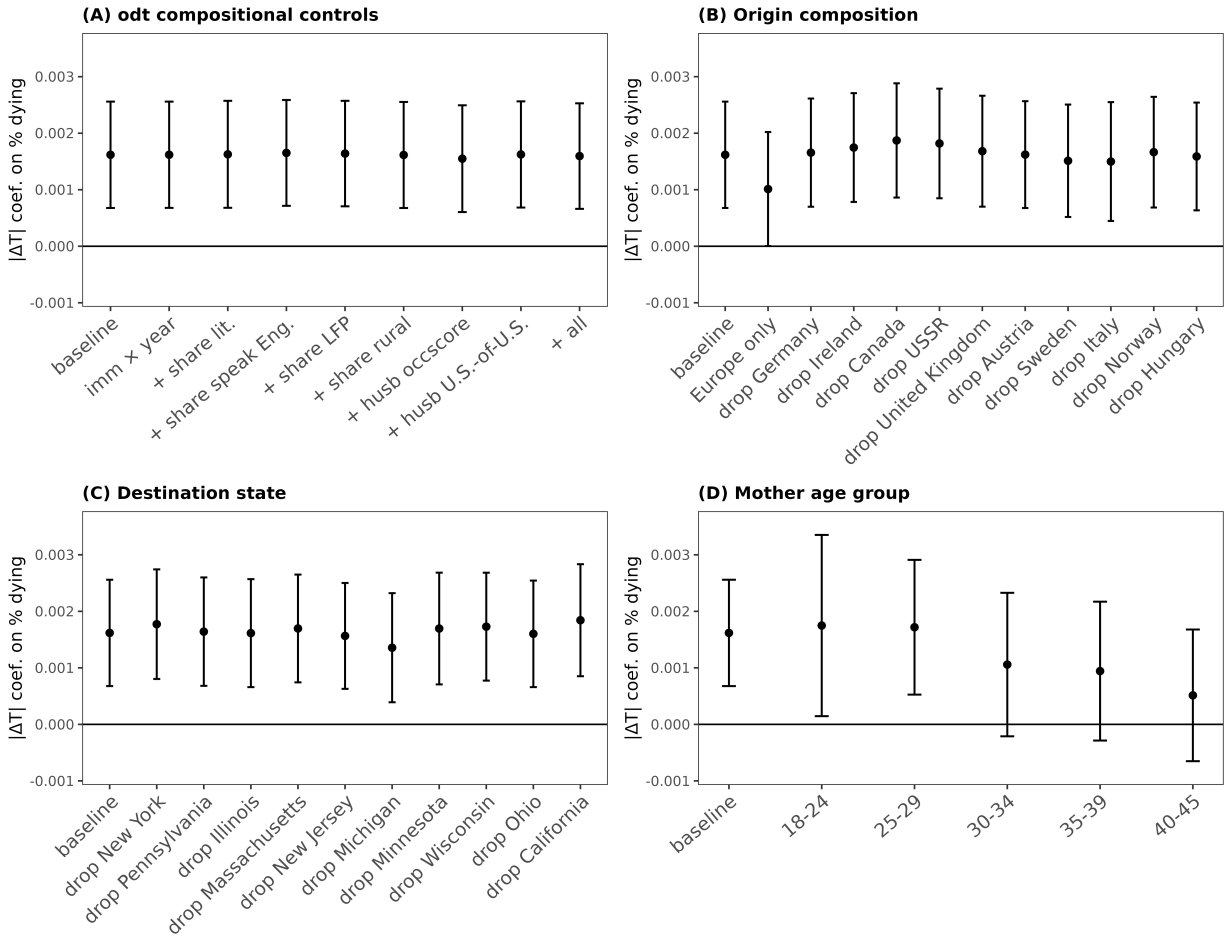

*Notes:* The figure plots the coefficient, with corresponding 95% confidence intervals, on the absolute difference in temperature between U.S. origin and destination counties for internal movers. The first dot ("All") shows the baseline specification from column 4 of Table 1. Each subsequent dot restricts the number of migrants to the subsample reported on the y-axis, with subsample membership measured in the baseline decade (before the move). Temperature distances are standardized within the relevant sample to have zero mean and standard deviation equal to one. Marital status is recorded only from the 1880 census onward and homeownership only from the 1900 census onward, so the married, unmarried, homeowner, and non-homeowner subsamples are estimated on the decades for which each characteristic is available; all other subsamples span the full sample period. Standard errors are clustered at the U.S. state of origin by U.S. state of destination level.

**Figure A.10.** $|\Delta T|$ Coefficient on Children Ever Born: Robustness



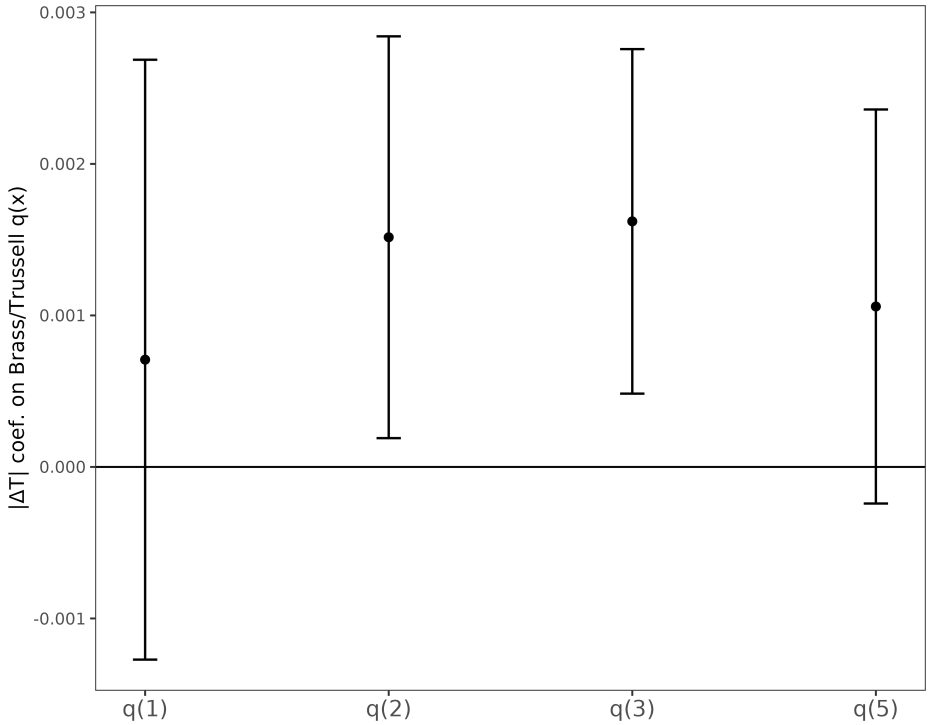

*Notes:* Each point is the $|\Delta T|$ coefficient (95% CI) on average children ever born per woman, from the column 4 specification of Table 4. The specification includes origin × year and destination-county × year fixed effects, average years in the U.S., average age, average marriage duration, share of agricultural labor force, and the log 1880 Burchardi immigrant stock. Sample: foreign-born women married after arriving, pooled 1900 and 1910, with no minimum cell size. Panel A varies the controls relative to this baseline. The second point ("imm × year") additionally interacts the log 1880 immigrant stock with year fixed effects. Each of the next six points adds a single cell-level compositional control to the baseline, one at a time rather than cumulatively (the "+" prefix denotes an addition to the baseline): share of mothers literate, English-speaking, in the labor force, and living in rural areas; husband average occupational income score (IPUMS `occscore`); and husband share of native whites of native parentage. The final point ("+ all") adds all six controls simultaneously, together with the immigrant stock × year interaction. Panel B drops the indicated origin group, where *Europe only* restricts to European origins and each subsequent point drops one of the ten most common origin countries. Panel C drops one of the ten most common destination states at a time. Panel D re-estimates on women in the indicated age band. In all panels, the leftmost point reproduces the full-sample baseline. Standard errors clustered at origin-country × destination-state.

**Figure A.11.** $|\Delta T|$ Coefficient on Child Mortality: Robustness



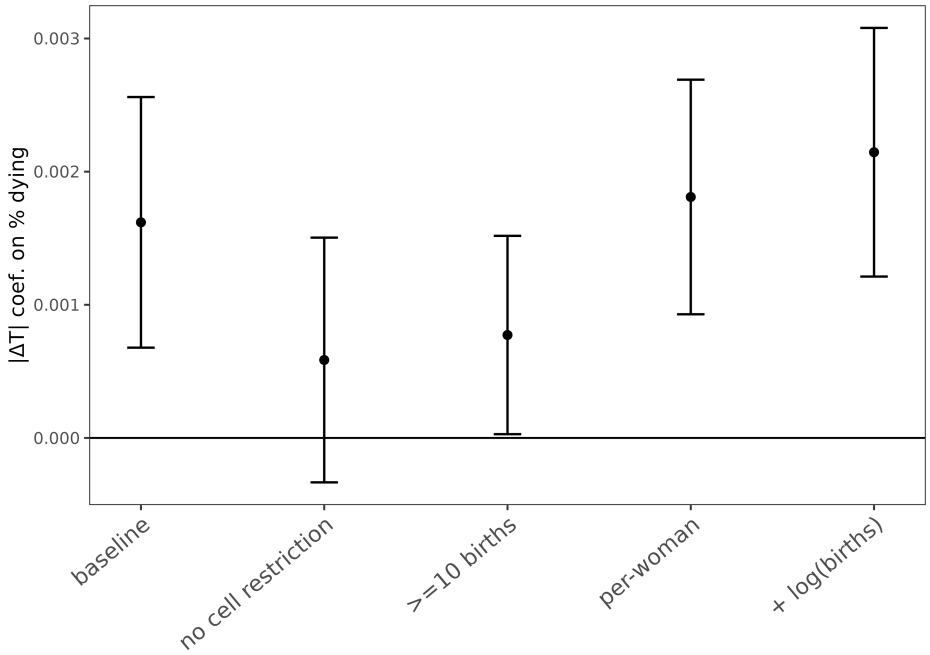

*Notes:* Each point is the $|\Delta T|$ coefficient (95% CI) on the share of ever-born children who died, from the column 4 specification of Table 4. The specification includes origin × year and destination-county × year fixed effects, average years in the U.S., average age, average marriage duration, share of agricultural labor force, and the log 1880 Burchardi immigrant stock. Sample: foreign-born women married after arriving, pooled 1900 and 1910, with *odt* cells restricted to at least five children ever born. Panel A varies the controls relative to this baseline, as in Panel A of Figure A.10: the second point interacts the log 1880 immigrant stock with year fixed effects; each of the next six points adds a single cell-level compositional control to the baseline, one at a time rather than cumulatively; and the final point adds all six controls simultaneously, together with the immigrant stock × year interaction. Panel B drops the indicated origin group, where *Europe only* restricts to European origins and each subsequent point drops one of the ten most common origin countries. Panel C drops one of the ten most common destination states at a time. Panel D re-estimates on women in the indicated age band. In all panels, the leftmost point reproduces the full-sample baseline. Standard errors clustered at origin-country × destination-state.

**Figure A.12.** $|\Delta T|$ Coefficient on Brass/Trussell-Corrected Child Mortality



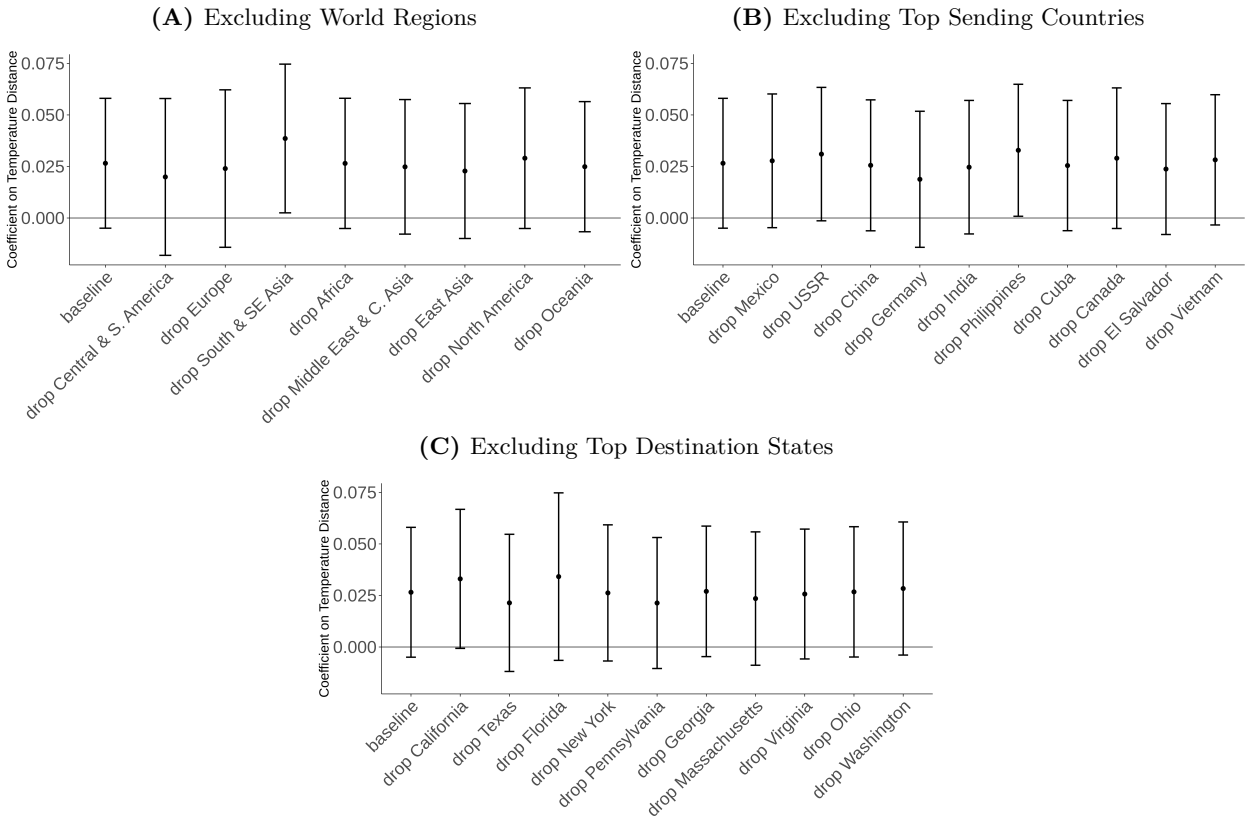

*Notes:* Each point is the $|\Delta T|$ coefficient (95% CI) on $\hat{q}(x)$, the Brass/Trussell-corrected probability that a child dies by exact age 1, 2, 3, or 5, recovered separately for mothers aged 15–19, 20–24, 25–29, and 30–34 following the age-model correction (United Nations 1983) as applied to the same 1900/1910 censuses by Dribe et al. (2020); construction details in Appendix D. The specification otherwise matches column 4 of Table 4: origin × year and destination-county × year fixed effects, average years in the U.S., average age, average marriage duration, share of agricultural labor force, and the log 1880 Burchardi immigrant stock, with *odt* cells restricted to at least five children ever born. The underlying sample extends the baseline to women aged 15–34, including childless women, as required to construct the average-parity terms entering the correction (Appendix D). $\hat{q}(1)$ (mothers 15–19) is the least precisely estimated of the four and should be read with caution: it rests on the fewest surviving *odt* cells and on a correction factor that substantially rescales the underlying mortality share relative to the other three ages. Standard errors clustered at origin-country × destination-state.

**Figure A.13.** $|\Delta T|$ Coefficient on Child Mortality: Alternative Samples and Measures



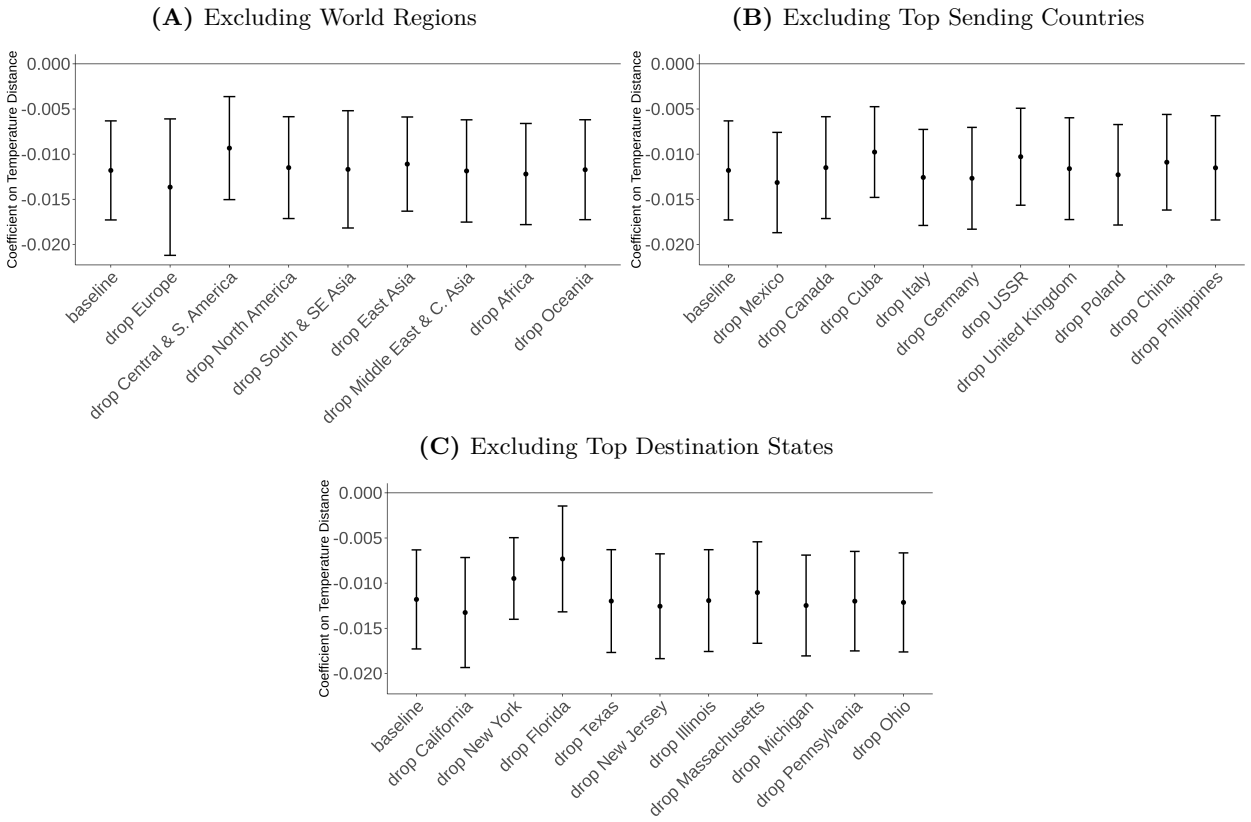

*Notes:* Each point re-estimates the column 4 baseline of Table 4 for the share of ever-born children who died, changing one feature at a time. *Baseline* reproduces the specification in Figure A.11; *no cell restriction* removes the requirement that *odt* cells contain at least five children ever born; *≥10 births* tightens that threshold; *per-woman* takes the cell mean of each mother's individual death ratio rather than the ratio of cell sums; and *+log(births)* adds log ever-born children as a control. These checks concern how the mortality rate is constructed and have no counterpart for average children ever born, which is already a simple per-woman mean. Standard errors clustered at origin-country × destination-state.

**Figure A.14.** $|\Delta T|$ Coefficient on Infant Mortality Rate: Excluding World Regions, Top Sending Countries, and Destination States




*Notes:* The figure plots the coefficient, with corresponding 95% confidence intervals, on the temperature distance between the U.S. county and the country of origin, from the baseline specification (column 4 of Table 5), re-estimated after dropping the indicated broad world region (Panel A), top-10 sending country of origin (Panel B), or top-10 destination U.S. state (Panel C) one at a time. The leftmost dot reproduces the baseline estimate. World regions are defined as follows: *Africa*, *Europe*, and *Oceania* follow the continent variable in the data. *North America*: Canada, Greenland, Saint Pierre and Miquelon. *East Asia*: China, Japan, North Korea, South Korea, Mongolia. *South & SE Asia*: India, Pakistan, Bangladesh, Bhutan, Nepal, Sri Lanka, Philippines, Vietnam, Thailand, Indonesia, Malaysia, Myanmar, Cambodia, Laos, Singapore, Brunei, Timor-Leste. *Middle East & C. Asia*: Iran, Iraq, Turkey, Israel, Lebanon, Syria, Jordan, Afghanistan, Yemen, Saudi Arabia, Kuwait, Oman, Qatar, UAE, Bahrain, Palestine, Cyprus. *Central & S. America*: all other origins in the Americas, including Mexico, Central America, the Caribbean, and South America (including Guyana, Suriname, and French Guiana); the Netherlands Antilles, coded as Oceania in the raw data, is also assigned here. Standard errors clustered at country-of-origin × U.S. state.

**Figure A.15.** $|\Delta T|$ Coefficient on Age at Death: Excluding World Regions, Top Sending Countries, and Destination States




*Notes:* The figure plots the coefficient, with corresponding 95% confidence intervals, on the temperature distance between the U.S. county of death and the country of origin, from the baseline specification (column 4 of Table 6), re-estimated after dropping the indicated broad world region (Panel A), top-10 sending country of origin (Panel B), or top-10 destination U.S. state (Panel C) one at a time. The leftmost dot reproduces the baseline estimate. World regions are defined as follows: *Africa*, *Europe*, and *Oceania* follow the continent variable in the data. *North America*: Canada, Greenland, Saint Pierre and Miquelon. *East Asia*: China, Japan, North Korea, South Korea, Mongolia. *South & SE Asia*: India, Pakistan, Bangladesh, Bhutan, Nepal, Sri Lanka, Philippines, Vietnam, Thailand, Indonesia, Malaysia, Myanmar, Cambodia, Laos, Singapore, Brunei, Timor-Leste. *Middle East & C. Asia*: Iran, Iraq, Turkey, Israel, Lebanon, Syria, Jordan, Afghanistan, Yemen, Saudi Arabia, Kuwait, Oman, Qatar, UAE, Bahrain, Palestine, Cyprus. *Central & S. America*: all other origins in the Americas, including Mexico, Central America, the Caribbean, and South America (including Guyana, Suriname, and French Guiana); the Netherlands Antilles, coded as Oceania in the raw data, is also assigned here. Standard errors clustered at country-of-origin × U.S. state-of-death.

**Table A.1.** Top-10 Immigrant Sending Countries, 1920 and 2010

| Year | 1920 | | 2010 | |
|---|---|---|---|---|
| Rank | Country | Immigrant Share (%) | Country | Immigrant Share (%) |
| 1 | Germany | 11.77 | Mexico | 28.93 |
| 2 | Italy | 11.49 | China | 5.213 |
| 3 | USSR | 11.46 | Philippines | 4.304 |
| 4 | Canada | 9.017 | India | 3.250 |
| 5 | United Kingdom | 8.231 | Germany | 2.949 |
| 6 | Poland | 7.652 | Vietnam | 2.931 |
| 7 | Ireland | 7.391 | El Salvador | 2.807 |
| 8 | Austria | 4.777 | USSR | 2.698 |
| 9 | Sweden | 4.461 | Cuba | 2.576 |
| 10 | Mexico | 3.525 | Canada | 2.331 |

*Notes:* The table reports the share of immigrants from each sending country, relative to all foreign-born individuals living in the U.S. in 1920 and 2010. Data come from the full-count U.S. Census and the ACS 5-year sample for 1920 and 2010, respectively. Country definitions are harmonized to 1990 boundaries as in Burchardi et al. 2019.

**Table A.2.** Spatial Correlation of Climate: Flexibly Predicting Temperature Distance

| Dep. Variable: | Temperature Distance | | | | | |
|---|---|---|---|---|---|---|
| | International Migration | | | U.S. Internal Migration | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Distance (100 km) | -0.001 | -0.075*** | -0.200*** | 0.146*** | 0.603*** | 0.766*** |
| | (0.002) | (0.008) | (0.028) | (0.009) | (0.027) | (0.053) |
| Distance (100 km)$^2$ | | 0.000*** | 0.002*** | | -0.013*** | -0.024*** |
| | | (0.000) | (0.000) | | (0.001) | (0.003) |
| Distance (100 km)$^3$ | | | -0.000*** | | | 0.000*** |
| | | | (0.000) | | | (0.000) |
| Observations | 553,046 | 553,046 | 553,046 | 9,650,342 | 9,650,342 | 9,650,342 |
| R-squared | 0.000 | 0.013 | 0.016 | 0.102 | 0.197 | 0.199 |

*Notes:* The sample includes all U.S. county-country pairs in columns 1–3 and all county pairs in the contiguous U.S. in columns 4–6. Temperature Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius. Distance is the physical distance between the origin and the destination, expressed in 100 km. In columns 1–3 (resp., columns 4–6), Origin $o$ refers to the origin country (resp., the origin U.S. county). Destination $d$ refers to a U.S. county in all columns. Standard errors, reported in parentheses, are clustered at the country (resp., U.S. state) of origin by U.S. state of destination level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

**Table A.3.** Climate Distance and Migration: The Role of Air Conditioning

| Dep. Variable: | Number of Migrants | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Historical: 1880–1920 | | | Modern: 1970–2010 | | | | |
| | | | | | | | Farmers | Non-farmers |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Annual Temp. Dist. | -0.174*** | | | -0.019* | | | | |
| | (0.021) | | | (0.011) | | | | |
| January Temp. Dist. | | -0.052*** | -0.042** | | -0.013** | -0.008 | -0.016 | -0.008 |
| | | (0.014) | (0.017) | | (0.006) | (0.006) | (0.010) | (0.006) |
| July Temp. Dist. | | -0.030* | 0.000 | | -0.042** | -0.080*** | -0.074*** | -0.081*** |
| | | (0.017) | (0.020) | | (0.019) | (0.022) | (0.022) | (0.022) |
| South × Jan. Temp. Dist. | | | -0.061*** | | | -0.026*** | -0.052*** | -0.019** |
| | | | (0.023) | | | (0.009) | (0.017) | (0.008) |
| South × July Temp. Dist. | | | -0.050* | | | 0.059*** | -0.011 | 0.046** |
| | | | (0.028) | | | (0.020) | (0.028) | (0.019) |
| Observations | 1,942,210 | 1,942,210 | 1,942,210 | 2,475,100 | 2,475,100 | 2,475,100 | 1,956,231 | 2,470,464 |
| Pseudo R-squared | 0.916 | 0.913 | 0.914 | 0.893 | 0.892 | 0.893 | 0.918 | 0.895 |
| Temp. Dist. Mean | 9.622 | | | 9.622 | | | | |
| Jan. Temp. Dist. Mean | | 17.94 | 17.94 | | 18.08 | 18.08 | 18.15 | 18.05 |
| July Temp. Dist. Mean | | 5.253 | 5.253 | | 5.184 | 5.184 | 5.159 | 5.188 |
| Origin × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The sample includes U.S. county-country pairs for each decade over the 1880–1920 period (except for 1890) in columns 1–3, and over the 1970–2010 period in columns 4–8. The definition of countries of origin is fixed to 1990 boundaries and harmonized following the procedure in Burchardi et al. (2019). Number of Migrants is the number of individuals from origin country $o$ living in destination county $d$ in census year $t$ who arrived in the previous decade (except for 1880, when information on year of arrival is not available). Temperature Distance is the absolute difference in temperature between the origin and the destination in degrees Celsius, measured first as an annual mean. Columns 1 and 4 replicate the baseline specification of Table 1, columns 2 and 3. Columns 2 and 5 replace the absolute difference in mean annual temperature with temperature measured in January and July. Columns 3 and 6 interact the absolute difference in January and July temperature with an indicator equal to one if the destination county's average July temperature is above the national median. Columns 7 and 8 replicate column 6 separately for farmers and non-farmers, respectively. All regressions also control for the absolute difference in precipitation and geographic distance and include country of origin × decade and destination county × decade fixed effects. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table A.4.** Internal Migration and Destination Pull Factors: Farmers vs. Non-Farmers

| Dep. Variable: | Number of Migrants | | | | |
|---|---|---|---|---|---|
| | (1) Railroad | (2) Homestead | (3) Frontier | (4) Bartik | (5) New Deal |
| *Panel A: All Movers* | | | | | |
| Temp. Dist. (std.) × Pull Factor | 0.258*** | 0.751*** | 0.857*** | 0.054*** | 0.135*** |
| | (0.052) | (0.092) | (0.105) | (0.013) | (0.041) |
| Temperature Distance (std.) | -1.243*** | -1.323*** | -1.422*** | -1.141*** | -0.994*** |
| | (0.072) | (0.076) | (0.081) | (0.075) | (0.090) |
| Observations | 13,119,955 | 15,646,574 | 11,087,951 | 31,105,383 | 4,692,511 |
| Pseudo R-squared | 0.730 | 0.733 | 0.693 | 0.747 | 0.789 |
| *Panel B: Farmers* | | | | | |
| Temp. Dist. (std.) × Pull Factor | 0.293*** | 0.731*** | 0.996*** | 0.054*** | 0.245*** |
| | (0.055) | (0.106) | (0.124) | (0.019) | (0.048) |
| Temperature Distance (std.) | -1.450*** | -1.560*** | -1.643*** | -1.414*** | -1.327*** |
| | (0.086) | (0.095) | (0.092) | (0.085) | (0.110) |
| Observations | 13,033,302 | 15,546,433 | 10,929,317 | 30,885,635 | 4,683,324 |
| Pseudo R-squared | 0.577 | 0.580 | 0.555 | 0.580 | 0.617 |
| *Panel C: Non-Farmers* | | | | | |
| Temp. Dist. (std.) × Pull Factor | 0.268*** | 0.740*** | 0.821*** | 0.056*** | 0.110*** |
| | (0.052) | (0.091) | (0.100) | (0.013) | (0.040) |
| Temperature Distance (std.) | -1.191*** | -1.262*** | -1.352*** | -1.080*** | -0.934*** |
| | (0.071) | (0.074) | (0.079) | (0.075) | (0.088) |
| Observations | 13,107,240 | 15,637,418 | 11,071,220 | 31,083,751 | 4,692,511 |
| Pseudo R-squared | 0.751 | 0.754 | 0.712 | 0.768 | 0.804 |
| Origin × Decade FE | Yes | Yes | Yes | Yes | Yes[a] |
| Destination × Decade FE | Yes | Yes | Yes | Yes | Yes[a] |

*Notes:* PPML Estimates. The sample and specification are as in Table 3; see that table's notes for full details. Panel A repeats the all-movers outcome. Panels B and C rerun the same five columns on the farmer and non-farmer outcomes, respectively. Temperature, precipitation, and geographic distance are standardized to zero mean and unit standard deviation within each column's estimation sample before entering the regression, so the reported coefficients are on a common per-standard-deviation scale and are comparable across columns and across the three panels. The pull factor itself is not restandardized: in columns 1–3 it is a binary destination indicator, so the interaction is per standard deviation of distance per unit change in the pull factor; in columns 4–5 it is already standardized, so the interaction is per standard deviation of distance per standard deviation of the shock. Because of the distance standardization, Panel A's coefficients are not numerically identical to Table 3, which reports the same regressions in the original distance units. Standard errors, reported in parentheses, are clustered at the origin state × destination state level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

[a] Collapses to plain $\alpha_o, \alpha_d$: only one decade (1930–1940) is in the sample for column 5.

**Table A.5.** Alternative Fertility Outcomes: Preferred Specification

| | Ever Born, 1900–10 | | Co-Resident, 1880–1920 | | | Co-Resident, Married, 1880–1920 | | |
|---|---|---|---|---|---|---|---|---|
| | (1) Any child ever born | (2) No. ever-born, if ≥1 | (3) No. children at home | (4) Any child at home | (5) No. children, if ≥1 | (6) No. children at home | (7) Any child at home | (8) No. children, if ≥1 |
| Temperature Distance | -0.0028*** | -0.0074* | -0.0114*** | -0.0022*** | -0.0097*** | -0.0109*** | -0.0019*** | -0.0095*** |
| | (0.0007) | (0.0042) | (0.0020) | (0.0005) | (0.0021) | (0.0021) | (0.0005) | (0.0021) |
| Precipitation Distance | 0.0001 | -0.0005 | 0.0003 | 0.0002** | -0.0001 | -0.0000 | 0.0001 | -0.0002 |
| | (0.0001) | (0.0006) | (0.0004) | (0.0001) | (0.0003) | (0.0004) | (0.0001) | (0.0003) |
| Distance (100 km) | 0.0005 | 0.0005 | 0.0064*** | 0.0017*** | 0.0028** | 0.0063*** | 0.0016*** | 0.0027** |
| | (0.0005) | (0.0027) | (0.0013) | (0.0003) | (0.0011) | (0.0013) | (0.0003) | (0.0012) |
| Observations | 45,606 | 43,418 | 111,398 | 111,398 | 101,025 | 109,780 | 109,780 | 100,113 |
| Adj. R-squared | 0.163 | 0.418 | 0.227 | 0.137 | 0.197 | 0.227 | 0.129 | 0.202 |
| Dep. Var. Mean | 0.850 | 3.816 | 2.171 | 0.749 | 2.862 | 2.213 | 0.760 | 2.875 |
| Origin × Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| County × Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* OLS Estimates. The samples in columns 1–2 include foreign-born women 18–45 married after arriving, pooled 1900 and 1910 (the same sample as Table 4, Panel A). The samples in columns 3–8 include foreign-born women 18–45, pooled 1880–1920. The unit of observation is the origin country × destination county × census year (*odt*) cell. Columns 1–2 report the share of women with at least one child ever born and average children ever born conditional on at least one. Columns 3–5 report the number of co-resident U.S.-born children aged 0–15 per woman, the share of women with at least one such child, and the average conditional on at least one. Columns 6–8 repeat columns 3–5 with outcomes computed over married women only. In columns 3–8 the controls also include average years in the U.S. with an 1880 missing-year indicator, in place of average marriage duration, which is unavailable before 1900. All regressions also control for *odt*-level characteristics and the log 1880 immigrant stock, entered linearly with its coefficient not reported, and include origin × year and county × year fixed effects. Standard errors, reported in parentheses, are clustered at the origin country × destination state level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table A.6.** Children Ever Born and Child Mortality: Baseline, Arrived<15, and 2nd-Generation

| | Children Ever Born per Woman | | | Share of Ever-Born Children Who Die | | |
|---|---|---|---|---|---|---|
| | (1) Baseline | (2) Arrived<15 | (3) 2nd-gen | (4) Baseline | (5) Arrived<15 | (6) 2nd-gen |
| Temperature Distance | -0.0115*** | -0.0130** | -0.0066 | 0.0016*** | 0.0018*** | 0.0000 |
| | (0.0042) | (0.0057) | (0.0053) | (0.0005) | (0.0005) | (0.0005) |
| Precipitation Distance | -0.0006 | -0.0008 | -0.0007 | -0.0003*** | -0.0002*** | -0.0001** |
| | (0.0006) | (0.0009) | (0.0007) | (0.0001) | (0.0001) | (0.0001) |
| Distance (100 km) | 0.0035 | 0.0001 | 0.0050 | -0.0005 | -0.0001 | 0.0002 |
| | (0.0028) | (0.0037) | (0.0037) | (0.0003) | (0.0004) | (0.0004) |
| Observations | 45,606 | 36,527 | 37,982 | 33,954 | 26,007 | 29,025 |
| Adj. R-squared | 0.466 | 0.409 | 0.414 | 0.114 | 0.104 | 0.113 |
| Dep. Var. Mean | 3.266 | 3.379 | 3.367 | 0.156 | 0.157 | 0.145 |
| Origin × Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| County × Year FE | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* OLS Estimates. The base sample includes foreign-born women 18–45 married after arriving, pooled 1900 and 1910. The unit of observation is the origin country × destination county × census year (*odt*) cell. The dependent variable is the number of children ever born in columns 1–3 and the share of ever-born children who did not survive in columns 4–6. Columns 1 and 4 reproduce Table 4, column 4, on the base sample. Columns 2 and 5 use the same specification, replacing the married-after-arrival restriction with women who arrived in the U.S. before age 15. Columns 3 and 6 use U.S.-born women whose parents were both born in the same foreign country, with origin defined by the parents' country; average years in the U.S. does not apply to a U.S.-born woman and so is dropped. However, the *odt*-cell share of working-age men in agriculture and the log 1880 immigrant stock are odt-cell/origin-community controls, not measures of the woman's own migration history, and so are retained, defining origin by the parents' country; these columns thus control for average age, average marriage duration, the *odt*-cell share of working-age men in agriculture, and the log 1880 immigrant stock. All other regressions also control for average years in the U.S., average age, average marriage duration, the share of working-age (15–64) men in the labor force employed in agriculture in the *odt* cell, and the log 1880 immigrant stock, entered linearly with its coefficient not reported, and include origin × year and county × year fixed effects. Standard errors, reported in parentheses, are clustered at the origin country × destination state level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table A.7.** Climate Distance, Low Birthweight, and Premature Birth

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *Panel A: Low Birthweight* | | | | |
| Temperature Distance | 0.249*** | 0.227*** | 0.179** | 0.155* |
| | (0.082) | (0.080) | (0.080) | (0.081) |
| Precipitation Distance | 0.014 | 0.013 | 0.024* | 0.023* |
| | (0.012) | (0.013) | (0.013) | (0.013) |
| Distance (100 km) | 0.014 | -0.003 | -0.011 | -0.021 |
| | (0.040) | (0.041) | (0.039) | (0.039) |
| Observations | 186,734 | 175,497 | 175,497 | 175,497 |
| Adj. R-squared | 0.044 | 0.055 | 0.055 | 0.055 |
| Dep. Var. Mean | 74.565 | 75.295 | 75.295 | 75.295 |
| *Panel B: Premature Birth* | | | | |
| Temperature Distance | 0.234** | 0.222** | 0.126 | 0.087 |
| | (0.107) | (0.108) | (0.106) | (0.107) |
| Precipitation Distance | -0.011 | -0.013 | 0.007 | 0.006 |
| | (0.015) | (0.015) | (0.015) | (0.015) |
| Distance (100 km) | -0.018 | -0.040 | -0.032 | -0.050 |
| | (0.043) | (0.044) | (0.039) | (0.039) |
| Observations | 186,734 | 175,497 | 175,497 | 175,497 |
| Adj. R-squared | 0.047 | 0.064 | 0.065 | 0.065 |
| Dep. Var. Mean | 110.060 | 109.429 | 109.429 | 109.429 |
| Country FE | Yes | | | |
| County FE | Yes | | | |
| Year FE | Yes | | | |
| Country × Year FE | | Yes | Yes | Yes |
| County × Year FE | | Yes | Yes | Yes |
| Mother Controls | | | Yes | Yes |
| Imm. Stock | | | | Yes |

*Notes:* OLS Estimates. The sample is an origin country × U.S. county × year panel covering 2005–2019 (selected to exclude the COVID years). In Panel A the dependent variable is the low-birthweight rate; in Panel B it is the premature-birth rate. Both are expressed per 1,000 live births. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 includes separate country, county, and year fixed effects, with the distance variables only. Column 2 replaces these with country × year and county × year fixed effects, again with the distance variables only. Column 3 adds the mother controls (average age, share married, and average prior live births), which are origin–destination constants held fixed across years. Column 4 adds the log 2000 immigrant stock $(o, d)$, entered linearly with its coefficient not reported. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table A.8.** Climate Distance and Age at Death: Birth-Order Controls

| Dep. Variable: | Age at Death | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | No HH FE | HH FE | Older Sibling | Age Gap |
| Temperature Distance | -0.018*** | -0.033*** | -0.033*** | -0.034*** |
| | (0.006) | (0.012) | (0.012) | (0.012) |
| Precipitation Distance | -0.004*** | -0.004* | -0.004* | -0.004 |
| | (0.001) | (0.002) | (0.002) | (0.002) |
| Distance (100 km) | 0.001 | 0.008 | 0.008 | 0.008 |
| | (0.003) | (0.006) | (0.006) | (0.006) |
| Observations | 96,768 | 88,610 | 88,610 | 88,608 |
| Adj. R-squared | 0.617 | 0.614 | 0.614 | 0.615 |
| Dep. Var. Mean | 79.66 | 79.62 | 79.62 | 79.62 |
| Sample | Siblings | Siblings | Siblings | Siblings |
| County × Cohort FE | Yes | Yes | Yes | Yes |
| Country × Cohort FE | Yes | Yes | Yes | Yes |
| Imm. Stock | Yes | Yes | Yes | Yes |
| Household FE | | Yes | Yes | Yes |

*Notes:* OLS Estimates. The sample includes the sibling subsample (individuals with at least one linked sibling; see Table 6), restricted to those who died at age 18 or older. Age at Death is the age in years at which the individual died. Columns 1–2 reproduce columns 6–7 of Table 6. Column 3 adds an indicator for being the oldest linked sibling in the family, by exact birth date (ties broken arbitrarily). Column 4 replaces this with the signed difference, in years, between an individual's age and the average age of their other linked siblings (positive means older than the family average). Both birth-order measures use exact birth date (year, month, day); day of birth is missing for two observations, dropped from column 4 only. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of death level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table A.9.** Climate Distance and Age at Death: Settlement and Mobility Robustness

| Dep. Variable: | Age at Death | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | Baseline | Stayers | Movers | Arrival State |
| Temperature Distance | -0.012*** | -0.013*** | -0.012*** | -0.015*** |
| | (0.003) | (0.004) | (0.003) | (0.004) |
| Precipitation Distance | -0.001** | -0.001* | -0.001*** | -0.001* |
| | (0.001) | (0.001) | (0.000) | (0.001) |
| Distance (100 km) | -0.002* | -0.001 | -0.004*** | -0.006*** |
| | (0.001) | (0.001) | (0.001) | (0.002) |
| Observations | 1,563,373 | 1,061,995 | 479,851 | 1,588,481 |
| Adj. R-squared | 0.870 | 0.874 | 0.849 | 0.875 |
| Dep. Var. Mean | 76.31 | 76.56 | 75.97 | 76.21 |
| Sample | All | Stayers | Movers | All |
| Country × Cohort FE | Yes | Yes | Yes | Yes |
| County × Cohort FE | Yes | Yes | Yes | |
| Imm. Stock | Yes | Yes | Yes | Yes |
| State × Cohort FE | | | | Yes |

*Notes:* OLS Estimates. The sample includes BUNMD immigrants who died 1988–2005 at age 18 or older, excluding those with a missing SS-application (arrival) state and those whose arrival state is Alaska or Hawaii; this restriction is common to all columns so that they are directly comparable, and makes column 1 slightly smaller than the corresponding baseline in Table 6. Age at Death is the age in years at which the individual died. Column 1 is the baseline specification, with distance measured to the county of death. Column 2 restricts to stayers, immigrants who died in the state where they applied for Social Security. Column 3 restricts to movers, those who died in a different state than the one of SS application. Column 4 replaces the county-of-death climate measure with the climate of the SS-application (arrival) state, measured as an unweighted average across counties within the state, with application state × cohort fixed effects in place of county × cohort fixed effects. Because state × cohort cells are coarser than county × cohort cells, fewer observations are absorbed and column 4 retains a larger sample than column 1. All regressions also control for individual-level characteristics (gender, year of SS application). Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of death level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table A.10.** Climate Distance and Age at Death, First Generation, NCHS 1959–1961

| Dep. Variable: | Age at Death | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Temperature Distance | -0.124*** | -0.025*** | -0.008*** | -0.025*** | -0.008*** |
| | (0.028) | (0.007) | (0.003) | (0.007) | (0.003) |
| Precipitation Distance | 0.014** | 0.002 | 0.001* | 0.002 | 0.001 |
| | (0.007) | (0.002) | (0.001) | (0.001) | (0.001) |
| Distance (100 km) | 0.004 | 0.000 | -0.002 | -0.001 | -0.003* |
| | (0.017) | (0.004) | (0.001) | (0.003) | (0.001) |
| Observations | 710,801 | 710,801 | 710,799 | 709,109 | 707,523 |
| Adj. R-squared | 0.102 | 0.802 | 0.933 | 0.801 | 0.932 |
| Dep. Var. Mean | 73.62 | 73.62 | 73.62 | 73.65 | 73.67 |
| Country FE | Yes | Yes | Yes | | |
| County FE | Yes | Yes | Yes | | |
| Birth Cohort FE | | 20-yr | 10-yr | | |
| Country × Cohort FE | | | | 20-yr | 10-yr |
| County × Cohort FE | | | | 20-yr | 10-yr |
| Imm. Stock | Yes | Yes | Yes | Yes | Yes |

*Notes:* OLS Estimates. The sample includes first-generation foreign-born decedents aged 18 or older in the NCHS Multiple Cause-of-Death microdata, national 1959–1961, with origin identified by own country of birth. Age at Death is the age in years at which the individual died. Temperature Distance is the absolute difference in mean annual temperature between the county of death and the country of origin, measured in degrees Celsius. Distance is physical distance, expressed in 100 km, between the population-weighted centroids of the origin country and the U.S. county of death. Column 1 includes separate country-of-origin and county-of-death fixed effects. Columns 2 and 3 add 20- and 10-year birth-cohort fixed effects. Columns 4 and 5 use interacted origin by cohort and county of death by cohort fixed effects with 20 and 10 year cohort windows respectively. All regressions include gender, the log 1930 immigrant stock of each origin–destination pair, precipitation distance, and geographic distance. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of death level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table A.11.** Climate Distance and Age at Death Across Generations, NCHS 1959–1963

| Dep. Variable: | Age at Death | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Temperature Distance | -0.026*** | -0.020*** | -0.020** | -0.023*** | -0.022*** |
| | (0.008) | (0.007) | (0.008) | (0.008) | (0.008) |
| Precipitation Distance | -0.004** | -0.003* | -0.003 | -0.003* | -0.003* |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Distance (100 km) | 0.017*** | 0.004 | 0.003 | 0.010*** | 0.005 |
| | (0.005) | (0.004) | (0.004) | (0.004) | (0.004) |
| Observations | 131,544 | 176,547 | 176,570 | 176,617 | 162,165 |
| Adj. R-squared | 0.816 | 0.869 | 0.869 | 0.869 | 0.870 |
| Dep. Var. Mean | 73.41 | 67.40 | 67.40 | 67.39 | 67.21 |
| Generation | First | Second | Second | Second | Second |
| Parental origin | | Father | Mother | Both (avg.) | Single origin |
| Country FE | Yes | Yes | Yes | Yes | Yes |
| County FE | Yes | Yes | Yes | Yes | Yes |
| Birth Cohort FE | 20-yr | 20-yr | 20-yr | 20-yr | 20-yr |
| Imm. Stock | Yes | Yes | Yes | Yes | Yes |

*Notes:* OLS Estimates. The sample includes decedents aged 18 or older in California, Massachusetts, and Rhode Island, estimated with the 20-year birth-cohort specification. For column 1 (first generation) these three states are a subset of the national sample in Table A.10; for columns 2–5 (second generation) they are the only states that recorded parental birthplace. Age at Death is the age in years at which the individual died. Temperature Distance is the absolute difference in mean annual temperature between the county of death and the country of origin, measured in degrees Celsius. Distance is physical distance, expressed in 100 km, between the population-weighted centroids of the origin country and the U.S. county of death. Column 1 covers first-generation foreign-born decedents (1959–1961), with origin from own country of birth. Columns 2–5 cover second-generation decedents (1960–1963), U.S.-born with a foreign-born parent, origin taken from parental birthplace using the recovered 1962 country codes; they differ only in how they handle decedents whose parents were born in different countries. Column 2 uses the father's origin climate, column 3 the mother's origin climate, and column 4 the average of the two parents' origin climates (with the mother's origin used in fixed effects). Column 5 drops decedents whose parents' origins conflict, keeping those with a single well-defined origin. All regressions include country-of-origin and county-of-death fixed effects, 20-year birth-cohort fixed effects, gender, the log 1930 immigrant stock of each origin–destination pair, precipitation distance, and geographic distance. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of death level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

# B Data Appendix

**Table B.1.** Summary of Data Sources

| Source | Description | Area | Spatial Res. | Period | Time Res. |
|---|---|---|---|---|---|
| Climate | | | | | |
| TerraClimate (Abatzoglou et al. 2018) | Mean annual temperature (°C) and precipitation (mm) from monthly gridded dataset; (i) For U.S. counties, county-level values are population-weighted averages of gridcells within county borders. For countries outside the U.S., values are population-weighted averages over gridcells within national borders; (ii) Robustness using averages within a 25 km radius around national capital cities. | Global | 4.6 km × 4.6 km (at the equator) | 1960–2000 | Averaged over period |
| Climatic Research Unit (CRU) (Harris et al. 2020) | Mean temperature (°C) and precipitation (mm/month) derived from a monthly gridded observational product (no underlying climate model). | Global | 55.7 km × 55.7 km (at the equator) | 1901–1930; 1991–2020 | Averaged over period |
| Immigration | | | | | |
| U.S. Census of Population (Ruggles et al. 2021) | International immigration to the U.S.; individual characteristics of the U.S. population. Full-count data for 1880–1920; 1% Form 1 Metro sample for 1970; 5% State sample for 1980 and 1990; 5% sample of 2000 Census; and ACS 5-Year sample of the 2010 Census. | U.S. | Individual | 1880–1920 (excluding 1890); 1970–2010 | Decade |
| Norwegian Censuses (Ruggles et al. 2025; The Digital Archive 2008a, 2008b, 2011) | Individual Characteristics of the Norwegian Population. | Norway | Individual | 1865; 1900; 1910 | |
| Census Tree Project (Price et al. 2021; Buckles et al. 2025) | Linked samples of individuals between censuses. Combined with the Census Place Project (Berkes et al. 2023) to construct historical internal migration matrices. Restricted to individuals 15 or older in the baseline decade. Because the 1890 Census is unavailable, we link individuals observed in 1880 to 1900. | U.S. | Individual | 1850–1940 | Decade |

| | | | | | |
|---|---|---|---|---|---|
| Census Place Project (Berkes et al. 2023) | Individual harmonized addresses. Combined with the Census Tree Project to construct historical internal migration matrices. Because the 1890 Census is unavailable, we link individuals observed in 1880 directly to 1900. | U.S. | Individual | 1850–1940 | Decade |
| IRS Statistics of Income Division (https://www.irs.gov/statistics/soi-tax-stats-migration-data) | Modern internal migration matrices. Constructed from IRS Change-of-Address Tables for 2011–2022, which draw upon year-to-year address changes reported on individual income tax returns. | U.S. | County-to-county | 2011–2019 | Calendar year |
| Fertility and Child Survival | | | | | |
| U.S. Census of Population (Ruggles et al. 2021) | Number of children ever born per foreign-born woman, restricted to foreign-born women aged 18–45 (heads or spouses) who married after arriving in the U.S. Share of ever-born children who did not survive, defined at the origin-destination-year cell level as one minus the ratio of total children surviving to total children ever born, summed across all sample mothers in the cell; the underlying sample is restricted to mothers with at least one child ever born, and cells are further restricted to at least five children ever born. | U.S. | Individual | 1900; 1910 | Decade |
| Vital Statistics from CDC's NCHS | Infant Health Outcomes (Infant Mortality, Low Gestation Weeks, Low Birthweight). | U.S. | Individual | 2005–2019 | Calendar year |
| Adult Longevity | | | | | |
| BUNMD (Goldstein et al. 2023) | Social Security Administration death records. | U.S. | Individual | 1988–2005 | Calendar year |
| NCHS Multiple Cause of Death Data (National Center for Health Statistics 2021) | Death certificates filed in vital statistics offices. | U.S. | Individual | 1959–1961 (country of birth); 1960–1963 (parental nativity) | Calendar year |
| Economic Pull Factors | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Connection to Railroads (Atack 2016) | Railroads connection data. | U.S. | County | 1826–1911 | Decade |
| Homestead (Bureau of Land Management, n.d.) | Share of the county area that was homesteaded in any given decade relative to the overall area of the county. | U.S. | County | 1870–1920 | Decade |
| U.S. Frontier (Bazzi et al. 2020) | Total frontier experience; dummy for being on the frontier in a decade. | U.S. | County | 1850–1890 | Decade |
| New Deal Generosity (Fishback et al. 2003) | Federal relief grants per capita. | U.S. | County | 1933–1939 | Cross-section |
| Great Depression Severity (Fishback et al. 2003) | County per-capita retail sales growth, 1929–1933. | U.S. | County | 1929–1933 | Cross-section |
| Miscellaneous | | | | | |
| Geographic Crosswalks (Eckert et al. 2020; Berkes et al. 2023) | Crosswalks between historical and modern county boundaries. | U.S. | County-to-county | 1850–2010 | Decade |
| Replication files from Burchardi et al. (2019) | Crosswalks between historical and modern country boundaries; crosswalks between U.S. county-groups and U.S. counties. | U.S., Global | Country-to-country; County-to-county | 1880–2010 | Decade |
| Replication package from Donaldson and Hornbeck (2016) | Market access; Lowest-cost county-to-county freight routes resulting in time-varying transportation costs. | U.S. | County | 1850–1920 | Decade |
| Geographic Features | Elevation (Danielson and Gesch 2011); Ruggedness, calculated as the spatial standard deviation of elevation values within a 4.5 km square neighborhood; Distance to coast (Carroll et al. 2009). Countries and U.S. counties values are processed in Google Earth Engine and constructed as spatial averages of gridded values within U.S. county borders and national borders, respectively. | Global | 11.1 × 11.1 km (at the equator) | Static | Cross-section |
| Soil Characteristics | Bulk density (Hengl 2018a), organic matter (Hengl and Wheeler 2018), soil pH (Hengl 2018b), water content (Hengl and Gupta 2019). | Global | 0.25 × 0.25 km (at the equator) | Static | Cross-section |

# C Robustness Checks – Evidence of Climate Matching

## C.1 Assessing Sensitivity to Controls and Alternate Specifications

**Gradual inclusion of controls.** This section examines the sensitivity of the baseline estimates (Table 1) to the gradual inclusion of controls and fixed effects. Table C.1 focuses on Norwegian immigration. Column 1 includes only temperature and precipitation distance. Both coefficients are negative and statistically significant, indicating that greater climate distance is associated with lower migration. Columns 2–5 progressively introduce origin and destination controls to account for the fact that climate similarity may correlate with origin and destination characteristics that also affect bilateral migration. Column 2 controls for geographic distance. Column 3 adds a vector of U.S. county and Norwegian municipality controls.[56] Using variables measured consistently in the Norwegian and U.S. Censuses, we control for population density, urban population share, sex ratios, the share of men in the labor force, and employment shares in agriculture and manufacturing. For the U.S., we additionally include the immigrant, Norwegian, and Black population shares; total frontier experience from Bazzi et al. (2020); and market access from Donaldson and Hornbeck (2016). Column 4 introduces U.S. state by cohort and Norwegian province by cohort fixed effects. To more explicitly control for physical distance, column 5 adds the distance from each U.S. destination county to New York City and from each Norwegian municipality to the nearest transatlantic port.[57] The coefficient on temperature distance decreases in magnitude as controls are included, but remains consistently negative and highly significant in all specifications. Finally, in column 6 we report the preferred specification (Table 1, column 1), where we replace state and province fixed effects with county and municipality fixed effects, respectively.

Tables C.2 and C.3 present the historical (1880–1920) and modern (1970–2010) international immigration results, respectively. Column 1 includes only temperature and precipitation distance; column 2 adds geographic distance; column 3 adds decade dummies. The temperature-distance coefficient remains negative and statistically significant throughout. Columns 4 and 5 sequentially add continent-of-origin and U.S. state-of-destination fixed effects, followed by country-of-origin and U.S. county-of-destination fixed effects. Column 6 reports the baseline specification (Table 1, columns 2 and 3), interacting decade dummies with country and county fixed effects. In both tables, the coefficient on temperature distance remains negative, statistically significant, and quantitatively large through column 4. In columns 5 and 6, it shrinks in absolute value by about a third in the historical sample and remains statistically significant at the 1% level; in the modern sample it becomes an order of magnitude smaller and is statistically significant only at the 10% level.

Tables C.4 and C.5 report analogous results for internal migration using the historical linked sample

56. Because the economic, demographic, and urban structure may be endogenous to climate, these variables may be "bad controls" (Angrist and Pischke 2009).

57. We consider the two major ports of this period—Oslo and Kristiansand—but results are unchanged when including other ports.

(1850–1940) and modern IRS data (2011–2019). Column 1 only includes temperature and precipitation distance. Column 2 adds geographic distance. Column 3 adds county-of-origin, county-of-destination, and period fixed effects (decade historically; calendar year in the IRS data). Column 4 interacts period dummies with state-of-origin and state-of-destination fixed effects. Column 5 reports the baseline specification (Table 1, columns 4 and 5), interacting period fixed effects with county-of-origin and county-of-destination fixed effects. The modern baseline excludes moves after 2019 to avoid potential COVID-19 distortions, but column 6 of Table C.5 shows that including 2019–2020 and 2020–2021 moves yields virtually identical results.

**International immigration: sample and climate measurement.** Table C.6 assesses the robustness of the historical and modern international immigration results to alternate sample restrictions and ways to measure climate. Columns 1–4 cover the Age of Mass Migration. Column 1 reports the baseline specification. Column 2 restricts the sample to European immigrants, who accounted for over 85% of arrivals during this period (Abramitzky and Boustan 2017); despite the smaller sample and reduced climate variation, estimates remain close to baseline. Column 3 excludes immigrants arriving in 1880, when year-of-arrival information is unavailable and immigrant counts therefore measure stocks rather than flows; results are unchanged.[58] Column 4 replaces population-weighted origin-country climate with capital-city temperatures, again yielding similar estimates. Columns 5–7 report the modern immigration results. Column 5 presents the baseline specification; column 6 excludes European immigrants, showing that the results are not driven by relatively small contemporary sending regions; and column 7 uses capital-city temperatures to measure origin-country climate. The point estimate remains negative but is less precise and no longer statistically significant, consistent with greater within-country climatic heterogeneity in the modern period.

**Clustering structure.** Baseline standard errors are clustered by Norwegian province × U.S. state of destination in the Norwegian sample, country of origin × U.S. state of destination for international migration and by U.S. state of origin × U.S. state of destination for internal migration. Table C.7 shows that coefficients remain statistically significant when clustering instead by Norwegian province of origin × U.S. census division of destination for Norwegian migration, country of origin × U.S. census division of destination for international migration, and by U.S. census division of origin × U.S. census division of destination for internal migration.

58. In 1880, year of arrival is not reported, so immigrant counts reflect stocks rather than flows; excluding 1880 therefore alleviates concerns about mixing stock and flow measures or allowing the results to be driven by this difference in measurement.

**Table C.1.** Climate Distance and Norwegian Immigration (1865–1920)

| Dep. Variable: | Number of Migrants | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Temperature Distance | -0.297*** | -0.286*** | -0.151*** | -0.057*** | -0.056*** | -0.078*** |
| | (0.015) | (0.017) | (0.011) | (0.009) | (0.009) | (0.014) |
| Precipitation Distance | -0.005*** | -0.004*** | -0.000 | -0.003*** | -0.004*** | -0.001* |
| | (0.002) | (0.002) | (0.001) | (0.001) | (0.001) | (0.001) |
| Distance (100 km) | | -0.022*** | 0.030*** | -0.049*** | -0.052*** | -0.138*** |
| | | (0.008) | (0.007) | (0.013) | (0.015) | (0.025) |
| U.S. Controls | | | Yes | Yes | Yes | |
| Norwegian Controls | | | Yes | Yes | Yes | |
| Distance-to-Port Controls | | | | | Yes | |
| Observations | 4,454,238 | 4,454,238 | 4,454,238 | 3,799,205 | 3,799,205 | 811,961 |
| Pseudo R-squared | 0.097 | 0.098 | 0.369 | 0.430 | 0.430 | 0.390 |
| Mean Temp. Dist. | 8.090 | 8.090 | 8.090 | 7.694 | 7.694 | 4.526 |
| SD Temp. Dist. | 4.775 | 4.775 | 4.775 | 4.862 | 4.862 | 3.790 |
| Mean Precip. Dist. | 46.93 | 46.93 | 46.93 | 47.89 | 47.89 | 53.36 |
| SD Precip. Dist. | 41.58 | 41.58 | 41.58 | 43.00 | 43.00 | 47.11 |
| Cohort FE | Yes | Yes | Yes | | | |
| U.S. state × cohort FE | | | | Yes | Yes | |
| Nor. province × cohort FE | | | | Yes | Yes | |
| Nor. municipality × cohort FE | | | | | | Yes |
| U.S. county × cohort FE | | | | | | Yes |

*Notes:* PPML Estimates. The sample includes all Norwegian municipality–U.S. county pairs for each matched cohort. Number of Migrants is the bilateral migrant flow from a Norwegian municipality of origin to a U.S. county of destination for each matched cohort. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters), using TerraClimate population-weighted averages. Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 includes cohort fixed effects only. Column 2 adds the bilateral distance. Column 3 adds U.S. and Norwegian control levels (population density; urban, employment, manufacturing-employment and agricultural-employment shares; sex ratio) together with U.S. market access, frontier, immigrant share, Norwegian immigrant share and Black population share. Column 4 adds U.S. state × cohort and Norwegian province × cohort fixed effects. Column 5 adds monadic distances (U.S. county to New York; Norwegian municipality to nearest international port). Column 6 is the preferred specification, with U.S. county × cohort and Norwegian municipality × cohort fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state × Norwegian province level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.2.** International Immigration (1880–1920): Gradual Inclusion of Controls

| Dep. Variable: | Number of Migrants | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Temperature Distance | -0.348*** | -0.383*** | -0.383*** | -0.245*** | -0.163*** | -0.174*** |
| | (0.021) | (0.023) | (0.023) | (0.023) | (0.020) | (0.021) |
| Precipitation Distance | -0.028*** | -0.026*** | -0.026*** | -0.013*** | 0.001 | -0.002 |
| | (0.004) | (0.004) | (0.004) | (0.003) | (0.004) | (0.004) |
| Distance (100 km) | | -0.029*** | -0.029*** | -0.048*** | -0.064*** | -0.064*** |
| | | (0.002) | (0.002) | (0.008) | (0.014) | (0.013) |
| Observations | 2,202,216 | 2,202,216 | 2,202,216 | 2,202,216 | 2,053,752 | 1,942,210 |
| Pseudo R-squared | 0.209 | 0.279 | 0.282 | 0.483 | 0.850 | 0.916 |
| Mean Temp. Dist. | 9.776 | 9.776 | 9.776 | 9.776 | 9.677 | 9.622 |
| SD Temp. Dist. | 5.693 | 5.693 | 5.693 | 5.693 | 5.735 | 5.752 |
| Mean Precip. Dist. | 55.79 | 55.79 | 55.79 | 55.79 | 53.11 | 52.67 |
| SD Precip. Dist. | 45.89 | 45.89 | 45.89 | 45.89 | 42.40 | 42.24 |
| Decade FE | | | Yes | Yes | Yes | |
| Origin Continent FE | | | | Yes | | |
| Destination State FE | | | | Yes | | |
| Origin FE | | | | | Yes | |
| Destination FE | | | | | Yes | |
| Origin × Decade FE | | | | | | Yes |
| Destination × Decade FE | | | | | | Yes |

*Notes:* PPML Estimates. The sample includes U.S. county-country pairs for each decade over the 1880–1920 period (except for 1890). Number of Migrants is the number of individuals from origin country $o$ living in destination county $d$ in decade $t$ who arrived in the previous decade (except for 1880, when information on year of arrival is not available). Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 includes only Temperature Distance and Precipitation Distance. Column 2 adds Distance. Column 3 includes decade fixed effects. Column 4 adds continent of origin and U.S. state of destination fixed effects. Column 5 adds country of origin and U.S. county of destination fixed effects. Column 6 reports the baseline specification from Table 1, column 2, which interacts decade dummies with country of origin and county of destination fixed effects. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.3.** International Immigration (1970–2010): Gradual Inclusion of Controls

| Dep. Variable: | Number of Migrants | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Temperature Distance | -0.112*** | -0.128*** | -0.128*** | -0.128*** | -0.020* | -0.019* |
| | (0.025) | (0.030) | (0.030) | (0.026) | (0.010) | (0.011) |
| Precipitation Distance | -0.003 | -0.001 | -0.001 | -0.005** | -0.008*** | -0.008*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Distance (100 km) | | -0.022*** | -0.022*** | -0.034*** | -0.051*** | -0.051*** |
| | | (0.006) | (0.006) | (0.009) | (0.004) | (0.004) |
| Observations | 2,765,230 | 2,765,230 | 2,765,230 | 2,765,230 | 2,749,695 | 2,475,100 |
| Pseudo R-squared | 0.035 | 0.090 | 0.113 | 0.368 | 0.871 | 0.893 |
| Mean Temp. Dist. | 9.791 | 9.791 | 9.791 | 9.791 | 9.771 | 9.622 |
| SD Temp. Dist. | 5.697 | 5.697 | 5.697 | 5.697 | 5.697 | 5.685 |
| Mean Precip. Dist. | 55.64 | 55.64 | 55.64 | 55.64 | 55.11 | 53.92 |
| SD Precip. Dist. | 45.72 | 45.72 | 45.72 | 45.72 | 45.25 | 43.91 |
| Decade FE | | | Yes | Yes | Yes | |
| Origin Continent FE | | | | Yes | | |
| Destination State FE | | | | Yes | | |
| Origin FE | | | | | Yes | |
| Destination FE | | | | | Yes | |
| Origin × Decade FE | | | | | | Yes |
| Destination × Decade FE | | | | | | Yes |

*Notes:* PPML Estimates. The sample includes U.S. county-country pairs for each decade over the 1970–2010 period. Number of Migrants is the number of individuals from origin country $o$ living in destination county $d$ in decade $t$ who arrived in the previous decade. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 includes only Temperature Distance and Precipitation Distance. Column 2 adds Distance. Column 3 includes decade fixed effects. Column 4 adds continent of origin and U.S. state of destination fixed effects. Column 5 adds country of origin and U.S. county of destination fixed effects. Column 6 reports the baseline specification from Table 1, column 3, which interacts decade dummies with country of origin and county of destination fixed effects. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.4.** U.S. Internal Migration (1850–1940): Gradual Inclusion of Controls

| Dep. Variable: | Number of Migrants | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Temperature Distance | -0.448*** | -0.314*** | -0.314*** | -0.313*** | -0.312*** |
| | (0.039) | (0.025) | (0.020) | (0.020) | (0.020) |
| Precipitation Distance | -0.056*** | -0.025*** | -0.017*** | -0.017*** | -0.016*** |
| | (0.006) | (0.004) | (0.002) | (0.002) | (0.002) |
| Distance (100 km) | | -0.214*** | -0.208*** | -0.209*** | -0.210*** |
| | | (0.037) | (0.015) | (0.015) | (0.015) |
| Observations | 38,428,111 | 38,428,111 | 38,032,399 | 36,367,930 | 31,105,383 |
| Pseudo R-squared | 0.212 | 0.273 | 0.725 | 0.734 | 0.746 |
| Mean Temp. Dist. | 5.062 | 5.062 | 5.052 | 5.029 | 4.923 |
| SD Temp. Dist. | 3.667 | 3.667 | 3.660 | 3.649 | 3.578 |
| Mean Precip. Dist. | 32.85 | 32.85 | 32.81 | 32.49 | 31.01 |
| SD Precip. Dist. | 24.43 | 24.43 | 24.42 | 24.29 | 23.76 |
| Decade FE | | | Yes | Yes | |
| Origin FE | | | Yes | Yes | |
| Destination FE | | | Yes | Yes | |
| Origin State × Decade FE | | | | Yes | |
| Destination State × Decade FE | | | | Yes | |
| Origin × Decade FE | | | | | Yes |
| Destination × Decade FE | | | | | Yes |

*Notes:* PPML Estimates. The sample includes county-pairs in the contiguous U.S. for each decade from 1850–1860 to 1930–1940. Number of Migrants is the number of individuals 15+ in the baseline year who moved from the origin to the destination county in the decade. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 includes only Temperature Distance and Precipitation Distance. Column 2 adds Distance. Column 3 introduces census year, county of origin, and county of destination fixed effects. Column 4 adds the interaction of census year dummies with U.S. state of origin and U.S. state of destination fixed effects. Column 5 reports the baseline specification from Table 1, column 4, which interacts census year dummies with county of origin and county of destination fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.5.** U.S. Internal Migration (2011–2019): Gradual Inclusion of Controls

| Dep. Variable: | Number of Migrants | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Temperature Distance | -0.404*** | -0.223*** | -0.237*** | -0.237*** | -0.237*** | -0.235*** |
| | (0.066) | (0.052) | (0.041) | (0.041) | (0.041) | (0.041) |
| Precipitation Distance | -0.059*** | -0.023*** | -0.030*** | -0.030*** | -0.030*** | -0.030*** |
| | (0.007) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| Distance (100 km) | | -0.272*** | -0.203*** | -0.204*** | -0.204*** | -0.204*** |
| | | (0.056) | (0.022) | (0.022) | (0.022) | (0.022) |
| Observations | 38,601,368 | 38,601,368 | 31,823,048 | 31,823,048 | 25,088,936 | 31,045,614 |
| Pseudo R-squared | 0.147 | 0.206 | 0.783 | 0.783 | 0.776 | 0.777 |
| Mean Temp. Dist. | 5.052 | 5.052 | 5.016 | 5.016 | 4.989 | 4.987 |
| SD Temp. Dist. | 3.662 | 3.662 | 3.644 | 3.644 | 3.632 | 3.632 |
| Mean Precip. Dist. | 32.87 | 32.87 | 32.00 | 32.00 | 31.06 | 31.01 |
| SD Precip. Dist. | 24.43 | 24.43 | 24.24 | 24.24 | 24.01 | 23.99 |
| Year FE | | | Yes | Yes | | |
| Origin FE | | | Yes | Yes | | |
| Destination FE | | | Yes | Yes | | |
| Origin State × Year FE | | | | Yes | | |
| Destination State × Year FE | | | | Yes | | |
| Origin × Year FE | | | | | Yes | Yes |
| Destination × Year FE | | | | | Yes | Yes |

*Notes:* PPML Estimates. The sample includes county-pairs in the contiguous U.S. for each calendar year from 2011–2012 to 2018–2019. Number of Migrants is the number of people who changed address between origin and destination counties, based on IRS Migration data from individual income tax returns. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 includes only Temperature Distance and Precipitation Distance. Column 2 adds Distance. Column 3 introduces year, county of origin, and county of destination fixed effects. Column 4 adds the interaction of year dummies with U.S. state of origin and U.S. state of destination fixed effects. Column 5 reports the baseline specification from Table 1, column 5, which interacts calendar year dummies with county of origin and county of destination fixed effects. Column 6 replicates column 5 including moves from 2019–2020 and 2020–2021. Standard errors, reported in parentheses, are clustered at the U.S. state of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.6.** International Immigration: Additional Robustness

| Dep. Variable: | Number of Migrants | | | | | | |
|---|---|---|---|---|---|---|---|
| | Historical: 1880–1920 | | | | Modern: 1970–2010 | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Temperature Distance | -0.174*** | -0.144*** | -0.162*** | -0.142*** | -0.019* | -0.034* | -0.017 |
| | (0.021) | (0.030) | (0.021) | (0.021) | (0.011) | (0.018) | (0.013) |
| Precipitation Distance | -0.002 | -0.006 | 0.003 | 0.001 | -0.008*** | -0.010*** | -0.007*** |
| | (0.004) | (0.005) | (0.004) | (0.005) | (0.002) | (0.002) | (0.002) |
| Distance (100 km) | -0.064*** | -0.001 | -0.060*** | -0.083*** | -0.051*** | -0.054*** | -0.051*** |
| | (0.013) | (0.036) | (0.013) | (0.014) | (0.004) | (0.004) | (0.004) |
| Observations | 1,942,210 | 376,782 | 1,450,765 | 1,942,210 | 2,475,100 | 2,003,462 | 2,475,100 |
| Pseudo R-squared | 0.916 | 0.906 | 0.915 | 0.915 | 0.893 | 0.903 | 0.893 |
| Mean Temp. Dist. | 9.622 | 5.070 | 9.605 | 9.468 | 9.622 | 10.68 | 9.443 |
| SD Temp. Dist. | 5.752 | 3.701 | 5.754 | 5.838 | 5.685 | 5.548 | 5.766 |
| Mean Precip. Dist. | 52.67 | 33.47 | 52.51 | 53.91 | 53.92 | 58.66 | 55.10 |
| SD Precip. Dist. | 42.24 | 29.41 | 42.14 | 47.70 | 43.91 | 45.38 | 48.54 |
| Origin × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Intl Mig Period | 1880–1920 | 1880–1920 | 1900–1920 | 1880–1920 | 1970–2010 | 1970–2010 | 1970–2010 |
| Origin Climate | Weighted Avg | Weighted Avg | Weighted Avg | Capital City | Weighted Avg | Weighted Avg | Capital City |
| Countries | Any | Europe only | Any | Any | Any | Non-Europe only | Any |

*Notes:* PPML Estimates. The samples in columns 1–4 and 5–7 include U.S. county-country pairs for each decade over the 1880–1920 (except for 1890) and 1970–2010 periods, respectively. Number of Migrants is the number of individuals from origin country $o$ living in destination county $d$ in census year $t$ who arrived in the previous decade (except for 1880, when information on year of arrival is not available). Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 replicates the historical baseline specification from Table 1, column 2. Column 2 restricts the sample to European origin countries only. Column 3 drops 1880 from the sample. Column 4 replaces the origin-country climate with capital-city TerraClimate temperature and precipitation. Column 5 replicates the modern baseline specification from Table 1, column 3. Column 6 drops European origin countries. Column 7 replaces the origin-country climate with capital-city TerraClimate temperature and precipitation. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.7.** Climate Distance and Migration: Clustering by U.S. Census Division

| Dep. Variable: | Number of Migrants | | | | |
|---|---|---|---|---|---|
| | Norway-U.S. 1865–1920 | Intl-U.S. 1880–1920 | Intl-U.S. 1970–2010 | Internal 1850–1940 | Internal 2011–2019 |
| | (1) | (2) | (3) | (4) | (5) |
| Temperature Distance | -0.078*** | -0.174*** | -0.019* | -0.312*** | -0.237*** |
| | (0.013) | (0.030) | (0.011) | (0.038) | (0.061) |
| Precipitation Distance | -0.001 | -0.002 | -0.008*** | -0.016*** | -0.030*** |
| | (0.001) | (0.005) | (0.002) | (0.004) | (0.009) |
| Distance (100 km) | -0.138*** | -0.064*** | -0.051*** | -0.210*** | -0.204*** |
| | (0.032) | (0.021) | (0.005) | (0.029) | (0.038) |
| Observations | 811,961 | 1,942,210 | 2,475,100 | 31,105,383 | 25,088,936 |
| Pseudo R-squared | 0.390 | 0.916 | 0.893 | 0.746 | 0.776 |
| Mean Temp. Dist. | 4.526 | 9.622 | 9.622 | 4.923 | 4.989 |
| SD Temp. Dist. | 3.790 | 5.752 | 5.685 | 3.578 | 3.632 |
| Mean Precip. Dist. | 53.36 | 52.67 | 53.92 | 31.01 | 31.06 |
| SD Precip. Dist. | 47.11 | 42.24 | 43.91 | 23.76 | 24.01 |
| Origin × Period FE | Yes | Yes | Yes | Yes | Yes |
| Destination × Period FE | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. Column 1 covers all Norwegian municipality–U.S. county pairs for each matched cohort. The samples in columns 2–3 include U.S. county-country pairs for each decade over the 1880–1920 (except for 1890) and 1970–2010 periods, respectively. The samples in columns 4–5 include county-pairs in the contiguous U.S. for each decade from 1850–1860 to 1930–1940 and for each calendar year from 2011–2012 to 2018–2019, respectively. In column 1, Number of Migrants is the bilateral migrant flow from a Norwegian municipality of origin to a U.S. county of destination. In columns 2–3, Number of Migrants is the number of individuals from origin country $o$ living in destination county $d$ in census year $t$ who arrived in the previous decade (except for 1880, when information on year of arrival is not available). In column 4, Number of Migrants is the number of individuals 15+ in the baseline year who moved from the origin to the destination county in the decade. In column 5, Number of Migrants is the number of people who changed address between origin and destination counties, based on IRS Migration data from individual income tax returns. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. All columns replicate the corresponding specifications in Table 1, changing only the level at which standard errors are clustered. In the fixed effects, period denotes the cohort in column 1, the decade in columns 2–4, and the year in column 5. Standard errors, reported in parentheses, are clustered at the U.S. Census division of destination × Norwegian province level in column 1, at the country of origin × U.S. Census division of destination level in columns 2–3, and at the U.S. Census division of origin × U.S. Census division of destination level in columns 4–5. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

## C.2 Addressing the Spatial Correlation of Climate

Because climate is spatially correlated, a concern is that our estimates may reflect migrants' aversion to traveling long distances rather than responses to climate distance. As discussed in Section 2.2, physical distance explains at most 1.6% of the variation in temperature distance between countries of origin and U.S. counties (Table A.2, columns 1–3), and up to 19.9% in the internal migration context (columns 4–6). Although higher for internal migration, this remains modest, leaving substantial independent variation in climate distance beyond geographic distance. While these patterns are reassuring, we address remaining concerns about spatial climate correlation in several ways. Our baseline specification controls for geographic distance between origin and destination counties, accounting for the fact that short-distance moves mechanically tend to connect places with similar climates. Because a linear distance control may not fully address this concern, we perform several additional exercises.

In Table C.8, we replicate the baseline specification (column 1) separately by direction of movement. For historical internal migration (Panel A), the temperature-distance coefficient remains negative and statistically significant for most directions except North–South moves (column 7). For modern migration (Panel B), estimates remain quantitatively and qualitatively similar to baseline for horizontal moves (columns 2–4), but are less precise for vertical moves (columns 5–7), with a positive and statistically significant coefficient for South–North moves (column 6). Overall, the relationship between temperature distance and migration is stronger for horizontal than vertical moves, consistent with historical accounts emphasizing east–west migration in U.S. settlement patterns (Steckel 1983). Notably, this horizontal gradient persists in the modern period.

In Table C.9, we exclude various subsets of moves: adjacent counties (column 2), next-to-adjacent counties (column 3), moves within 100 km (column 4), within-state moves (column 5), moves across adjacent states (column 6), and states with potentially distinctive migration patterns, California (column 7) and Florida (column 8). Despite substantial reductions in sample size, coefficients remain negative and statistically significant in both historical (Panel A) and modern (Panel B) samples. Their magnitude declines when short-distance moves are excluded, particularly in the modern sample, but they remain precisely estimated.

Finally, in Table C.10 we flexibly control for geographic distance with up to quartic polynomials as well as the log of distance, absorbing much of the spatial variation that could confound climate distance and migration. In the historical sample (Panel A), the temperature-distance coefficient remains negative and statistically significant, though attenuated, indicating that the relationship is not driven by nonlinearities in geographic distance. In the modern sample (Panel B), the estimates are instead not robust to this check, consistent with the weaker climate–migration relationship documented elsewhere. Taken together, the climate-distance effect remains robust historically—when climate-specific skills were likely more important—but is weaker in the modern period, when adaptation technologies such as air conditioning may have reduced the importance of climate matching.

**Table C.8.** Climate Distance and Migration, by Direction of Move

| Dep. Variable: | Number of Migrants | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| *Panel A: U.S. Internal Migration, 1850–1940* | | | | | | | |
| Temperature Distance | -0.312*** | -0.251*** | -0.073*** | -0.110*** | -0.170*** | -0.125* | -0.013 |
| | (0.020) | (0.021) | (0.026) | (0.023) | (0.032) | (0.072) | (0.040) |
| Observations | 31,105,383 | 20,455,194 | 11,170,082 | 9,118,348 | 10,483,311 | 4,196,734 | 6,206,746 |
| Pseudo R-squared | 0.746 | 0.735 | 0.784 | 0.792 | 0.828 | 0.870 | 0.859 |
| *Panel B: U.S. Internal Migration, 2011–2019* | | | | | | | |
| Temperature Distance | -0.237*** | -0.234*** | -0.284*** | -0.137** | -0.041 | 0.171** | 0.017 |
| | (0.041) | (0.038) | (0.074) | (0.058) | (0.065) | (0.071) | (0.084) |
| Observations | 25,088,936 | 12,364,382 | 3,529,688 | 4,308,246 | 6,454,796 | 2,584,105 | 1,713,116 |
| Pseudo R-squared | 0.776 | 0.773 | 0.845 | 0.807 | 0.833 | 0.869 | 0.910 |
| Direction | All | Horizontal | East–West | West–East | Vertical | South–North | North–South |
| Origin × Decade/Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade/Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The samples in Panels A–B include county-pairs in the contiguous U.S. for each decade from 1850–1860 to 1930–1940 and for each year from 2011–2012 to 2018–2019, respectively. Number of Migrants in Panel A is the number of individuals 15+ in the baseline year who moved from the origin to the destination county in the decade. Number of Migrants in Panel B is the number of people who changed address between origin and destination counties, based on IRS Migration data from individual income tax returns. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 replicates the internal baseline specifications from Table 1, columns 4–5. Columns 2–7 retain only specific directions of county pairs. All regressions also control for precipitation and geographic distance and include county of origin × decade (Panel A) or year (Panel B) and county of destination × decade/year fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.9.** Climate Distance and Migration: Dropping Selected Counties

| Dep. Variable: | Number of Migrants | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Panel A: U.S. Internal Migration, 1850–1940* | | | | | | | | |
| Temperature Distance | -0.312*** | -0.215*** | -0.185*** | -0.182*** | -0.190*** | -0.092*** | -0.314*** | -0.331*** |
| | (0.020) | (0.012) | (0.011) | (0.011) | (0.013) | (0.011) | (0.019) | (0.020) |
| Observations | 31,105,383 | 31,032,570 | 30,884,079 | 30,884,032 | 30,004,136 | 25,935,079 | 29,884,776 | 29,837,255 |
| Pseudo R-squared | 0.746 | 0.736 | 0.720 | 0.720 | 0.697 | 0.703 | 0.758 | 0.749 |
| *Panel B: U.S. Internal Migration, 2011–2019* | | | | | | | | |
| Temperature Distance | -0.237*** | -0.074*** | -0.033*** | -0.043*** | -0.042*** | -0.041*** | -0.193*** | -0.317*** |
| | (0.041) | (0.018) | (0.012) | (0.013) | (0.013) | (0.013) | (0.045) | (0.042) |
| Observations | 25,088,936 | 14,187,146 | 8,428,492 | 8,820,534 | 5,818,035 | 5,747,484 | 23,993,808 | 23,851,324 |
| Pseudo R-squared | 0.776 | 0.795 | 0.816 | 0.829 | 0.763 | 0.764 | 0.775 | 0.790 |
| Sample | Full | Drop Adjacent Counties | Drop Adjacent & Next to Adjacent Counties | Drop Moves $< 100$ km | Between States Only | Drop Adjacent States | Drop California | Drop Florida |
| Origin × Decade/Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade/Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The samples in Panels A–B include county-pairs in the contiguous U.S. for each decade from 1850–1860 to 1930–1940 and for each year from 2011–2012 to 2018–2019, respectively. Number of Migrants in Panel A is the number of individuals 15+ in the baseline year who moved from the origin to the destination county in the decade. Number of Migrants in Panel B is the number of people who changed address between origin and destination counties, based on IRS Migration data from individual income tax returns. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 replicates the internal baseline specifications from Table 1, columns 4–5. Column 2 drops adjacent county pairs. Column 3 drops adjacent and next-to-adjacent county pairs. Column 4 removes county pairs with a migration distance of less than 100 km. Column 5 retains only county pairs across different states. Column 6 drops county pairs from adjacent states. Column 7 removes county pairs where either the origin or the destination is in California. Column 8 removes county pairs where either the origin or the destination is in Florida. All regressions also control for precipitation and geographic distance and include county of origin × decade (Panel A) or year (Panel B) and county of destination × decade/year fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.10.** U.S. Internal Migration: Non-Linear Geographic Distance Controls

| Dep. Variable: | Number of Migrants | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| *Panel A: U.S. Internal Migration, 1850–1940* | | | | | |
| Temperature Distance | -0.312*** | -0.201*** | -0.102*** | -0.101*** | -0.084*** |
| | (0.020) | (0.016) | (0.011) | (0.010) | (0.009) |
| Observations | 31,105,383 | 31,105,383 | 31,105,383 | 31,105,383 | 31,105,383 |
| Pseudo R-squared | 0.746 | 0.787 | 0.817 | 0.835 | 0.854 |
| Mean Temp. Dist. | 4.923 | 4.923 | 4.923 | 4.923 | 4.923 |
| SD Temp. Dist. | 3.578 | 3.578 | 3.578 | 3.578 | 3.578 |
| *Panel B: U.S. Internal Migration, 2011–2019* | | | | | |
| Temperature Distance | -0.237*** | -0.045 | 0.053** | 0.018 | 0.071*** |
| | (0.041) | (0.032) | (0.022) | (0.017) | (0.018) |
| Observations | 25,088,936 | 25,088,936 | 25,088,936 | 25,088,936 | 25,088,936 |
| Pseudo R-squared | 0.776 | 0.827 | 0.867 | 0.885 | 0.904 |
| Mean Temp. Dist. | 4.989 | 4.989 | 4.989 | 4.989 | 4.989 |
| SD Temp. Dist. | 3.632 | 3.632 | 3.632 | 3.632 | 3.632 |
| Physical distance controls | Linear | Quadratic | Cubic | Quartic | Log |
| Origin × Decade/Year FE | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade/Year FE | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The samples in Panels A–B include county-pairs in the contiguous U.S. for each decade from 1850–1860 to 1930–1940 and for each year from 2011–2012 to 2018–2019, respectively. Number of Migrants in Panel A is the number of individuals 15+ in the baseline year who moved from the origin to the destination county in the decade. Number of Migrants in Panel B is the number of people who changed address between origin and destination counties, based on IRS Migration data from individual income tax returns. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 replicates the internal baseline specifications from Table 1, columns 4–5. Columns 2, 3, and 4 control, respectively, for the second, third, and fourth order polynomials of physical distance, always including lower-order terms. Column 5 controls for log geographic distance. All regressions also control for precipitation distance and include county of origin × decade (Panel A) or year (Panel B) and county of destination × decade/year fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

## C.3 Including Bilateral Controls

In this section, we assess the robustness of the baseline results to the inclusion of bilateral controls. We begin by controlling for additional geographic attributes—such as elevation, ruggedness, and coastal access—that may be correlated with climate distance and may independently shape migration patterns (Albouy et al. 2021). Table C.11 reports results for the Norwegian sample, including key socioeconomic controls (column 2) and geographic controls (columns 3–5). Tables C.12 and C.13 report results for international immigration and U.S. internal migration, respectively. In both tables, Panel A presents estimates for historical migration, while Panel B reports results for modern migration. With the exception of specifications that add ruggedness distance in the modern international context (Table C.12, columns 3 and 5), the point estimates remain in line with the baseline results reported in column 1.

Next, we turn to latitude and longitude. Especially in the context of historical internal migration, latitude was often cited as a key factor shaping predominantly horizontal migration patterns (Steckel 1983). Tables C.14 and C.15 report results for international and internal migration, respectively. In both tables, Panel A presents estimates for historical migration, while Panel B reports results for modern migration. Given the prominence of these variables in the migration literature, we also report the coefficients on the additional controls. Columns 2 and 3 introduce latitude and longitude distance separately; column 4 includes both measures jointly; column 5 replicates column 4 without the geographic distance control.

Across specifications, the coefficient on temperature distance remains negative and statistically significant. For historical internal migration (Table C.15, Panel A), the coefficient on latitude distance is consistently negative and statistically significant, confirming long-standing historical accounts that emphasize the importance of latitudinal sorting in U.S. migration (Steckel 1983). Notably, this latitudinal pattern persists in the modern internal migration sample as well (Panel B), suggesting a durable role for north–south climatic differences in shaping internal mobility even as other climate-related mechanisms have weakened.

Another feature that may be correlated with climate—and that may matter for migration decisions, particularly among farmers—is soil type. Soil formation is a long-run geological process shaped in part by local biomes and vegetation histories, which themselves reflect historical climatic conditions. Although formal soil science concepts—such as soil pH—were not articulated until the early 20$^{\text{th}}$ century, farmers likely possessed practical knowledge of soil characteristics through experience. Using gridded soil data, we construct county-level averages of four soil attributes: bulk density (column 2), organic matter content (column 3), soil pH (column 4), and water-holding capacity (column 5). Column 6 includes all soil measures jointly.[59] We report results for each of the four

59. Bulk density is the weight of dry soil per unit volume, with higher values indicating compacted soil. Organic matter concentration is the percentage of decomposed plant and animal material in the soil—features that can influence soil fertility and structure. Soil pH is a measure of soil acidity that affects nutrient availability and the types of crops that can be grown. Soil water content refers to the water holding capacity of the soil, which depends

contexts—historical international, modern international, historical internal, and modern internal migration—in Tables C.16 through C.19.

Across specifications, the coefficient on temperature distance remains close to its baseline value. By contrast, the coefficients on the various soil-distance measures (other than organic matter) are unstable in the international immigration setting (Tables C.16 and C.17). For internal migration, however, soil distance is strongly negatively associated with migration in most specifications and is often precisely estimated (Tables C.18 and C.19). This pattern is consistent with historical and anecdotal accounts suggesting that farmer migrants actively sought destinations with soil characteristics similar to those of their places of origin.[60]

In Table C.20, we address the concern that the historical internal migration results may be driven by large changes in transportation costs over the long period we study (1850–1940). In column 2, we interact geographic distance with decade dummies to allow its effect to vary flexibly over time, capturing potential correlations between distance-related frictions and climate distance. Reassuringly, the coefficient on temperature distance remains close to the baseline estimate reported in column 1.

Next, we use data on the U.S. railroad network expansion from Donaldson and Hornbeck (2016) to compute bilateral time-varying transportation costs for each U.S. county-pair. To this end, we augment the railroad network with straight connections within and between county centroids, which are meant to proxy stagecoach connections. Then, we assign a weight to each edge of the resulting network. Transportation costs can be expressed either in hours or in dollars. In the former case, we use as weights 25 miles per hour for a railroad edge and 8 miles per hour for all other edges. In the latter case, we use \$0.03 per mile for a train ride and \$0.15 for all other edges.[61] With this weighted network at hand, we compute the least-cost paths between each county pair, for each decade between 1860 and 1920.[62] In columns 3 and 4, we augment the baseline specification by controlling for time-varying county-pair travel costs, measured in hours and dollars, respectively. Columns 5 and 6 replicate columns 3 and 4 but exclude geographic distance. As expected, the coefficient on travel costs is negative and statistically significant. More importantly, the coefficient on temperature distance remains similar in magnitude to that in the baseline specification.

Finally, one may be concerned that origin–destination differences in economic or demographic characteristics correlated with climate distance could confound the relationship between climate

on soil texture and structure. Spatial averages of each soil characteristic for each county were computed using the OpenLandMap product available on Google Earth Engine with data from Hengl (2018a), Hengl and Wheeler (2018), Hengl (2018b), and Hengl and Gupta (2019).

60. Steckel (1983) also conjectured that the east-west migration gradient prevailing in the U.S. during the 19$^{th}$ century was partly explained by farmers seeking similar soil types. Another anecdotal example is that of the "Cajun Prairie" region of Southwest Louisiana, which was first intensively farmed by Midwestern migrants in the 1880s who were attracted by the similar Mollisol-type prairie soils (see https://www.loc.gov/item/sn88064676/).

61. These numbers were gathered from Newcomb and Ward Jr. (1901) and Kingsford (1852), respectively.

62. Since railroad expansion data are available only through 1920, we assign the 1920 values to 1930 and 1940. The results are unchanged when excluding observations from 1930 and 1940 from the analysis.

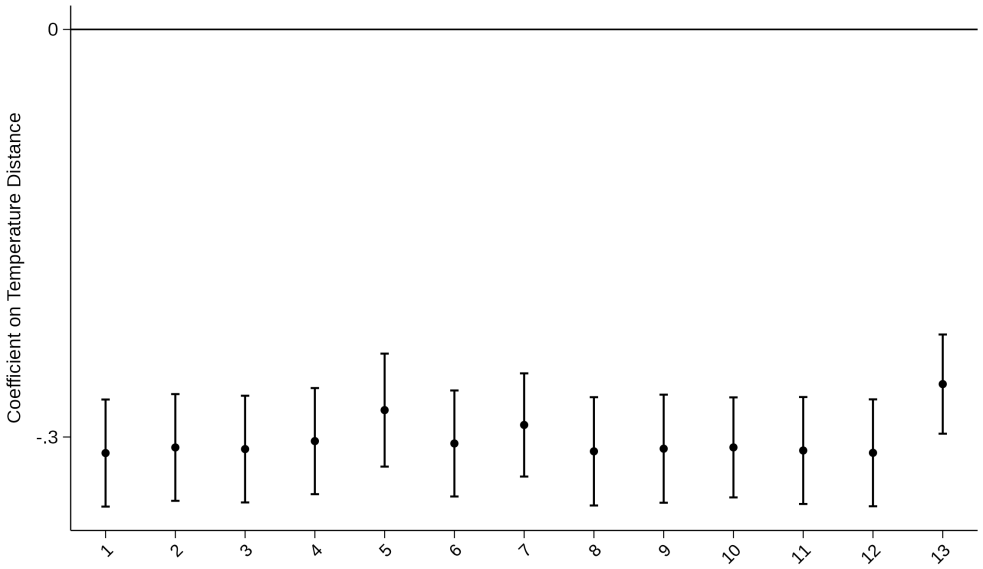
and migration. The long-difference analysis in Table 2 mitigates this concern by controlling for origin-by-destination fixed effects. For historical internal migration, we further assess robustness by controlling for a rich set of origin–destination characteristics measured at the beginning of each decade using the full-count U.S. Census of Population. Figure C.1 replicates the baseline specification from Table 1, column 4 (shown by the leftmost dot), and sequentially adds county-pair differences in these characteristics.

The second, third, and fourth dots from the left control for the county-pair difference in labor force participation, manufacturing employment share, and agricultural employment share, respectively.[63] The subsequent dots include the difference in, respectively: the Black, the urban, and the immigrant population share; sex ratios; and population density. Finally, we consider three forces that have been shown to shape population movement and economic activity during our sample period: exposure to the frontier (Bazzi et al. 2020); market access (Donaldson and Hornbeck 2016); and connection to railroads (Atack 2016).[64] The very last dot includes all variables simultaneously. Coefficients on climate distances always remain negative, precisely estimated, and close to those from the baseline specification.

63. In all cases, the variables are defined for men 15–64 in the baseline decade. Results are unchanged when using different age thresholds, extending the sample to women, or when considering a larger set of economic outcomes.

64. We measure frontier exposure as the total number of years a county was on the frontier, according to Bazzi et al. (2020). Because this is a time-invariant control, we interact it with decade fixed effects to allow for differential trends over time. Market access is taken from Donaldson and Hornbeck (2016); and dummies for being connected to railroads in a given decade are taken from Atack (2016). The measure of market access is constant after 1920, and so we use this value for subsequent decades.

**Figure C.1.** U.S. Internal Migration (1850–1940): Including County-Pair Controls




*Notes:* The figure plots the coefficient, with corresponding 95% confidence intervals, on the absolute difference in temperature between U.S. origin and destination counties for internal movers. The first dot represents the baseline specification from Table 1, column 4. Dots 2 through 12 represent results obtained by including, one at a time, the absolute value of the difference in the following county-pair variables (measured in the baseline decade): labor force participation; manufacturing employment share; agriculture employment share; Black population share; urban population share; immigrant population share; sex ratios; population density; frontier exposure from Bazzi et al. (2020); market access from Donaldson and Hornbeck (2016); and a dummy equal to one for being connected to railroads. The final dot reports results obtained by including all variables simultaneously. Standard errors are clustered at the U.S. state of origin by U.S. state of destination level.

**Table C.11.** Climate Distance and Norwegian Immigration: Additional Controls

| Dep. Variable: | Number of Migrants | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Temperature Distance | -0.078*** | -0.063*** | -0.062*** | -0.078*** | -0.053*** |
| | (0.014) | (0.013) | (0.013) | (0.014) | (0.014) |
| Precipitation Distance | -0.001* | -0.001** | -0.001 | -0.001* | -0.001** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Distance (100 km) | -0.138*** | -0.123*** | -0.129*** | -0.141*** | -0.143*** |
| | (0.025) | (0.028) | (0.024) | (0.026) | (0.026) |
| Socioeconomic controls | | Yes | | | |
| Elevation | | | Yes | | Yes |
| Ruggedness | | | | Yes | Yes |
| Observations | 811,961 | 811,961 | 811,961 | 811,961 | 811,961 |
| Pseudo R-squared | 0.390 | 0.392 | 0.390 | 0.390 | 0.391 |
| Mean Temp. Dist. | 4.526 | 4.526 | 4.526 | 4.526 | 4.526 |
| SD Temp. Dist. | 3.790 | 3.790 | 3.790 | 3.790 | 3.790 |
| Mean Precip. Dist. | 53.36 | 53.36 | 53.36 | 53.36 | 53.36 |
| SD Precip. Dist. | 47.11 | 47.11 | 47.11 | 47.11 | 47.11 |
| Norwegian municipality × cohort FE | Yes | Yes | Yes | Yes | Yes |
| U.S. county × cohort FE | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The sample includes all Norwegian municipality–U.S. county pairs for each matched cohort. Number of Migrants is the bilateral migrant flow from a Norwegian municipality of origin to a U.S. county of destination for each matched cohort. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters), using TerraClimate population-weighted averages. Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 is the baseline with no additional controls. Column 2 adds the absolute origin–destination differences in socioeconomic characteristics (population density; urban, employment, manufacturing-employment and agricultural-employment shares; sex ratio). Column 3 adds the difference in elevation. Column 4 adds the difference in ruggedness. Column 5 adds both. All regressions include U.S. county × cohort and Norwegian municipality × cohort fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state × Norwegian province level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.12.** International Immigration: Controlling for Distance in Geographic Features

| Dep. Variable: | Number of Migrants | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| *Panel A: International Immigration, 1880–1920* | | | | | |
| Temperature Distance | -0.174*** | -0.184*** | -0.175*** | -0.173*** | -0.186*** |
| | (0.021) | (0.020) | (0.021) | (0.021) | (0.021) |
| Observations | 1,942,210 | 1,942,210 | 1,942,210 | 1,942,210 | 1,942,210 |
| Pseudo R-squared | 0.916 | 0.918 | 0.916 | 0.917 | 0.918 |
| Mean Temp. Dist. | 9.622 | 9.622 | 9.622 | 9.622 | 9.622 |
| SD Temp. Dist. | 5.752 | 5.752 | 5.752 | 5.752 | 5.752 |
| *Panel B: International Immigration, 1970–2010* | | | | | |
| Temperature Distance | -0.019* | -0.020* | -0.008 | -0.018* | -0.007 |
| | (0.011) | (0.011) | (0.009) | (0.010) | (0.009) |
| Observations | 2,475,100 | 2,475,100 | 2,475,100 | 2,475,100 | 2,475,100 |
| Pseudo R-squared | 0.893 | 0.894 | 0.895 | 0.895 | 0.897 |
| Mean Temp. Dist. | 9.622 | 9.622 | 9.622 | 9.622 | 9.622 |
| SD Temp. Dist. | 5.685 | 5.685 | 5.685 | 5.685 | 5.685 |
| Geographic controls | | Elevation | Ruggedness | Coastal | All |
| Origin × Decade FE | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade FE | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The samples in Panels A–B include U.S. county-country pairs for each decade over the 1880–1920 (except 1890) and 1970–2010 periods, respectively. Number of Migrants is the number of individuals from origin country $o$ living in destination county $d$ in census year $t$ who arrived in the previous decade (except for 1880, when information on year of arrival is not available). Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 replicates the international baseline specifications from Table 1, columns 2–3. Column 2 additionally controls for the distance in elevation between $o$ and $d$. Column 3 additionally controls for the distance in the standard deviation of elevation. Column 4 additionally controls for a dummy equal to one if both origin and destination are coastal (population-weighted distance to the ocean coast below 50 km). Column 5 includes all three geographic controls. All regressions also control for precipitation and geographic distance and include country of origin × decade and county of destination × decade fixed effects. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.13.** U.S. Internal Migration: Controlling for Distance in Geographic Features

| Dep. Variable: | Number of Migrants | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| *Panel A: U.S. Internal Migration, 1850–1940* | | | | | |
| Temperature Distance | -0.312*** | -0.297*** | -0.311*** | -0.308*** | -0.292*** |
| | (0.020) | (0.020) | (0.021) | (0.019) | (0.020) |
| Observations | 31,105,383 | 31,105,383 | 31,105,383 | 31,105,383 | 31,105,383 |
| Pseudo R-squared | 0.746 | 0.748 | 0.746 | 0.748 | 0.750 |
| Mean Temp. Dist. | 4.923 | 4.923 | 4.923 | 4.923 | 4.923 |
| SD Temp. Dist. | 3.578 | 3.578 | 3.578 | 3.578 | 3.578 |
| *Panel B: U.S. Internal Migration, 2011–2019* | | | | | |
| Temperature Distance | -0.237*** | -0.197*** | -0.231*** | -0.234*** | -0.199*** |
| | (0.041) | (0.040) | (0.041) | (0.039) | (0.040) |
| Observations | 25,088,936 | 25,088,936 | 25,088,936 | 25,088,936 | 25,088,936 |
| Pseudo R-squared | 0.776 | 0.783 | 0.781 | 0.780 | 0.788 |
| Mean Temp. Dist. | 4.989 | 4.989 | 4.989 | 4.989 | 4.989 |
| SD Temp. Dist. | 3.632 | 3.632 | 3.632 | 3.632 | 3.632 |
| Geographic controls | | Elevation | Ruggedness | Coastal | All |
| Origin × Decade/Year FE | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade/Year FE | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The samples in Panels A–B include county-pairs in the contiguous U.S. for each decade from 1850–1860 to 1930–1940 and for each year from 2011–2012 to 2018–2019, respectively. Number of Migrants in Panel A is the number of individuals 15+ in the baseline year who moved from the origin to the destination county in the decade. Number of Migrants in Panel B is the number of people who changed address between origin and destination counties, based on IRS Migration data from individual income tax returns. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 replicates the internal baseline specifications from Table 1, columns 4–5. Column 2 additionally controls for the distance in elevation between the county of origin and the county of destination. Column 3 additionally controls for the distance in the standard deviation of elevation. Column 4 additionally controls for a dummy equal to one if both origin and destination counties are coastal (population-weighted distance to the ocean coast below 50 km). Column 5 includes all three geographic controls. All regressions also control for precipitation and geographic distance and include county of origin × decade (Panel A) or year (Panel B) and county of destination × decade/year fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.14.** International Immigration: Controlling for Latitude and Longitude Distance

| Dep. Variable: | Number of Migrants | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| *Panel A: International Immigration, 1880–1920* | | | | | |
| Temperature Distance | -0.174*** | -0.166*** | -0.177*** | -0.165*** | -0.166*** |
| | (0.021) | (0.026) | (0.020) | (0.026) | (0.026) |
| Distance (latitude) | | -0.016 | | -0.029 | -0.055** |
| | | (0.025) | | (0.027) | (0.022) |
| Distance (longitude) | | | -0.008 | -0.015 | -0.036*** |
| | | | (0.014) | (0.016) | (0.010) |
| Observations | 1,942,210 | 1,942,210 | 1,942,210 | 1,942,210 | 1,942,210 |
| Pseudo R-squared | 0.916 | 0.916 | 0.917 | 0.917 | 0.916 |
| Mean Temp. Dist. | 9.622 | 9.622 | 9.622 | 9.622 | 9.622 |
| SD Temp. Dist. | 5.752 | 5.752 | 5.752 | 5.752 | 5.752 |
| *Panel B: International Immigration, 1970–2010* | | | | | |
| Temperature Distance | -0.019* | -0.050** | -0.017* | -0.049** | -0.052** |
| | (0.011) | (0.021) | (0.010) | (0.021) | (0.025) |
| Distance (latitude) | | 0.037* | | 0.039** | 0.002 |
| | | (0.019) | | (0.019) | (0.020) |
| Distance (longitude) | | | 0.002 | 0.004 | -0.028*** |
| | | | (0.005) | (0.004) | (0.003) |
| Observations | 2,475,100 | 2,475,100 | 2,475,100 | 2,475,100 | 2,475,100 |
| Pseudo R-squared | 0.893 | 0.894 | 0.893 | 0.894 | 0.889 |
| Mean Temp. Dist. | 9.622 | 9.622 | 9.622 | 9.622 | 9.622 |
| SD Temp. Dist. | 5.685 | 5.685 | 5.685 | 5.685 | 5.685 |
| Origin × Decade FE | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade FE | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The samples in Panels A–B include U.S. county-country pairs for each decade over the 1880–1920 (except for 1890) and 1970–2010 periods, respectively. Number of Migrants is the number of individuals from origin country $o$ living in destination county $d$ in census year $t$ who arrived in the previous decade (except for 1880, when information on year of arrival is not available). Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 replicates the international baseline specifications from Table 1, columns 2–3. Columns 2–3 add controls for the distance in latitude and longitude, respectively. Column 4 includes both measures simultaneously. Distance (latitude) and Distance (longitude) are the absolute differences in population-weighted latitude and longitude between the origin and the destination, measured in degrees; the longitude difference is taken the shorter way around the globe, so it is at most 180 degrees. Column 5 replicates column 4 without controlling for geographic distance. All regressions also control for precipitation distance and include country of origin × decade and county of destination × decade fixed effects. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.15.** U.S. Internal Migration: Controlling for Latitude and Longitude Distance

| Dep. Variable: | Number of Migrants | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| *Panel A: U.S. Internal Migration, 1850–1940* | | | | | |
| Temperature Distance | -0.312*** | -0.154*** | -0.186*** | -0.154*** | -0.156*** |
| | (0.020) | (0.025) | (0.022) | (0.024) | (0.025) |
| Distance (latitude) | | -0.225*** | | -0.107*** | -0.350*** |
| | | (0.023) | | (0.035) | (0.024) |
| Distance (longitude) | | | 0.217*** | 0.143*** | -0.141*** |
| | | | (0.026) | (0.038) | (0.010) |
| Observations | 31,105,383 | 31,105,383 | 31,105,383 | 31,105,383 | 31,105,383 |
| Pseudo R-squared | 0.746 | 0.751 | 0.751 | 0.752 | 0.748 |
| Mean Temp. Dist. | 4.923 | 4.923 | 4.923 | 4.923 | 4.923 |
| SD Temp. Dist. | 3.578 | 3.578 | 3.578 | 3.578 | 3.578 |
| *Panel B: U.S. Internal Migration, 2011–2019* | | | | | |
| Temperature Distance | -0.237*** | -0.148*** | -0.221*** | -0.147*** | -0.147*** |
| | (0.041) | (0.042) | (0.042) | (0.042) | (0.042) |
| Distance (latitude) | | -0.125** | | -0.231*** | -0.253*** |
| | | (0.049) | | (0.052) | (0.050) |
| Distance (longitude) | | | 0.025 | -0.119** | -0.143*** |
| | | | (0.050) | (0.053) | (0.015) |
| Observations | 25,088,936 | 25,088,936 | 25,088,936 | 25,088,936 | 25,088,936 |
| Pseudo R-squared | 0.776 | 0.777 | 0.777 | 0.778 | 0.778 |
| Mean Temp. Dist. | 4.989 | 4.989 | 4.989 | 4.989 | 4.989 |
| SD Temp. Dist. | 3.632 | 3.632 | 3.632 | 3.632 | 3.632 |
| Origin × Decade/Year FE | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade/Year FE | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The samples in Panels A–B include county-pairs in the contiguous U.S. for each decade from 1850–1860 to 1930–1940 and for each year from 2011–2012 to 2018–2019, respectively. Number of Migrants in Panel A is the number of individuals 15+ in the baseline year who moved from the origin to the destination county in the decade. Number of Migrants in Panel B is the number of people who changed address between origin and destination counties, based on IRS Migration data from individual income tax returns. For the modern internal sample (Panel B), latitude and longitude controls are computed using population-weighted coordinates from 2010 and held constant across all years in the sample. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 replicates the internal baseline specifications from Table 1, columns 4–5. Columns 2–3 add controls for the distance in latitude and longitude, respectively. Column 4 includes both measures simultaneously. Distance (latitude) and Distance (longitude) are the absolute differences in population-weighted latitude and longitude between the origin and the destination, measured in degrees. Column 5 replicates column 4 without controlling for geographic distance. All regressions also control for precipitation distance and include county of origin × decade (Panel A) or year (Panel B) and county of destination × decade/year fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.16.** International Immigration (1880–1920): Controlling for Soil Type Distance

| Dep. Variable: | Number of Migrants | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Temperature Distance | -0.174*** | -0.174*** | -0.171*** | -0.175*** | -0.173*** | -0.173*** |
| | (0.021) | (0.021) | (0.020) | (0.021) | (0.021) | (0.020) |
| Bulk Density Distance | | 0.006 | | | | 0.012 |
| | | (0.011) | | | | (0.013) |
| Organic Matter Distance | | | -0.126*** | | | -0.136*** |
| | | | (0.035) | | | (0.036) |
| pH Distance | | | | 0.008 | | 0.012 |
| | | | | (0.008) | | (0.008) |
| Water Content Distance | | | | | 0.074 | 0.067 |
| | | | | | (0.046) | (0.046) |
| Observations | 1,942,210 | 1,942,210 | 1,942,210 | 1,942,210 | 1,942,210 | 1,942,210 |
| Pseudo R-squared | 0.916 | 0.916 | 0.917 | 0.917 | 0.917 | 0.918 |
| Mean Temp. Dist. | 9.622 | 9.622 | 9.622 | 9.622 | 9.622 | 9.622 |
| SD Temp. Dist. | 5.752 | 5.752 | 5.752 | 5.752 | 5.752 | 5.752 |
| Origin × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The sample includes U.S. county-country pairs for each decade over the 1880–1920 period (except for 1890). Number of Migrants is the number of individuals from origin country $o$ living in destination county $d$ in census year $t$ who arrived in the previous decade (except for 1880, when information on year of arrival is not available). Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 replicates the historical international baseline specification from Table 1, column 2. Columns 2–5 add, separately, distance in each soil measure (bulk density, organic matter, pH, and water content). Column 6 includes all four soil distances. All regressions also control for precipitation and geographic distance and include country of origin × decade and county of destination × decade fixed effects. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.17.** International Immigration (1970–2010): Controlling for Soil Type Distance

| Dep. Variable: | Number of Migrants | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Temperature Distance | -0.019* | -0.018* | -0.018* | -0.019* | -0.018* | -0.018* |
| | (0.011) | (0.011) | (0.010) | (0.010) | (0.011) | (0.010) |
| Bulk Density Distance | | -0.011* | | | | -0.007 |
| | | (0.007) | | | | (0.007) |
| Organic Matter Distance | | | -0.083*** | | | -0.069** |
| | | | (0.025) | | | (0.028) |
| pH Distance | | | | -0.022*** | | -0.019*** |
| | | | | (0.007) | | (0.007) |
| Water Content Distance | | | | | 0.026* | 0.031** |
| | | | | | (0.015) | (0.016) |
| Observations | 2,475,100 | 2,475,100 | 2,475,100 | 2,475,100 | 2,475,100 | 2,475,100 |
| Pseudo R-squared | 0.893 | 0.893 | 0.894 | 0.894 | 0.893 | 0.894 |
| Mean Temp. Dist. | 9.622 | 9.622 | 9.622 | 9.622 | 9.622 | 9.622 |
| SD Temp. Dist. | 5.685 | 5.685 | 5.685 | 5.685 | 5.685 | 5.685 |
| Origin × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The sample includes U.S. county-country pairs for each decade over the 1970–2010 period. Number of Migrants is the number of individuals from origin country $o$ living in destination county $d$ in census year $t$ who arrived in the previous decade. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 replicates the modern international baseline specification from Table 1, column 3. Columns 2–5 add, separately, distance in each soil measure (bulk density, organic matter, pH, and water content). Column 6 includes all four soil distances. All regressions also control for precipitation and geographic distance and include country of origin × decade and county of destination × decade fixed effects. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.18.** U.S. Internal Migration (1850–1940): Controlling for Soil Type Distance

| Dep. Variable: | Number of Migrants | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Temperature Distance | -0.312*** | -0.297*** | -0.293*** | -0.312*** | -0.302*** | -0.281*** |
| | (0.020) | (0.020) | (0.019) | (0.020) | (0.019) | (0.019) |
| Bulk Density Distance | | -0.059*** | | | | -0.042*** |
| | | (0.007) | | | | (0.007) |
| Organic Matter Distance | | | -0.298*** | | | -0.208*** |
| | | | (0.033) | | | (0.034) |
| pH Distance | | | | -0.024*** | | -0.013* |
| | | | | (0.007) | | (0.007) |
| Water Content Distance | | | | | -0.147*** | -0.115*** |
| | | | | | (0.013) | (0.013) |
| Observations | 31,105,383 | 31,105,383 | 31,105,383 | 31,105,383 | 31,105,383 | 31,105,383 |
| Pseudo R-squared | 0.746 | 0.751 | 0.750 | 0.747 | 0.751 | 0.756 |
| Mean Temp. Dist. | 4.923 | 4.923 | 4.923 | 4.923 | 4.923 | 4.923 |
| SD Temp. Dist. | 3.578 | 3.578 | 3.578 | 3.578 | 3.578 | 3.578 |
| Origin × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The sample includes county-pairs in the contiguous U.S. for each decade from 1850–1860 to 1930–1940. Number of Migrants is the number of individuals 15+ in the baseline year who moved from the origin to the destination county in the decade. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 replicates the historical internal baseline specification from Table 1, column 4. Columns 2–5 add, separately, distance in each soil measure (bulk density, organic matter, pH, and water content). Column 6 includes all four soil distances. All regressions also control for precipitation and geographic distance and include county of origin × decade and county of destination × decade fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.19.** U.S. Internal Migration (2011–2019): Controlling for Soil Type Distance

| Dep. Variable: | Number of Migrants | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Temperature Distance | -0.237*** | -0.221*** | -0.225*** | -0.234*** | -0.226*** | -0.217*** |
| | (0.041) | (0.041) | (0.041) | (0.040) | (0.039) | (0.039) |
| Bulk Density Distance | | -0.068*** | | | | -0.058*** |
| | | (0.014) | | | | (0.012) |
| Organic Matter Distance | | | -0.135** | | | 0.042 |
| | | | (0.058) | | | (0.069) |
| pH Distance | | | | -0.055*** | | -0.035*** |
| | | | | (0.010) | | (0.010) |
| Water Content Distance | | | | | -0.213*** | -0.186*** |
| | | | | | (0.025) | (0.023) |
| Observations | 25,088,936 | 25,088,936 | 25,088,936 | 25,088,936 | 25,088,936 | 25,088,936 |
| Pseudo R-squared | 0.776 | 0.781 | 0.777 | 0.778 | 0.783 | 0.786 |
| Mean Temp. Dist. | 4.989 | 4.989 | 4.989 | 4.989 | 4.989 | 4.989 |
| SD Temp. Dist. | 3.632 | 3.632 | 3.632 | 3.632 | 3.632 | 3.632 |
| Origin × Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Year FE | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The sample includes county-pairs in the contiguous U.S. for each year from 2011–2012 to 2018–2019. Number of Migrants is the number of people who changed address between origin and destination counties, based on IRS Migration data from individual income tax returns. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 replicates the modern internal baseline specification from Table 1, column 5. Columns 2–5 add, separately, distance in each soil measure (bulk density, organic matter, pH, and water content). Column 6 includes all four soil distances. All regressions also control for precipitation and geographic distance and include county of origin × year and county of destination × year fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.20.** U.S. Internal Migration (1850–1940): Controlling for Time-Varying Travel Cost

| Dep. Variable: | Number of Migrants | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Temperature Distance | -0.312*** | -0.311*** | -0.254*** | -0.241*** | -0.265*** | -0.243*** |
| | (0.020) | (0.020) | (0.017) | (0.016) | (0.018) | (0.017) |
| Distance (100 km) | -0.210*** | | 0.093*** | 0.020 | | |
| | (0.015) | | (0.019) | (0.013) | | |
| Transportation Cost | | | -0.060*** | -0.047*** | -0.044*** | -0.044*** |
| | | | (0.004) | (0.003) | (0.002) | (0.002) |
| Observations | 31,105,383 | 31,105,383 | 30,032,508 | 30,032,508 | 30,032,508 | 30,032,508 |
| Pseudo R-squared | 0.746 | 0.747 | 0.772 | 0.777 | 0.770 | 0.777 |
| Mean Temp. Dist. | 4.923 | 4.923 | 4.930 | 4.930 | 4.930 | 4.930 |
| SD Temp. Dist. | 3.578 | 3.578 | 3.582 | 3.582 | 3.582 | 3.582 |
| Distance × Decade | | Yes | | | | |
| Origin × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Travel Cost Measure | – | – | Hours | Dollars | Hours | Dollars |

*Notes:* PPML Estimates. The sample includes county-pairs in the contiguous U.S. for each decade from 1850–1860 to 1930–1940. Number of Migrants is the number of individuals 15+ in the baseline year who moved from the origin to the destination county in the decade. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 replicates the historical internal baseline specification from Table 1, column 4. Column 2 replicates column 1 by interacting geographic distance with decade dummies. Columns 3–4 add time-varying travel costs (hours or dollars) in addition to physical distance. Columns 5–6 replicate columns 3–4 without controlling for geographic distance. Decades are assigned travel cost based on the network existing at the end of the decade. All regressions also control for precipitation distance and include county of origin × decade and county of destination × decade fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

## C.4 Alternative Climate Statistics

In this section, we consider additional measures of climate distance. First, we consider seasonality. Mean annual temperature is the basis for the primary climate distance measure used in all of our analyses. While this measure is transparent and easy to interpret, it masks a large degree of variation: Washington, DC, and San Francisco, for example, have similar annual mean temperatures, but very different seasonal patterns. To account for this dimension, Tables C.21 and C.22 replicate our preferred specifications for international and internal migration, reporting results for the historical and modern periods in columns 1–3 and 4–6, respectively. We augment the baseline by controlling for distance in climate seasonality using two approaches: the standard deviation of temperature and precipitation over the year (columns 2 and 5), and the difference between average annual maximum and minimum temperature and precipitation (columns 3 and 6).[65]

In most cases, the coefficient on temperature distance remains negative, quantitatively in line with the baseline, and statistically significant. The only exception is modern international immigration (Table C.21, columns 4–6): in this case, while the coefficient on temperature distance remains negative, it becomes smaller in absolute value and no longer statistically significant. The coefficients on the additional climate statistics are negative and statistically significant for modern migration, but insignificant in the historical sample.

We also verify that our results are robust to alternative definitions of climate distance. Previous work has linked U.S. population growth patterns to seasonal temperature extremes, often proxied by January and July temperatures (Glaeser and Tobio 2007). Tables C.23 and C.24 report results for international and internal migration, with historical and modern periods shown in columns 1–4 and 5–8, respectively. The estimated effects remain similar when temperature distance is constructed using the mean of annual maximum temperatures (columns 2 and 6), average summer temperatures from April to September (columns 3 and 7), or average winter temperatures from October to March (columns 4 and 8). These estimates can be directly compared to those based on annual mean temperature (columns 1 and 5).

65. Using the above example, San Francisco would have lower values for its temperature seasonality given its mild climate year round compared to the summer and winter extremes in Washington, DC.

**Table C.21.** International Immigration: Controlling for Distance in Seasonality

| Dep. Variable: | Number of Migrants | | | | | |
|---|---|---|---|---|---|---|
| | Historical: 1880–1920 | | | Modern: 1970–2010 | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Temperature Distance | -0.174*** | -0.191*** | -0.190*** | -0.019* | -0.010 | -0.010 |
| | (0.021) | (0.022) | (0.023) | (0.011) | (0.011) | (0.011) |
| Temp. SD Distance | | 0.051 | | | -0.055*** | |
| | | (0.037) | | | (0.016) | |
| Temp. Range Distance | | | 0.017 | | | -0.019*** |
| | | | (0.013) | | | (0.006) |
| Observations | 1,942,210 | 1,942,210 | 1,942,210 | 2,475,100 | 2,475,100 | 2,475,100 |
| Pseudo R-squared | 0.916 | 0.917 | 0.917 | 0.893 | 0.894 | 0.894 |
| Mean Temp. Dist. | 9.622 | 9.622 | 9.622 | 9.622 | 9.622 | 9.622 |
| SD Temp. Dist. | 5.752 | 5.752 | 5.752 | 5.685 | 5.685 | 5.685 |
| Origin × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The samples in columns 1–3 and 4–6 include U.S. county-country pairs for each decade over the 1880–1920 (except for 1890) and 1970–2010 periods, respectively. Number of Migrants is the number of individuals from origin country $o$ living in destination county $d$ in census year $t$ who arrived in the previous decade (except for 1880, when information on year of arrival is not available). Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Columns 1 and 4 replicate the international baseline specifications from Table 1, columns 2 and 3, respectively. Columns 2 and 5 add controls for Temperature and Precipitation SD Distance, the absolute difference in the standard deviation of temperature and precipitation over the year. Columns 3 and 6 control for Temperature and Precipitation Range Distance, the absolute difference in the range of temperatures experienced over a year. Each measure of variability is first calculated at the annual level, and then averaged across years. All regressions also control for precipitation and geographic distance and include country of origin × decade and county of destination × decade fixed effects. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.22.** U.S. Internal Migration: Controlling for Distance in Seasonality

| Dep. Variable: | Number of Migrants | | | | | |
|---|---|---|---|---|---|---|
| | Historical: 1850–1940 | | | Modern: 2011–2019 | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Temperature Distance | -0.312*** | -0.304*** | -0.300*** | -0.237*** | -0.190*** | -0.186*** |
| | (0.020) | (0.021) | (0.021) | (0.041) | (0.039) | (0.039) |
| Temp. SD Distance | | -0.042 | | | -0.317*** | |
| | | (0.048) | | | (0.071) | |
| Temp. Range Distance | | | -0.025 | | | -0.117*** |
| | | | (0.017) | | | (0.026) |
| Observations | 31,105,383 | 31,105,383 | 31,105,383 | 25,088,936 | 25,088,936 | 25,088,936 |
| Pseudo R-squared | 0.746 | 0.746 | 0.747 | 0.776 | 0.779 | 0.779 |
| Mean Temp. Dist. | 4.923 | 4.923 | 4.923 | 4.989 | 4.989 | 4.989 |
| SD Temp. Dist. | 3.578 | 3.578 | 3.578 | 3.632 | 3.632 | 3.632 |
| Origin × Decade/Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade/Year FE | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The samples in columns 1–3 and 4–6 include county-pairs in the contiguous U.S. for each decade from 1850–1860 to 1930–1940 and for each calendar year from 2011–2012 to 2018–2019, respectively. In columns 1–3, Number of Migrants is the number of individuals 15+ in the baseline year who moved from the origin to the destination county in the decade. In columns 4–6, Number of Migrants is the number of people who changed address between origin and destination counties, based on IRS Migration data from individual income tax returns. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Columns 1 and 4 replicate the internal baseline specifications from Table 1, columns 4 and 5, respectively. Columns 2 and 5 add controls for Temperature and Precipitation SD Distance, the absolute difference in the standard deviation of temperature and precipitation over the year. Columns 3 and 6 control for Temperature and Precipitation Range Distance, the absolute difference in the range of temperatures experienced over a year. Each measure of variability is first calculated at the annual level, and then averaged across years. All regressions also control for precipitation and geographic distance and include county of origin × decade (columns 1–3) or year (columns 4–6) and county of destination × decade/year fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.23.** International Immigration: Alternative Climate Definitions

| Dep. Variable: | Number of Migrants | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Historical: 1880–1920 | | | | Modern: 1970–2010 | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Temperature Distance | -0.174*** | -0.087*** | -0.124*** | -0.096*** | -0.019* | -0.037*** | -0.022** | -0.013** |
| | (0.021) | (0.022) | (0.023) | (0.015) | (0.011) | (0.011) | (0.011) | (0.006) |
| Observations | 1,942,210 | 1,942,210 | 1,942,210 | 1,942,210 | 2,475,100 | 2,475,100 | 2,475,100 | 2,475,100 |
| Pseudo R-squared | 0.916 | 0.910 | 0.911 | 0.915 | 0.893 | 0.893 | 0.893 | 0.893 |
| Mean Temp. Dist. | 9.622 | 5.130 | 6.649 | 14.87 | 9.622 | 5.115 | 6.634 | 14.99 |
| SD Temp. Dist. | 5.752 | 4.182 | 4.696 | 8.110 | 5.685 | 4.333 | 4.843 | 8.099 |
| Origin × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Temperature Measurement | Yearly Avg. | Yearly Max | Summer | Winter | Yearly Avg. | Yearly Max | Summer | Winter |

*Notes:* PPML Estimates. The samples in columns 1–4 and 5–8 include U.S. county-country pairs for each decade over the 1880–1920 (except for 1890) and 1970–2010 periods, respectively. Number of Migrants is the number of individuals from origin country $o$ living in destination county $d$ in census year $t$ who arrived in the previous decade (except for 1880, when information on year of arrival is not available). Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Columns 1 and 5 replicate the international baseline specifications from Table 1, columns 2 and 3, respectively. The other columns replicate this specification by calculating temperature distance with alternate definitions of temperature. Columns 2 and 6 use annual maximum temperature, columns 3 and 7 use summer temperature (averaged from April–September), and columns 4 and 8 use winter temperature (averaged from October–March). All regressions also control for precipitation and geographic distance and include country of origin × decade and county of destination × decade fixed effects. Standard errors, reported in parentheses, are clustered at the country of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.24.** U.S. Internal Migration: Alternative Climate Definitions

| Dep. Variable: | Number of Migrants | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Historical: 1850–1940 | | | | Modern: 2011–2019 | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Temperature Distance | -0.312*** | -0.282*** | -0.318*** | -0.240*** | -0.237*** | -0.142*** | -0.170*** | -0.191*** |
| | (0.020) | (0.025) | (0.023) | (0.017) | (0.041) | (0.040) | (0.043) | (0.033) |
| Observations | 31,105,383 | 31,105,383 | 31,105,383 | 31,105,383 | 25,088,936 | 25,088,936 | 25,088,936 | 25,088,936 |
| Pseudo R-squared | 0.746 | 0.737 | 0.742 | 0.745 | 0.776 | 0.771 | 0.772 | 0.777 |
| Mean Temp. Dist. | 4.923 | 3.472 | 4.154 | 6.177 | 4.989 | 3.561 | 4.251 | 6.268 |
| SD Temp. Dist. | 3.578 | 2.690 | 3.093 | 4.513 | 3.632 | 2.734 | 3.149 | 4.601 |
| Origin × Decade/Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade/Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Temperature Measurement | Yearly Avg. | Yearly Max | Summer | Winter | Yearly Avg. | Yearly Max | Summer | Winter |

*Notes:* PPML Estimates. The samples in columns 1–4 and 5–8 include county-pairs in the contiguous U.S. for each decade from 1850–1860 to 1930–1940 and for each calendar year from 2011–2012 to 2018–2019, respectively. In columns 1–4, Number of Migrants is the number of individuals 15+ in the baseline year who moved from the origin to the destination county in the decade. In columns 5–8, Number of Migrants is the number of people who changed address between origin and destination counties, based on IRS Migration data from individual income tax returns. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Columns 1 and 5 replicate the internal baseline specifications from Table 1, columns 4 and 5, respectively. The other columns replicate this specification by calculating temperature distance with alternate definitions of temperature. Columns 2 and 6 use annual maximum temperature, columns 3 and 7 use summer temperature (averaged from April–September), and columns 4 and 8 use winter temperature (averaged from October–March). All regressions also control for precipitation and geographic distance and include county of origin × decade (columns 1–4) or year (columns 5–8) and county of destination × decade/year fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

## C.5 Alternative Samples and Linking Procedures

Finally, we consider robustness to alternative sample constructions and datasets.

**Norwegian immigration.** In Table C.25, we address the potential concern that our estimates for historical Norwegian migration may be biased due to false positive matches obtained in our linking procedure. Column 1 replicates Table 1, column 1, using the standard linking procedure from Abramitzky et al. (2021). Column 2 uses Abramitzky et al. (2021)'s conservative matching algorithm. Column 3 uses the same linking procedure as column 1, but relaxes age restrictions to include migrants of any age. Column 4 links migrants with Jaro–Winkler string similarity, while columns 5 and 6 retain the standard match and vary the age window, at the Norwegian origin and at the U.S. destination respectively. Across linking methods, results are always similar to those obtained from the main sample.

In Table C.26, we show that results in the Norwegian sample are not driven by a limited number of strong migration corridors by using a series of sample restrictions. Columns 2 and 3 drop the top 1% of destination counties and origin municipalities by number of immigrants. Column 4 drops the top 1% of municipality–county pairs, and column 5 excludes all migration to Minnesota (a key destination for Norwegian immigrants). In each exercise, coefficients are similar in magnitude to baseline results.

**Historical internal migration.** In Table C.27, we show that the historical internal migration results are robust to alternative sample restrictions and to using different datasets to measure migration. Column 1 reports the baseline specification (Table 1, column 4), which includes all county pairs in the contiguous United States in each decade. Column 2 restricts the sample to counties already existing in 1860, while columns 3 and 4 further limit the sample to county pairs observed in all decades and to pairs with a strictly positive number of migrants, respectively. Across these exercises, the coefficient on temperature distance remains close to the baseline.

We next address potential concerns related to the linked sample used to construct internal migration flows. In the baseline specification, we include all individuals aged 15 and older. In column 5, we restrict the sample to men aged 15 and above, reflecting the more traditional approach in the linked-census literature (Abramitzky et al. 2021). In column 6, we instead use the linked sample of men aged 15 and above constructed by Abramitzky et al. (2020).[66] In column 7, we address remaining concerns related to record linkage by exploiting a feature unique to the 1940 Census, which asked respondents about their place of residence five years earlier. We use this information to construct a migration matrix capturing moves between 1935 and 1940.[67] For consistency with

66. The data from Abramitzky et al. (2020) and Price et al. (2021) both draw on the full-count U.S. Census but differ in scope and linking methodology: Price et al. (2021) provide broader coverage using machine-learning approaches, while Abramitzky et al. (2020) construct smaller samples using more conservative linking algorithms.

67. As with the linked sample, we harmonize destination county boundaries using the Census Place Project for 1940 (Berkes et al. 2023). Because the Census Place Project cannot be applied to counties of origin in 1935, we rely instead on the crosswalk provided by Eckert et al. (2020).

the linked-sample analysis, we restrict attention to individuals who were at least 20 years old in 1940 and thus at least 15 years old at their location of origin in 1935. In all cases, the estimated effect of temperature distance remains stable in sign, magnitude, and statistical significance.

**Table C.25.** Climate Distance and Norwegian Immigration: Alternative Linking Methods

| Dep. Variable: | Number of Migrants | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Temperature Distance | -0.078*** | -0.087*** | -0.080*** | -0.103*** | -0.085*** | -0.078*** |
| | (0.014) | (0.021) | (0.014) | (0.030) | (0.016) | (0.014) |
| Precipitation Distance | -0.001* | -0.002** | -0.001* | -0.003** | -0.001 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Distance (100 km) | -0.138*** | -0.211*** | -0.134*** | -0.184*** | -0.135*** | -0.139*** |
| | (0.025) | (0.036) | (0.026) | (0.047) | (0.027) | (0.025) |
| Linking method / sample | Standard | Conservative | Full | Jaro–Winkler | Age restr. 1 | Age restr. 2 |
| Observations | 811,961 | 539,317 | 858,334 | 420,217 | 690,395 | 810,147 |
| Pseudo R-squared | 0.390 | 0.347 | 0.407 | 0.346 | 0.371 | 0.390 |
| Mean Temp. Dist. | 4.526 | 4.259 | 4.548 | 4.111 | 4.407 | 4.524 |
| SD Temp. Dist. | 3.790 | 3.597 | 3.764 | 3.457 | 3.703 | 3.789 |
| Mean Precip. Dist. | 53.36 | 54.24 | 53.19 | 54.16 | 53.70 | 53.38 |
| SD Precip. Dist. | 47.11 | 47.65 | 47.07 | 47.86 | 47.48 | 47.11 |
| Norwegian municipality × cohort FE | Yes | Yes | Yes | Yes | Yes | Yes |
| U.S. county × cohort FE | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The sample includes all Norwegian municipality–U.S. county pairs for each matched cohort, built under alternative record-linkage methods. Number of Migrants is the bilateral migrant flow from a Norwegian municipality of origin to a U.S. county of destination for each matched cohort. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters), using TerraClimate population-weighted averages. Distance is physical distance, expressed in 100 km, between the origin and the destination. All columns use the preferred specification and differ only in how the linked flow is constructed: standard Abramitzky et al. (2021) match (baseline), conservative match, full match (no age restriction), and Jaro–Winkler match, together with two age-restricted linked samples (Age restr. 1 restricts to migrants aged 15–40 in the Norwegian origin census; Age restr. 2 to migrants aged 18–65 in the U.S. destination census). All regressions include U.S. county × cohort and Norwegian municipality × cohort fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state × Norwegian province level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.26.** Climate Distance and Norwegian Immigration: Alternative Samples

| Dep. Variable: | Number of Migrants | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Temperature Distance | -0.078*** | -0.066*** | -0.091*** | -0.078*** | -0.088*** |
| | (0.014) | (0.014) | (0.015) | (0.013) | (0.022) |
| Precipitation Distance | -0.001* | -0.000 | -0.001* | -0.001 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Distance (100 km) | -0.138*** | -0.115*** | -0.128*** | -0.119*** | -0.138*** |
| | (0.025) | (0.026) | (0.028) | (0.025) | (0.025) |
| Sample | Full | Drop top counties | Drop top munis | Drop top pairs | Excl. Minnesota |
| Observations | 811,961 | 776,299 | 720,498 | 811,280 | 681,719 |
| Pseudo R-squared | 0.390 | 0.293 | 0.283 | 0.319 | 0.394 |
| Mean Temp. Dist. | 4.526 | 4.530 | 4.370 | 4.527 | 4.844 |
| SD Temp. Dist. | 3.790 | 3.795 | 3.676 | 3.790 | 3.893 |
| Mean Precip. Dist. | 53.36 | 53.21 | 53.47 | 53.37 | 53.41 |
| SD Precip. Dist. | 47.11 | 47.16 | 47.17 | 47.12 | 46.96 |
| Norwegian municipality × cohort FE | Yes | Yes | Yes | Yes | Yes |
| U.S. county × cohort FE | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The sample includes all Norwegian municipality–U.S. county pairs for each matched cohort. Number of Migrants is the bilateral migrant flow from a Norwegian municipality of origin to a U.S. county of destination for each matched cohort. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters), using TerraClimate population-weighted averages. Distance is physical distance, expressed in 100 km, between the origin and the destination. All columns use the preferred specification and differ only in sample. Column 1 uses the full sample. Column 2 drops the top 1% of destination counties by Norwegian inflow within cohort. Column 3 drops the top 1% of origin municipalities by outflow within cohort. Column 4 drops the top 1% of positive flow municipality–county pairs within cohort. Column 5 excludes Minnesota. All regressions include U.S. county × cohort and Norwegian municipality × cohort fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state × Norwegian province level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

**Table C.27.** U.S. Internal Migration: Sample Restrictions and Alternative Datasets

| Dep. Variable: | Number of Migrants | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Temperature Distance | -0.312*** | -0.307*** | -0.307*** | -0.260*** | -0.296*** | -0.254*** | -0.236*** |
| | (0.020) | (0.025) | (0.025) | (0.027) | (0.018) | (0.014) | (0.022) |
| Observations | 31,105,383 | 15,666,317 | 15,578,785 | 2,793,966 | 31,088,261 | 30,998,396 | 4,825,169 |
| Pseudo R-squared | 0.746 | 0.767 | 0.767 | 0.690 | 0.730 | 0.715 | 0.764 |
| Mean Temp. Dist. | 4.923 | 4.590 | 4.580 | 2.774 | 4.923 | 4.918 | 5.062 |
| SD Temp. Dist. | 3.578 | 3.321 | 3.313 | 2.570 | 3.578 | 3.575 | 3.667 |
| Origin × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Decade FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* PPML Estimates. The sample includes county-pairs in the contiguous U.S. for each decade from 1850–1860 to 1930–1940, unless otherwise stated. Number of Migrants is the number of individuals 15+ in the baseline year who moved from the origin to the destination county in the decade. Temperature (resp., Precipitation) Distance is the absolute difference in mean annual temperature between the origin and the destination, measured in degrees Celsius (resp., monthly precipitation in millimeters). Distance is physical distance, expressed in 100 km, between the origin and the destination. Column 1 reports the baseline specification from Table 1, column 4. Column 2 restricts the sample to counties already existing in 1860. Columns 3 and 4 further restrict the sample to county-pairs observed in all decades and with a strictly positive number of migrants, respectively. Columns 5 and 6 use alternative linked-census samples to construct internal migration flows: column 5 restricts the linked sample to men aged 15+, while column 6 uses the linked sample of men aged 15+ constructed by Abramitzky et al. (2020). Column 7 uses 1940 Census information on place of residence five years earlier to construct migration flows between 1935 and 1940; destination county boundaries are harmonized using the Census Place Project for 1940 of Berkes et al. (2023), while counties of origin in 1935 are harmonized using the crosswalk provided by Eckert et al. (2020). In column 7, the sample is restricted to individuals aged 20+ in 1940 (and thus 15+ at origin in 1935). All regressions also control for precipitation and geographic distance and include county of origin × decade and county of destination × decade fixed effects. Standard errors, reported in parentheses, are clustered at the U.S. state of origin × U.S. state of destination level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

# D Brass/Trussell Child-Survivorship Correction

Our child mortality outcome from Section 4.3—the share of children ever born who are no longer alive at the census date—is not a measure of infant mortality. The 1900 and 1910 censuses report how many children each mother has ever borne and how many are still living, but not the age or date of death of children who died. Because children of older mothers have, on average, been exposed to mortality risk for longer, the raw outcome combines differences in mortality with differences in the maternal-age—and therefore child-age—composition of each *odt* cell. We address this using the indirect estimation method developed by Brass (1964) and Trussell (1975), in the age-model version described in United Nations (1983, pp. 76–81). The method uses the share of children ever born who have died, tabulated by maternal age, to estimate the probability that a child dies before a given exact age. Preston and Haines (1991) applied this approach to the 1900 census, and Dribe et al. (2020) extended it to the 1900 and 1910 censuses. We follow their approach but, rather than constructing the summary mortality index used by Dribe et al. (2020), recover the four underlying age-specific mortality probabilities directly.

For each origin country × destination county × census-year cell $c$ and maternal age band $j \in \{15\text{–}19, 20\text{–}24, 25\text{–}29, 30\text{–}34\}$, let

$$D_{jc} = \frac{(\mathrm{CEB}_{jc} - \mathrm{CS}_{jc})}{\mathrm{CEB}_{jc}}$$

denote the share of children ever born (CEB) who had died by the census date, where CS denotes children surviving. We next calculate average parity (children ever born) for each origin country $o$, pooling across destination counties and census years and including women with zero births:

$$P_1(o) = \overline{\mathrm{CEB}}_{15\text{–}19,o}, \quad P_2(o) = \overline{\mathrm{CEB}}_{20\text{–}24,o}, \quad P_3(o) = \overline{\mathrm{CEB}}_{25\text{–}29,o}.$$

We pool parity at the origin level rather than computing it within each *odt* cell because some five-year age bands contain only one or two mothers, making cell-level parity ratios highly unstable and potentially generating implausible correction factors. Pooling across destinations and census years within each origin stabilizes these ratios while preserving variation in $D_{jc}$ at the *odt* level.

The correction factor for age band $j$ is

$$k_j(o) = a_j + b_j \cdot \frac{P_1(o)}{P_2(o)} + c_j \cdot \frac{P_2(o)}{P_3(o)},$$

using the Coale–Demeny West model coefficients (United Nations 1983):

| Mother's age | $a_j$ | $b_j$ | $c_j$ |
|---|---|---|---|
| 15–19 ($\to q(1)$) | 1.1415 | −2.7070 | 0.7663 |
| 20–24 ($\to q(2)$) | 1.2563 | −0.5381 | −0.2637 |
| 25–29 ($\to q(3)$) | 1.1851 | 0.0633 | −0.4177 |
| 30–34 ($\to q(5)$) | 1.1720 | 0.2341 | −0.4272 |

so that $\hat{q}_{jc} = k_j(o) \cdot D_{jc}$ recovers an estimate of the probability that a child born to a mother in origin $o$, destination county, and census-year cell $c$ dies before exact age 1, 2, 3, or 5, respectively.

Constructing both the raw mortality share $D_{jc}$ and the parity terms $P_1$–$P_3$ requires observations for women as young as 15 and women with no children. Since our main estimation sample is restricted to women aged 18–45 with at least one child ever born (Table B.1), we construct a separate sample of women aged 15–34 who married after arriving in the United States, without imposing the positive-birth restriction. This sample is used only to construct the corrected mortality measures, not in the main analysis. For each age band $j$, we then re-estimate our baseline specification (Table 4, column 4), replacing the raw mortality share with $\hat{q}_{jc}$. Figure A.12 presents the results, which we discuss in Section 4.3. As in the baseline analysis, we restrict the sample to *odt* cells with at least five children ever born in the relevant age band. We further exclude cells for which $P_1$–$P_3$ cannot be constructed for the corresponding origin.[68]

68. Pooling parity at the origin level makes the latter restriction negligible, excluding 15 cells.