Immigrant Knowledge and the Growth of American Agriculture

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Abstract

In this paper, we study the effect of immigrant location-specific knowledge on agricultural development. In particular, we focus on late nineteenth- and early twentieth-century Russian German immigration to the US, a case in which immigrants brought superior farming knowledge compared to the local population. We demonstrate that the inflow of Russian Germans, through their own farming practices as well as the diffusion of their knowledge to neighboring farmers, caused a shift in agricultural practices from less adapted to more adapted to local environmental conditions, specifically, crowding out corn in favor of wheat farming. Our findings highlight the importance of the match quality between immigrants and their receiving locations, as well as the extent to which knowledge diffusion across group boundaries can augment the impact of smaller immigrant groups.

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1 Introduction

In this paper, we study the effect of immigrant location-specific knowledge on agricultural development. In particular, we exploit the historical case of Russian German immigration to the United States and the subsequent growth of wheat farming. Russian Germans, driven by the abolition of privileges in the Russian Empire, immigrated from the arid and cold Russian steppe in the late nineteenth and early twentieth centuries. Upon arrival in the United States, they largely settled in the frontier region of the Great Plains, where conditions were not dissimilar to their sending region. Having been forced to engage in agriculture back in the Russian Empire, and having successfully pioneered the development of a large wheat-based agricultural industry there, Russian Germans continued to use their location-specific agricultural expertise in their new home. We thus ask, to what extent did Russian German immigrants contribute to the growth of American agriculture through the diffusion of wheat farming?

The existing literature has long argued that the growth of agricultural production in the US in the second half of the nineteenth and first half of the twentieth centuries was made possible by mechanization and westward expansion (Cochrane, 1979; Hayami and Ruttan, 1985; Parker and Klein, 1996), on the one hand, and biological innovations, on the other (Olmstead and Rhode, 2002). In this paper, we document the contribution of immigrant knowledge to this transformation. We argue that Russian Germans, a relatively small immigrant group, played a major role in the growth of American wheat farming through bringing with them specific agricultural knowledge that fundamentally changed what people believed could be produced in the newly settled frontier region. More specifically, we show that the inflow of Russian German immigrants caused a shift in agricultural practices from corn production—that is, the general agricultural practices brought over with earlier internal migrants from the Midwest—to wheat production.

This result relies on five sets of findings. First, we provide descriptive evidence of the association between increased wheat cultivation and the settlement of Russian Germans. We are able to do so by identifying Russian German immigrants in the full-count US population censuses for the first time in the literature, and by combining this with crop production data from the US agricultural censuses.

Second, we estimate difference-in-differences and two-way fixed-effects models to examine how wheat cultivation causally evolved in counties that received Russian German immigrants relative to counties that did not, before and after their arrival. We find consistently positive, significant, and large-in-magnitude effects across all models and specifications. In particular, we find that wheat production increases by approximately 300,000 bushels in treated counties relative to controls counties, in the post-period.

Third, we validate this empirical strategy by showing that the timing of Russian German settlement was determined by exogenous push-factors from the Russian Empire, as opposed to endogenous pull-factors from the US. We additionally identify the main drivers of the location choice of Russian German immigrants and show that they were uncorrelated with wheat production. Lastly, we provide evidence to directly support the identifying assumption that in the absence of the arrival of Russian Germans, wheat cultivation in our group of treated counties would not have been systematically different from that in our control counties.

Fourth, we conduct a series of placebo exercises to substantiate our causal claims. Namely, we demonstrate that while Russian Germans appear to have significantly contributed to the growth of wheat production, similar effects are not observed for other crops. We also decompose wheat production and show that wheat varieties unfamiliar to Germans in the Russian Empire are *not* driving our results. To further isolate the specific role of Russian Germans, we lastly show that our results are not driven by other immigrant groups.

We conclude the paper by exploring the mechanisms at play and show that wheat yields did not increase, but rather that there was an increase in farmland used to produce wheat. Moreover, this increased wheat acreage could not be entirely explained by wheat produced directly by Russian Germans, and so spillover effects are necessarily present. To this end, we find that the arrival of Russian Germans caused non-Russian German farmers to switch out of corn production and into wheat production. This provides evidence in support of the hypothesis that Russian German immigrants contributed to the growth of American agriculture not just by producing wheat themselves, but also by spreading their location-specific agricultural human capital to neighboring farmers.

This success experienced by Russian Germans was in no way pre-ordained. In fact, many Great Plains settlements failed because weather-information problems hindered the ability of settlers to adapt their crops and farming techniques to this particular climate (Libecap and Hansen, 2002). This highlights the importance of the precise applicability of the human capital that Russian Germans possessed. Ultimately, Russian Germans fundamentally changed what people believed was capable of being cultivated in what was otherwise known as the "Great American Desert." This illustrates the potential for high reward with successful matches between immigrants and their receiving locations.

This paper contributes to three broad literatures: the effect of immigrants on receiving regions, the development of American agriculture, and knowledge diffusion. To begin, our work complements the historical literature on the Age of Mass Migration and the effect of immigrants on the American economy and society (Moser et al., 2014; Abramitzky and Boustan, 2017; Sequeira et al., 2020; Tabellini, 2020). Findings broadly demonstrate that historical immigration increased industrial output, contributed to human capital stock, and spurred innovative activity. The effects on agriculture, however, are relatively understudied. One exception in the US context is Boberg-Fazlic and Sharp (2024), which studies the effect of immigration from Denmark, the then-frontier of the dairy industry, on the development of the dairy industry in the US. They show that counties with more Danes in 1880 became more specialized in dairying and used more modern practices. We show that this story, of a niche immigrant group with specific human capital impacting the relevant industry in their receiving region, goes beyond the case of Danes and dairy. Russian Germans had particular knowledge of wheat cultivation under the climatic conditions to which they migrated.[1] And

[1]The importance of this location-specific human capital echoes Bazzi et al. (2016). Studying a rural relocation program in contemporary Indonesia, they demonstrate that immigrants who were assigned to locations with climatic conditions similar to their sending regions outperformed those who ended up in areas with an unfamiliar environment.

they put this knowledge into practice, engaging in wheat farming themselves and spurring the growth of the industry more broadly. This suggests that perhaps immigrants, to a much larger scale then previously acknowledged, impacted the growth of American agriculture in their receiving regions and beyond.

The literature on the economic history of American agriculture has argued that mechanization and westward expansion (i.e., the increase in crop acreage) were the primary drivers of wheat farming growth in the nineteenth and early twentieth centuries (Cochrane, 1979; Hayami and Ruttan, 1985; Parker and Klein, 1996). Olmstead and Rhode (2002) fundamentally altered this view by highlighting the importance of biological innovations, such as the introduction of new wheat varieties resistant to harsher climates and plant diseases, during this time period. Building on this, we show that immigrants, and the knowledge they brought with them, contributed to crop choices and cultivation decisions that ultimately enabled the expansion of American wheat production.

Lastly, we bring the scholarly discussion of knowledge diffusion to the economic history of American agriculture. Lastly, we bring the scholarly discussion of knowledge diffusion to the economic history of American agriculture. In particular, we show that personal-contact transmission channels were important to the adoption of wheat cultivation in the US. This finding echoes the work of Foster and Rosenzweig (1995) and Conley and Udry (2010), who document farmers in India and Ghana adopting new technologies from their more productive and willing-to-experiment neighbors, family members, and friends. There is also a growing literature on the transmission of knowledge across group boundaries. A number of recent papers demonstrate that knowledge spillovers from more skilled and educated immigrants can substantially benefit the local population. For example, Hornung (2014) demonstrates that Huguenot migrants who fled from France to Prussia in the late 17th century contributed to the spread of technical skills in textile production among the local population. Similarly, Natkhov and Vasilenok (2021) show the diffusion of advanced agricultural implements and crops from German immigrants to the neighboring Russian population in the Russian steppe. We provide evidence that such knowledge diffusion from particularly skilled, well-sorted immigrants to the local population was an important driver of growth in American agriculture.

2 Historical Context

2.1 Germans in the Russian Empire

In the Russian Empire, Germans constituted a notable minority of approximately 1.8 million people, or 1.43% of the population, according to the 1897 Census.[2] Most of them belonged to three spatially concentrated groups: the Baltic Germans, the Volga Germans, and the Black Sea Germans. In the Baltic provinces, Germans constituted the urban political elite even before the region was annexed by the Russian Empire in the first half of the eighteenth century. In contrast, Volga and Black Sea Germans were mostly peasants and artisans who

[2]The 1897 Russian Imperial Census was the first and only census carried out in the Russian Empire.

migrated from the German lands in the mid-eighteenth and nineteenth centuries under the colonization policy of the Russian government.

The colonization policy intended to increase state presence and develop agriculture in the sparsely settled or recently annexed regions of the Russian Empire. It was launched by Catherine II, a Russian Empress of German origin, who invited Germans to immigrate to Russia in 1763. The prospective settlers were granted a number of privileges, including exemption from military conscription, administrative autonomy, and religious freedom (Bartlett, 1979). The Imperial government did, however, forcibly channel newcomers to the frontier areas (e.g., the Volga region, Crimea, and Moldova), and require them to engage in agricultural work. Panel (A) of Figure A1 in the Appendix shows the spatial distribution of the German population across the districts of the Russian Empire.

On both the Volga River and the Black Sea, the first generation of German immigrants had to adjust their agricultural practices to the steppe climate, where long cold winters and short hot summers starkly differed from the milder climate of central Europe. Panel (B) of Figure A1 shows the spatial distribution of steppe land cover across the districts of the Russian Empire.[3] Except for those in the Baltic provinces, the German population was concentrated in the steppe belt of the Empire.

Both on the Volga River and the Black Sea, German settlements quickly transformed into the local technological frontier and developed comparatively large grain and agricultural machinery industries that supplied both local and national markets.[4] Remarkably, this economic success –that spurred the economic growth of the recipient regions– came despite the calamities of the first decades following their arrival, when the combination of weather volatility and a lack of farming experience in the unknown steppe environment lead to numerous crop failures and ultimately hunger (Koch, 1977; Pleve, 2008).

In the end, German immigration fulfilled the ambition of Catherine II, who expected the settlers to spread the advanced farming practices present in Germany at the time to the backward Russian peasants. Natkhov and Vasilenok (2021) demonstrate that Russian peasants living in proximity to the German settlements shifted from rye, the staple crop historically cultivated in central Russia, to wheat, the dominant crop among Russian Germans. Russians also adopted advanced agricultural implements, such as iron ploughs, fanning mills, and reapers, widely used and produced by the German settlers. This, in turn, contributed to an increase in the productivity of peasant agriculture.

2.2 Russian Germans in the United States

The abolition of German privileges in the 1870s gave impetus to the out-migration of German settlers from the Russian Empire to the United States and Latin America. The law of 1871 abolished German self-government and transferred the German settlers to the Russian administration. Shortly after, the conscription reform of 1874 made German colonists eligible for military service. Amplified by increasing land tension in the settlements, fears of being

[3]For details on our construction of steppe land cover, see Section 3.3.

[4]Based on data from nine districts in the Saratov province (all with large German populations) in 1917, wheat accounted for 58% of farmland and rye an additional 28% (Natkhov and Vasilenok, 2021).

drafted in looming wars, and the formation of immigrant networks overseas, Russian German out-migration reached a peak in 1912 (Sallet, 1974; Williams, 1975). As of the 1920 census, there were approximately 120,000 German immigrants from the Russian Empire living in the United States.

On the eve of the first influx of Russian-German immigration, the frontier region largely consisted of the Great Plains, with newly constructed railroad access, remaining availability of large tracts of land, and a climate that exhibited substantial similarities to the Russian steppe (Sallet, 1974).[5] Accordingly, the Dakota Territory, Kansas, Minnesota, and Nebraska were the four areas with the largest Russian-German population as of 1880.[6] By 1920, the absolute majority of Russian Germans was still highly concentrated in the northern part of the Great Plains. In fact, just over 52% of all Russian-German immigrants resided in only five states (Colorado, Kansas, Nebraska, North Dakota, and South Dakota), and approximately 20% resided in North Dakota alone.[7]

Figure 1 presents the evolution of the spatial distribution of Russian Germans across all US counties from 1880 to 1920. Settlement patterns remained consistent, with Russian Germans originally settling in the Great Plains upon arrival to the US, subsequent immigration waves following suit, and no clear evidence of internal migration post-arrival.

2.3 Russian Germans and American Agriculture

Precisely as German immigrants fostered agricultural development in the steppe frontiers of the Russian Empire, the historical narrative suggests that Russian Germans maintained their specialization in farming and agricultural labor, and contributed to the growth of wheat cultivation in the United States (Koch, 1977; Moon, 2020).[8] At the onset of Russian-German immigration, the center of wheat production was far from the modern wheat belt of the Great Plains. Olmstead and Rhode (2002) report that in 1869, the center of wheat production was located in central Illinois, whereas by 1919 it had moved to the Iowa-Nebraska borderlands.

Russian Germans did not just contribute to the spread of wheat cultivation, but also to the adoption of new wheat varieties. According to a widely cited anecdote, the first German immigrants from Crimea, who settled in Kansas in 1873, "brought over a bushel or more of Crimean wheat for seed" per family "and from this seed was grown the first crop of Kansas hard winter wheat" (Carleton, 1915). While the veracity of this specific account has not been proven, there is substantial evidence that Russian Germans played an active role in promoting Russian wheat varieties in the US. For example, Bernard Warkentin, a Russian-German migrant from Crimea, arranged the large-scale shipment of Turkey Red Wheat from

[5] See Section 5 for a detailed discussion of the drivers of the location choice of Russian German immigrants.

[6] We use the phrase "Dakota Territory", as this was the formal name of the incorporated territory that eventually became North and South Dakota in 1889.

[7] These five states were also amongst those with the highest *shares* of Russian Germans in terms of the state's total population. As of the 1920 census, North Dakota's population was 3.7% Russian German. North Dakota was followed by South Dakota at 1.5%, Colorado at 1.1%, Nebraska at 0.8%, Montana at 0.6%, and Kansas at 0.5%.

[8] In contrast, European immigrants were less likely to engage in farming than the local population (Abramitzky et al., 2014).

the Russian steppes to Kansas for distribution among the Kansas farmers (Moon, 2008).

Prior to the arrival of Russian Germans, the early settlers to this frontier land were largely internal migrants from the Midwest who brought with them experience in corn cultivation. In a study of Clay County in Nebraska between 1880 and 1900, Baltensperger (1983) finds that Russian Germans had persistently higher wheat acreage than American and European immigrant farmers who extensively cultivated corn. Yet, if we look to modern crop suitability, it appears that corn was a sub-optimal crop choice under the climatic conditions of the Great Plains. Table A1 reports the average suitability of wheat and corn in the ten states with the largest share of Russian Germans. In all cases, average wheat suitability greatly exceeds average corn suitability.[9]

It therefore appears that the experience of steppe farming in the Russian Empire may have provided Russian Germans with a substantial comparative advantage on the Great Plains. First, the climatic conditions in the settlement areas favored wheat cultivation over corn. Second, the arid summers and cold winters of the Great Plains required wheat varieties and farming practices different from those prevalent in the more humid East. We will thus explore if Russian German location-specific human capital contributed to the spread of wheat farming in the US.

3 Data

3.1 Treatment: Russian Germans

In this paper, we measure the share of Russian German population in the US for the first time in the literature. Russian Germans were never identified as a separate ethnic group in the US population census, being recorded as immigrants from the Russian Empire. However, the introduction of the mother tongue question to the 1920 census makes possible the identification of Russian Germans among the US population. We classify an individual as a Russian German if their native language is German and they were born in the Russian Empire.[10] To identify Russian Germans in previous years, we employ the Census Linking Project developed by Abramitzky et al. (2022). While census-to-census linking is always subject to the presence of inaccurate matches and missed links, this would only be a concern

[9] Rhode (2024) evaluates the suitability of FAO-GAEZ crop suitability indices for the historical analysis of American agricultural development, concluding that they likely capture technological change not yet present in our historical period and may not reflect dynamic environment changes. As a result, the numbers we present might partly *reflect* the contribution of Russian Germans to agriculture. Due to these limitations, we do not rely on the FAO-GAEZ indices in our main analysis, employing them in the robustness checks.

[10] Although the census does not allow us to distinguish between Volga and Black Sea Germans, the historical narrative suggests that the Volga Germans mostly settled in the Dakotas, whereas the Black Sea Germans settled in Kansas and Colorado (Sallet, 1974). Both, however, were engaged in similar agriculture practices in the Russian Empire. We are additionally unable, however, to specifically identify Baltic Germans. This group was an urban political elite in the Russian Empire and did not undergo a significant out-migration during this time period (Sallet, 1974). To the extent that our identification may pick up a small number of Baltic Germans, that would only hinder our ability to find significant results as Baltic Germans were not farmers and would presumably not have had an impact on wheat production upon migration to the US. As such, their inclusion makes our results conservative.

if errors in our sample of Russian Germans followed a spatial pattern. We do not have any reason to believe this to be the case.

To ensure the accuracy of the measurement of the Russian German population, we take advantage of the fact that the 1920 census contains information on the number of years that immigrants have resided in the United States. We can use this information to plot, in Panel (A) of Figure 2, an estimate of the annual inflow of Russian Germans to the US.[11] The inflow of Germans from the Russian Empire to the US was virtually non-existent before the 1870s. The first spike in Russian-German immigration, denoted with a solid vertical red line, coincides with the 1874 conscription reform. Williams (1975) reports that two other large out-migration waves were induced by the hardships of the Russian famine in 1891-1892, and the fears of being drafted for the Russo-Japanese War in 1904-1905. Both spikes are present in the figure. The final out-migration wave roughly coincides with the start of the Balkan Wars in 1912-1913. Given that our plot of the inflow of Russian German immigrants cleanly aligns with known migration push-factors, we can be confident in our measurement of Russian Germans in the 1920 Census.

Given our initial identification of 120,173 Russian Germans in the 1920 census, we can now link these individuals backwards in time to previous censuses and document the total number of Russian Germans identified at each point in time. We have identified 2,302 Russian Germans in 1880, 14,110 in 1900, and 39,044 in 1910.[12] To test the sensibility of this overall trend, we can first recreate Panel (A) of Figure 2, where instead of plotting the inflow of Russian German immigrants in each year, we instead plot the cumulative number residing in the US.[13] We then add to this figure the number of Russian Germans that we have identified in each year via census-to-census linking. See Panel (B) of Figure 2. While the number of Russian Germans identified via our census-to-census links (as shown by the series of points connected with a dotted line) is clearly lower in magnitude, the overall trends align.

From the full-count US population censuses we also retrieve information on the share of the population that is foreign-born, as well as the share of Russian and German immigrants.[14] Data on these two specific immigrant groups allow us to not only understand what drove

[11] Technically, this plot shows the year in which Russian Germans present in the United States in 1920 initially immigrated. In order to use this as a proxy for the annual inflow of Russian Germans to the US, we need to acknowledge that our proxy progressively underestimates the volume of immigration in earlier years due to mortality in older ages. Our proxy would also underestimate the volume of immigration in earlier years if Russian Germans migrated out of the US after arrival. The historical records report, however, that once Russian Germans came to the US, very few went back to the Russian Empire (Sallet, 1974; Williams, 1975). And so, this is not of particular concern.

[12] In each census year, the number of Russian Germans that we identify via census-to-census linking is approximately half of what we estimate to be the true Russian German population. See Panel (B) of Figure 2.

[13] More specifically, we will take the inflow estimates used to create Panel (A) of Figure 2, and from them calculate the cumulative population in each year to be: $Population_T = \sum_{t=1800}^{T} Inflow_t$. This cumulative estimation is subject to the same concerns as the initial inflow estimation.

[14] To measure Russian immigrants who are not Russian Germans, we count individuals who were born in the Russian Empire and whose native language is *not* German. We then employ census-to-census linking, just as we did for Russian Germans, to identify these immigrants in all earlier years.

the location choice of Russian German immigrants, but also to use them as placebo, demonstrating that our findings are driven by Russian Germans specifically, as opposed to either the Russian or German immigrant groups more broadly.

As the 1890 full-count population census was destroyed by fire, data on Russian Germans, Russians, and Germans for that year are missing. To supplement our panel with data for 1890, we construct an estimate of each of these 1890 population-share variables to be a county-level linear extrapolation of 1880 and 1900. Results are robust to the exclusion of 1890.

3.2 Outcome: Wheat Cultivation

To measure our primary outcome of interest, wheat cultivation, we rely on the US agricultural censuses. First, we use wheat production in bushels, which is reported in 1840-1910 and 1930. As all other data are available for 1920, our main empirical strategy ideally includes this year. For that reason, we construct an estimate of wheat production in 1920 as a county-level linear extrapolation of 1910 and 1930. Results are robust to the exclusion of 1920.

Additionally, we use wheat acreage, which is only reported starting in 1880, that is, not predating the onset of the Russian German immigration. To compare different wheat varieties, we refer to the 1930 census, which distinguishes between the production in bushels of spring, winter, and durum wheat, and also reports the acreage of all three varieties. To conduct placebo exercises, we collect the same set of variables for both corn and buckwheat. Lastly, we include the number of farms and the total amount of farmland (in acres), as this allows us to normalize our production outcomes and explore mechanisms.

3.3 Covariates

To compare the environment of the receiving regions to those of the sending regions, we employ data from Shaver et al. (2019). We first calculate the share of each type of land cover across the districts of the Russian Empire. We then look to the districts with a nontrivial German population and identify the land cover types that are present.[15] Three land cover types consistently comprise over 80% of land in these districts: rain-fed cropland, prevailing mosaic cropland, and prevailing mosaic vegetation.[16] As this land area is the Russian Steppe, we define this combination of land cover types to be “steppe land cover.” We then use the QGIS software to calculate the share of steppe land cover across US counties.

For climatic conditions, we use Fick and Hijmans (2017) for data on average annual temper-

[15] The resultant land cover construction is robust to various definitions of “nontrivial.” The German population in the Russian Empire, by virtue of their lack of freedom of mobility, was highly concentrated in specific geographic areas. Out of 500 districts in the Empire, 11 have a population that is at least 10% German and 23 have a population that is at least 5% German. If the threshold is decreased to 1% German, then the number of districts increases to 76. At each stage, the additional districts are simply a fanning out in the same geographic region and they thus posses the same land cover types.

[16] In defining land cover types, Shaver et al. (2019) follow the United Nations Land Cover Classification System. We follow suit and use types 14 (rain-fed croplands), 20 (50-70% mosaic cropland and 25-50% terrestrial vegetation), and 30 (50-70% terrestrial vegetation and 25-50% mosaic cropland).

ature (in Celsius), average annual precipitation (in millimeters), and average elevation (in meters). We use Shaver et al. (2019) for data on average terrain ruggedness. To control for general agricultural suitability we use Ramankutty et al. (2001). We use the US population censuses to control for both general development (by way of population density) and the share of the population that is foreign-born. In addition, we use historical railroad shape-files from Sequeira et al. (2020) to determine whether a county had railroad access at each year of our analysis.[17]

4 Empirical Strategy

4.1 Descriptive Evidence

To motivate our empirical strategy, we first present descriptive evidence of the association between increased wheat cultivation and the settlement of Russian Germans. Figure 3 shows the evolution of wheat production across the counties of the US between 1870 and 1910, overlaid with the area of Russian German settlement. Wheat farming is increasing nationwide, with average county-level production rising from 100,035 bushels in 1870 to 223,030 bushels in 1910. Maximum county-level production is also rising, from 2.5 million bushels in 1870 to 10.7 million bushels in 1910. Furthermore, there is notable westward shift in the geographical distribution of wheat farming from the Midwest to the Great Plains. In 1910, the areas with the largest presence of wheat production were the same areas that saw the highest concentration of Russian German settlement. Moreover, these areas did not become epicenters of wheat production until *after* the arrival of Russian Germans. The remainder of this section will explore whether there is a causal relationship present between Russian German immigration and the growth of American wheat farming.

4.2 Sample Restrictions

In our baseline analysis, we restrict the sample to states that received a substantial influx of Russian Germans between 1880 and 1920. Those are: Colorado, Idaho, Kansas, Montana, Nebraska, North Dakota, Oklahoma, South Dakota, Washington, and Wyoming.[18] In terms of our unit of analysis, these 10 states are comprised of 615 counties as defined by 1920 borders. This restriction aims to capture i) the set of counties that were the most common receiving regions of Russian German immigrants, and ii) the set of counties that were most similar to the receiving regions. Our results are robust to alternative sample restrictions.

[17]The timing of railroad data does not perfectly align with census data, and so we simply match the railroad shape-file that is *closest* in time to the census year. We match as follows: 1873 railroad to 1870 census, 1883 to 1880, 1898 to 1900, 1912 to 1910, and 1921 to 1920.

[18]Upon a visual inspection of Figure 1, you can see that these are the ten states that stand out as having counties with the highest concentrations of Russian Germans. We can further substantiate this selection with two slightly different exercises: First, we calculate the *maximum* county-level share of Russian Germans for each state across years 1880, 1900, 1910, and 1920. Ranking the states according to this metric, 10 states have a value of at least 3%. Second, we calculate the *mean* county-level share of Russian Germans for each state across years 1880, 1900, 1910, and 1920. Ranking the states according to this metric, 10 states have a value of at least 0.8%. Across both exercises and the visual inspection, the resulting sample includes the same set of 10 states.

4.3 Empirical Strategy: Baseline

This subsection introduces a difference-in-differences specification, where we examine how wheat cultivation evolved in counties that received Russian German immigrants, relative to those counties that did not, before and after the initial 1874 influx, between 1840 and 1930. Our unit of observation is a county defined by the 1920 borders. To build a geographically-consistent panel, we employ the historical county crosswalks constructed by Ferrara et al. (2021), which use population densities to link historical counties across census years.

We estimate

$$Y_{it} = \beta_0 + \beta_1 RG_i^{0.25} + \beta_2 PostInflux_t + \beta_3 RG_i^{0.25} \cdot PostInflux_t + X_{it}\Gamma + \alpha_i + \eta_t + \varepsilon_{it}, \quad (1)$$

where Y_{it} is our outcome of interest, the number of bushels of wheat produced in county i in year t. $\mathrm{RG}_i^{0.25}$ is an indicator variable that takes on a value of 1 if county i was treated by an influx of Russian German immigrants. As the initial influx of Russian Germans was in 1874, we define $PostInflux_t$ to be an indicator variable that is equal to 1 if the year is 1880 or later. $RG_i^{0.25} \cdot PostInflux_t$ is our main interaction of interest, indicating whether county i was treated by Russian German immigrants *and* time t is after their initial arrival. The vector of controls X_{it} includes logarithm of population density, share of the population that is foreign-born, average temperature, average precipitation, average elevation, average terrain ruggedness, average agricultural suitability, and railroad connectivity, measured with an indicator variable that takes on a value of 1 if county c had connectivity to the railroad network in year t.[19] Finally, we include county and year fixed effects μ_i and η_t respectively. In all specifications, we cluster standard errors at the county level.

In this most basic analysis, we define a county i to be treated if at any point in time it has a share of Russian German immigrants that exceeds 0.25%. Results are robust to alternative definitions of a threshold. Control counties are then defined to be counties that at no point in time had a share of Russian German immigrants above 0.25%.[20] And so in our base sample, we have 253 treated counties and 362 control counties.

Note that in our preferred strategy we define Russian German "treatment" according to the *maximum* share of Russian Germans in a county over our time period. We do this for two reasons. First, in our measurement of Russian Germans, we do not capture the US-born children of Russian German immigrants. As Russian German immigration to the US largely stopped prior to 1920 (when country-specific entry quotas were introduced by the United States), there are very few "new" Russian German immigrants that appear in the 1930 census (Abramitzky et al., 2023). Second, the later the time period, the greater the likelihood that older Russian German immigrants will have died. And so, the share of the population that is Russian German that we capture will mechanically decrease over time, particularly in 1930. We do not, however, perceive the treatment to be decreasing over this time period. In fact, the historical narrative suggests that the US-born children of Russian Germans, a group *increasing* in number over this time period, were maintaining the tradition of wheat

[19] Results are robust to using the crop-specific FAO GAEZ suitability index instead of the Ramankutty et al. (2001) general agricultural suitability index.

[20] In Section 6.4 we use alternative control group constructions and find that our results are robust.

farming (Sallet, 1974). If our model captured the share of Russian German immigrants *at each point in time*, we would be misrepresenting the true dynamics of the Russian German effect on local agriculture.

This baseline model, however, does not permit us to test for differences based on the intensity of treatment. And so, we additionally estimate the following two models. First, we present Model 2:

$$Y_{it} = \beta_0 + \beta_1 RG_i^{Th} + \beta_2 PostInflux_t + \beta_3 RG_i^{Th} \cdot PostInflux_t + X_{it}\varGamma + \alpha_i + \eta_t + \varepsilon_{it} \quad (2)$$

Here, RG_i^{Th} defines a county i to be treated if at any point in time it has a share of Russian German immigrants that is at least $Th\%$, where $Th \in \{0.5, 1, 2\}$ is a series of arbitrary thresholds.[21] A county i is thus in the control group if at *no* point in time the share of Russian German immigrants reached $Th\%$.

Finally, in Model 3, we estimate

$$Y_{it} = \beta_0 + \beta_1 RG_i^{Cont} + \beta_2 PostInflux_t + \beta_3 RG_i^{Cont} \cdot PostInflux_t + X_{it}\varGamma + \alpha_i + \eta_t + \varepsilon_{it} \quad (3)$$

RG_i^{Cont} is now a continuous measure that takes on the maximum share of Russian Germans present in county i between 1880 and 1930.[22]

4.4 Empirical Strategy: Staggered Adoption Design

As presented in Figure 2, not all Russian Germans who ever migrated to the US did so in the first immigration influx of 1874. However, our baseline empirical strategy does not allow us to exploit these time-varying influxes. For this reason, we proceed with a generalized difference-in-differences specification with staggered treatment adoption. We estimate a standard two-way fixed effects model

$$Y_{it} = \beta_0 + \beta_1 PostInflux_{it}^{Th} + X_{iu}\varGamma + \alpha_i + \eta_t + \varepsilon_{it}, \quad (4)$$

where $PostInflux_{it}^{Th}$ is an indicator variable that takes on a value of 1 if county c has reached the Russian German threshold to be considered treated (according to any of the definitions presented in the baseline strategy) at time t. The distribution of adoption timing for each of the treatment definitions can be seen in Figure A2. The trend is fairly stable across treatment definitions, with consistently high treatment adoption in 1890 and 1920. In our setting, there is no treatment reversal. In other words, once a county i is treated, it remains exposed to this treatment throughout our time frame of interest.

[21]The number of counties defined to be treated under each of these treatment thresholds is as follows: 183, 120, and 79, respectively.

[22]The mean value of RG_i^{Cont} across counties is 1.07%, with a median of 0.14%. Approximately 20% of counties have a share greater than 1%, 6% have a share greater than 5%, and only 2% of counties have a share greater than 10%.

5 Validation of Empirical Strategy

To validate our empirical strategy, we need to understand the assignment mechanism that drove Russian Germans to i) move to the US *when* they did, and ii) settle in the locations *where* they did. First, we will show that the timing of Russian German settlement was due to exogenous push-factors from the Russian Empire, as opposed to endogenous pull-factors from the US. Second, we will demonstrate that the main drivers of the location choice of Russian German immigrants were the availability of homesteading land, railroad connectivity, and climate matching. Third, we will show that these location drivers are uncorrelated with wheat production. Fourth, we will provide evidence to support the identifying assumption that in the absence of the arrival of Russian Germans, wheat cultivation in our group of treated counties would not have been systematically different from that in our control counties. Lastly, we will address the potential presence of heterogeneous treatment effects.

5.1 Timing of Russian German Settlement

An overview of the timing of Russian German immigration to the US is presented in Panel (A) of Figure 2. As discussed in Section 3.1, each major influx of Russian Germans to the US can be traced back to an exogenous shock within the Russian Empire. The first spike in Russian-German immigration, denoted with a solid red line in Panel (A) of Figure 2, coincides with the 1874 conscription reform. Williams (1975) reports that two other large out-migration waves were induced by the hardships of the Russian famine in 1891-1892, and the fears of being drafted for the Russo-Japanese War in 1904-1905. Both spikes are apparent in the figure. The final out-migration wave roughly coincides with the start of the Balkan Wars in 1912-1913. Therefore, it was exogenous push-factors from the Russian Empire, as opposed to endogenous pull-factors from the US, that explain the timing of Russian German migration.

We can confirm the validity of these push-factors by recreating Panel (A) of Figure 2 for other immigrant groups from the Russian Empire. Figure A3 includes all immigrants from the Russian Empire whose mother tongue is not German, Figure A4 looks at the subset of Jewish immigrants, and Figure A5 looks at the subset of Polish immigrants.[23] We see that the conscription reform did not spark the out-migration of any other group except for Russian Germans. Moreover, the outflow of Jewish immigrants aligns with two waves of anti-Jewish pogroms that started in 1881 and 1903, consistent with earlier evidence on pogrom-driven migration (Spitzer, 2021).

5.2 Location Choice of Russian Germans

Figure 1 demonstrates where Russian Germans settled and how these settlement patterns evolved over time. Each panel plots the share of each county's population that is Russian German in 1880, 1900, 1910, and 1920 respectively. The first immigrants largely settled in

[23] We identify Russian Jews by selecting the subset of immigrants from Russia who report Hebrew or Yiddish as their mother tongue. We identify Russian Poles by selecting the subset of immigrants from Russia who report Polish as their mother tongue.

Kansas, Nebraska, and South Dakota. Immigration to these areas persisted, with the notable addition of North Dakota, and to a lesser extent southeast Washington, by 1900. By 1920, while the epicenters of settlement are in the Dakotas, northeast Colorado, and southeast Washington, there is also a meaningful presence across all 10 states of our restricted sample.

The literature on immigration highlights several potential drivers of spatial settlement: availability of homesteading land and railroad connectivity, pre-existing immigrant networks, the location of established industries, and climate matching (Sequeira et al., 2020; Obolensky et al., 2024). We address each of these drivers below.

Availability of homesteading land and railroad connectivity. The historical narrative emphasizes the availability of large tracts of unpopulated land as a key factor in shaping initial settlement decisions of Russian Germans. In the 1870s-1880s, they established settlements on homesteading land in Nebraska, the Dakotas, and Kansas. Following the opening of the Indian Territory of western Oklahoma in the 1890s and Montana in the 1900s, Russian Germans began settling in these areas as well (Sallet, 1974).

The development of a railroad network facilitated access to newly available land, with the establishment of Russian German towns following the opening of new lines. In addition, as railroad companies themselves owned large tracts of land along the lines, they actively conducted widespread advertising campaigns abroad. According to Sallet (1974), German-language promotional materials produced by the Burlington and Quincy Railroad and the Union Pacific Railroad reached the German colonies in the Russian Empire in the early 1870s, while Santa Fe Railroad sent an emissary to Russia in 1875 to promote resettlement to Kansas.

To bring this narrative to the data, we first overlay county-level population density and Russian German settlement for 1880-1920 in Figure A6. In each panel, Russian German settlement is indeed on the frontier of settled land. Figure A7 then overlays Russian German settlement in 1880 and 1900 with the existing railroad network both before and after the start of the respective decade. Taken together, these maps show that Russian Germans settled in regions with available land accessible by railroad.

Pre-existing immigrant networks. When Russian Germans initially migrated to the US, German immigrants were the pre-existing immigrant group that was most similar in terms of both a shared language and common culture.[24] As such, we ask whether Russian Germans migrated to areas in which Germans had already settled. In Figure A8, we plot the 1880 spatial distribution of Germans, and overlay this with the area of Russian German settlement. The highest concentration of Germans was in the Midwest, and Russian Germans congregated in the Great Plains upon first arrival. Moreover, we can focus in on the Germans immigrants who did live in the Great Plains, and see that these areas are not the counties in which Russian Germans settled. Therefore, there is no evidence to consider the existence of pre-existing immigrant networks as a driver for the initial settlement patterns of Russian Germans.

[24]Importantly, Russians are not the immigrant group that we look to for a pre-existing immigrant network. First, Russians were virtually nonexistent in the US upon first arrival of Russian Germans. Second, we know that Russian Germans did not assimilate into Russian culture (Velistyn, 1893; Natkhov and Vasilenok, 2021).

Pre-existing wheat cultivation. If Russian Germans were adept at wheat cultivation in the Russian Empire, then it is reasonable to question whether Russian Germans immigrated to areas in the US that already had pre-existing wheat agriculture. Panel (A) of Figure 3 shows the spatial distribution of wheat production in 1870, that is. Overlaid in this figure are the areas in which Russian Germans were settled as of 1880. It shows that Russian Germans did not seem to settle in areas with burgeoning wheat farming at the time (Olmstead and Rhode, 2011).

Climate matching. Obolensky et al. (2024) show that immigrants tend to settle in places with climates similar to those of their sending regions, and provide two complementary mechanisms: climate-specific human capital and climate as an amenity. They find that climate-specific human capital is an important driver, particularly for individuals in more weather-exposed occupations. Moreover, they demonstrate that the connection between climate and location choice is larger in magnitude for farmers than for non-farmers.

In our setting, as virtually all Russian Germans immigrating to the US were farmers, we would expect climate-matching to have played a particularly large role. Obolensky et al. (2024) use precipitation and temperature as measures of climate, and we map these two variables for both the sending and receiving regions of Russian Germans in Figure A9. There is clearly a strong correlation. Moreover, we can use our construction of steppe land cover outlined in Section 3.3, and plot the share of steppe land cover across US counties in Figure A10. Overlaid in this figure is Russian German settlement as of 1880, demonstrating that they did settle in areas that had land cover similar to their sending regions. Taken together, this provides evidence of climate-matching (in terms of temperature, precipitation, and land cover) as a feasible driver of the location choice of Russian Germans.

5.3 Settlement Drivers and Wheat Cultivation

We will now show that the outlined assignment mechanism is uncorrelated with our outcome variable, the magnitude of wheat cultivation. Above, we provided evidence to support the claim that the availability of homesteading land was a driver of the location choice of Russian Germans.

If the treated counties in our sample have more available land than the control counties, that could be cause for concern, as rural counties may inherently have greater scope for agricultural development. We are, however, controlling for population density, climate and terrain characteristics, and general agricultural suitability in our model. And so any possible advantages from more available land would have to appear through another channel. That being said, it is not the case that the counties that Russian Germans moved to were *inherently* more rural than our control counties. Rather, they were just more rural *at the time of the arrival* of Russian Germans. Indeed, we find that mean county-level population density and urbanization rates were not statistically different across our treated and control counties by 1900.[25] And so, there is no reason to believe that the counties that had available land

[25] Urbanization rates are defined according to the US Population Census definition: the percentage of the population that is living in places with more than 2,500 dwellers.

upon Russian German settlement had inherently greater scope for agricultural —specifically wheat— cultivation.

Next, we provided evidence that railroad connectivity was an additional factor driving the location choice of Russian Germans. To our knowledge, the railroad network was not built with the intention of maximizing wheat cultivation.

Finally, we discussed the role of climate-matching in location choice. This could be a concern if Russian Germans chose their location based on a particular climate, and if that climate was directly correlated with wheat cultivation. But, Figures A9-A10 show that our control counties (i.e., counties within our 10 state restricted sample that did not receive an influx of Russian Germans) had a similar climate to our treated counties. As our results rely on differences *between* our treated and control counties, climate could not be a driver. Rather, it is the *interaction* between this common climate and the climate-specific human capital that the Russian Germans possess.

5.4 Parallel Trends

We will now show the evolution of wheat cultivation separately for counties in our sample that were treated by the influx of Russian German immigrants, compared to those that were not. From Figure 4, we see that treated and control counties had parallel trends in wheat production prior to the arrival of Russian Germans, at which point the trajectories diverged.[26,27] Moreover, the pre-treatment *levels* were even similar across the treated and control groups. This provides additional evidence above and beyond what is necessary for our identifying assumption.

Now, we conduct a placebo exercise in which we test to see if treatment status had an effect on wheat production in years *prior* to treatment. For this, we regress our outcome variable on pairwise interactions between our treatment indicator and year-specific dummy variables. For completeness, we also include the treatment indicator and year fixed effects. If the parallel trends assumption holds, then treatment status should not have a significant interaction with any year indicator in the pre-treatment period. It should only be for years in the post-period in which we see significant effects. We plot the coefficients of each pairwise interaction, along with their 95% confidence intervals, in Figure A11.[28] All coefficients for years 1890 and prior are not statistically significantly different from 0. Starting in 1900, the coefficients gain statistical significance, and increase in magnitude over time. This provides formal evidence in support of the parallel trends assumption, and additionally shows the lack of anticipation effects present in the data.

[26] As 1920 wheat production is a linear extrapolation of that in 1910 and 1930, we omit it from Figure 4 for transparency.

[27] The vertical line represents the *initial* inflow of Russian German immigrants in 1874, but we know from Panel (A) of Figure 2 that Russian German immigration increased through 1920. The fact that trends in wheat production do not diverge until 1890 is as expected given this increase in the magnitude of immigration over time, as well as the time it took for Russian Germans to settle into wheat cultivation in the US.

[28] 1870, the year immediately prior to the transition into the treatment phase, is omitted for comparison. This is the typical practice.

5.5 Homogeneous Treatment Effects

Given our use of a two-way fixed effects model in our staggered adoption empirical analysis, the last major assumption that we need to address is that of homogeneous treatment effects. That is, that the treatment (i.e., the influx of Russian German immigrants) has the same causal effect for all units (i.e., counties). In our setting, we cannot rule out the possibility that the treatment could have differential impacts depending on county-level characteristics such as soil suitability, climate, or the time of arrival of Russian Germans. To account for this possibility, we extend our staggered adoption analysis to include the use of heterogeneous treatment effect (HTE) robust estimators that have recently been proposed in the literature. Return migration to the Russian Empire is virtually non-existent, and internal migration within the United States is low. As such, counties do not receive a significant influx of Russian German immigrants and then revert to a zero share. Given this lack of treatment reversal, we employ the two "simplest" HTE-robust estimators: Sun and Abraham (2021) and Callaway and Sant'Anna (2021).[29] We omit any detailed conversation of them here. For details, please see the papers directly, or Chiu et al. (2024) for a nice discussion of this recent literature.

6 Results

6.1 Baseline Results

In Panel (A) of Table 1 we present the results of estimating Equation 1. In the first column, we report the simple difference-in-differences model, without any further controls or fixed effects. In the second column, we include the county-level characteristics outlined in Section 4.3. In Columns (3) and (5), we add in county and year fixed effects. In each column, we show the estimated coefficient of interest corresponding to the treated group in the post-period.[30] The table shows a positive and statistically significant coefficient of equal magnitude across all specifications. If we look to our most complete model in Column (5), we see that the production of wheat increases by approximately 204,000 bushels in treated counties relative to control counties, in the post-period. Note that control counties between 1880 and 1930 have a mean wheat production of approximately 333,000 bushels, implying a substantial treatment effect.

In Panel (B) of Table 1 we now present the results of estimating Equation 2.[31] Recall that in this model, we define a county to be treated if at any point in time it has a share of Russian German immigrants was at least $Th\%$, where $Th \in \{0.5, 1, 2\}$. In Panel (B)

[29] Both models are based on canonical DIDs, also referred to as "DID extensions", as opposed to imputation. In both cases, we use the "not yet treated" units as the comparison group. The estimator from Sun and Abraham (2021) is obtained from a TWFE regression with cohort dummies fully interacted with indicators of relative time to the onset of treatment. We implement this method using five lags and three leads relative to the onset of treatment. The estimator from Callaway and Sant'Anna (2021) differs from Sun and Abraham (2021) in that it conditions only on *pre-treatement* covariates using stabilized inverse probability weighting and ordinary least squares, and that the number of leads/lags is not user-specified.

[30] For the complete regression output, including all estimated coefficients, see Table A2.

[31] For the complete regression output, including all estimated coefficients, see Tables A3-A5.

we have a separate row for each threshold in the set. All coefficients in this panel match that in Panel (A) in terms of sign, significance, and magnitude. The coefficient of interest increases as the treatment threshold increases (from approximately 270,000 bushels at the 0.5% treatment threshold to approximately 435,000 bushels at the 2% treatment threshold), though no coefficients in Panels (A) or (B) are statistically distinguishable from one other.

Finally, in Panel (C) of Table 1 we present the results of estimating Equation 3, our difference-in-differences model with continuous treatment.[32] The results continue to remain consistent in terms of sign and significance, although are now one order of magnitude smaller. Here, production of wheat increases by approximately 27,000 bushels in treated counties relative to control counties, in the post-period. This is statistically significantly smaller than all coefficients in Panels (A) and (B). This reduction in magnitude likely arises from the fact that we would only expect the treatment effect to become significant beyond a certain level of treatment intensity. That is, we expect that Russian Germans only have a significant effect on county-level wheat production when their presence in a county is "large enough". For example, we would not expect a single Russian German wheat farmer - or even a handful - to necessarily shift a county's level of wheat production. Such counties would be considered controls in our model that uses a binary treatment measure. But, these counties are considered treated in the model with a continuous treatment measure, and as such may dilute the treatment effects.

6.2 Staggered Adoption Results

Now, we proceed with our staggered adoption empirical strategy as outlined in Equation 4. For ease of comparison, we will continue to present our results in Table 1. Note that our simplest regression for a two-way fixed-effects model necessarily includes county and year fixed effects. And so, we will present our base case in Column (4) and then proceed to Column (5) with the addition of controls. Just as in Panel (B), we will have a separate row for each treatment threshold (0.25, 0.5, 1, 2). See Panel (D) of Table 1. The results are consistent in sign, significance, and magnitude with our standard difference-in-differences results. The coefficient of interest once again increases as the treatment threshold increases (from approximately 425,000 bushels at the 0.25% treatment threshold to approximately 541,000 bushels at the 2% treatment threshold), though no coefficients are statistically distinguishable from each other or from those presented in Panels (A) or (B). For ease, Figure 5 presents the estimated coefficients for the most complete specification (that is, from Column (5) of Table 1) for all 9 models employed.

Table A7 presents the estimation of dynamic treatment effects and their accompanying 95% confidence intervals using the interaction weighted (IW) estimator proposed by Sun and Abraham (2021). Effects leading up to the treatment are negative, statistically significant, and consistent in magnitude across all lags. The effects post-treatment are significant, positive, large in magnitude, and increasing over time. The simple weighted average of the average treatment effects on the treated from the Callaway and Sant'Anna (2021) heterogeneous treatment effect robust estimator is approximately 324,000 bushels of wheat. Figure

[32]For the complete regression output, including all estimated coefficients, see Table A6.

A12 presents the ATT for each period leading up to and after the time of treatment. Once again, we see insignificant pre-treatment effects and positive, statistically significant effects that increase over time in the post-treatment. Notably, these two sets of results are not only consistent (in terms of sign, significance, and magnitude) with all other models, but they also confirm a lack of pre-trends and anticipation effects.

6.3 Placebo Analyses

We now conduct a series of placebo analyses in order to substantiate our causal claims. First, we show that this is in fact a story about wheat in particular, and that analogous results are not present in other crops. Second, we decompose wheat production and show that wheat varieties unknown to Germans in the Russian Empire are *not* driving our results. To further isolate the specific role of Russian Germans, we lastly show that our results are not driven by other immigrant groups.

Buckwheat production is a meaningful placebo outcome, as it is a pseudo-cereal (i.e., not a grain, but a crop that we consume like a grain) and thus a reasonable comparison to wheat (a cereal). Moreover, we have buckwheat production data for Russian Germans back in the Russian Empire and so can be certain that it is not a crop with which they had particularly extensive experience.[33] Figure A13 shows the evolution of buckwheat's production (in bushels) in treated and control counties. As you can see, the trends are similar in both the pre- and post-periods. Moreover, there is no systematic change in production in treated counties in response to the arrival of Russian Germans. In Table A8 we replace our baseline outcome variable (wheat production) with buckwheat production (in bushels) and recreate Table 1. The estimated coefficient of interest corresponding to the treated group in the post-period is largely negative and insignificant.[34] And so, we have further evidence that this is a wheat-specific story.

Wheat, however, is a broad crop with multiple varieties of note in this time period. The 1930 census is the first to report specific production outcomes for the winter, spring, and durum varieties. Importantly, the durum wheat variety was unknown to Russian Germans in the Russian steppe. And so, we decompose total 1930 wheat production, by variety, in order to ensure that durum wheat production is not driving our results. We find that in our treated counties, approximately 57% of 1930 wheat production was the winter wheat variety, approximately 31% was spring wheat, and only 12% was durum wheat. As durum wheat is an exceedingly small share of total wheat production, we can be confident that this is not driving our (large in magnitude) results. This is aligned with our narrative, as a significant production of a wheat variety not historically associated with Russian Germans would have raised doubts on the validity of our causal claim.

Now, we show that this is about *Russian* Germans in particular, and not a story of Germans

[33] Natkhov and Vasilenok (2021) have data from nine German districts in the Saratov Province in 1917. They find that approximately 0.8% of crop acreage was for buckwheat cultivation, in contrast to the almost 60% of crop acreage used for wheat production.

[34] The largely negative coefficients could be a sign of spillovers, as will be discussed in Section 7. The n

more broadly.[35] As German immigrants were much more prevalent relative to Russian German immigrants, defining a county to be treated according to an arbitrarily small threshold of German immigrants is not meaningful. Instead we define a county to be treated by Germans if at any point in time the share of German immigrants exceeded 3%.[36] We then plot the evolution of wheat production by this new treatment status. Figure A14 shows that treated and control counties have similar trends in the pre- and post-periods. Both groups have a spike in production post-1874, which can be explained by the fact that Russian Germans (the group that we believe define the "true" treatment status) are present in both the treated and control counties (when treatment is defined by the level of *German* immigrants as it is here). We can take this one step further and bring our placebo treatment definition to the empirical analyses and find, as presented in Table A9, that the coefficients of interest are now small in magnitude, of varying signs, and generally insignificant (or omitted). And so, it is clear that German immigrants are not driving our results.

6.4 Robustness

We now conduct a series of robustness exercises to demonstrate the strength of our results. We find that our results are robust to alternative control group constructions as well as to alternative treatment definitions.

To begin, we construct three alternative control groups. First, we acknowledge that counties geographically close to treated counties may be more similar in terms of unobservable characteristics. And so, we could require control counties to be untreated counties *adjacent* to treated counties. That said, geographically close counties may also be more susceptible to spillover effects. And so, we can alternatively require control counties to be untreated counties *not adjacent* to treated counties. Lastly, effects similar in nature to anticipation effects could be present. This is because treated counties likely do have a Russian German population prior to the point in time at which they reach the threshold to be formally considered treated. And so, we can require control counties to have a zero share of Russian Germans across all time periods. See Tables A10-A11, where, once again, the coefficients of interest remain unchanged in terms of sign, significance, and magnitude.[37]

Now, we implement two alternative treatment definitions. First, we define treatment intensity at not only the county-level, but also the year-level. That is, instead of defining Russian German treatment to be the *maximum* share of Russian Germans in a county over our time period, we now define Russian German treatment for a county to be the share of Russian Germans present *at each point in time*. This is not our preferred strategy for reasons outlined in Section 4.3, but we include it here for completeness. Table A12 presents the results for

[35]From the historical context we know that this is not plausibly a story about (non-German) Russians. In fact, ethnic Russians did not migrate - to any substantial extent - until the Russian Revolution that began in 1917.

[36]This choice of 3% is arbitrary. Results are robust to alternative thresholds.

[37]Requiring control counties to be untreated counties *adjacent* to treated counties limits our sample size to a great extent. Take, for example, the case where treatment is defined at the 1% level. When we require control counties to be untreated counties adjacent to treated counties, we lose almost 90% of untreated counties. As such, we are unable to get reliable estimates and omit this strategy from the results.

Equation 4. Our coefficients of interest are consistent with the main results in terms of sign, significance, and magnitude.

7 Mechanisms

In this section, we show that wheat yields did not increase, but rather there was just an increase in farmland used to produce wheat. Moreover, this increased wheat acreage could not be entirely explained by Russian Germans themselves, and so spillover effects are necessarily present. To this end, we find that the arrival of Russian Germans caused non-Russian German farmers to (partially) switch out of corn production and into wheat production. A next step is to explore *how* this diffusion took place. We now address each point in turn.

7.1 Wheat Acreage

Given that we find a large and significant effect of Russian Germans on wheat production, the first natural question to ask is what exactly is driving this increase.[38] At a high level, it could be that acres used to produce wheat had increased yields, that more acres started to be used for wheat cultivation, or a combination of the two. To explore this, we first present some simple descriptive evidence in Figure 6. Panel (A) plots wheat production, over time, by treatment status. Panel (B) does the same for the number of acres being used for wheat production.[39] Panel (C) combines the two into a yield measure, that is, the number of bushels of wheat produced per the number of acres being used to produce wheat. The number of wheat acres increases in treated counties, relative to control counties, post-treatment. But, wheat per acre is incredibly stable over time, with remarkably similar yields across treated and control counties. This suggests that it is an increase in the number of acres being used to produce wheat, rather than an increase in the yield of wheat cultivation, that is driving our results.

We can substantiate this descriptive evidence by conducting the same set of causal analyses used for our main set of results, but now for these two new outcome variables.[40] Table 2 shows that the estimated coefficients of interest confirm what was starkly apparent in Figure 6. That is, that the effect of Russian Germans is almost exclusively coming from an increase in the number of wheat acres, as opposed to an increase in wheat yield (i.e., output per acre). This could be coming from the intensive and/or extensive margins. In other words, it could be that wheat-producing farms put more acres towards wheat production and/or that more farms became wheat-producing. We cannot distinguish between the two in our data.

[38]Importantly, there were not other contemporaneous increases in wheat production. See Figure A15, which shows the evolution of wheat production, over this time period, for everywhere in the US *excluding* our restricted sample. It is remarkably constant.

[39]This variable is only available starting in 1880.

[40]Wheat acreage is only available starting in 1880. And so we are unable to employ the standard difference-in-differences model as it uniformly defines the post-period to start in 1880, leaving us without a pre-period for any outcome variable that relies on wheat acreage. Instead, we necessarily need to employ our staggered adoption model for this new set of outcome variables.

7.2 Existence of Spillovers

Next, we want to ask whether it is possible that wheat directly produced by Russian Germans accounts for the entire effect. Given that our data are at the county-level, we are unable to identify wheat production by farmer ethnicity. Instead, we do a series of back-of-the-envelope calculations. To begin, we will conservatively assume that every male Russian German household head of a farm household owns their own farm.[41] We will then assume that the average farm size of a Russian German farmer is equal to the county-level average farm size (in terms of improved acreage). With these assumptions in hand, we can estimate the number of Russian German-farmed acres as the product of the number of male Russian German household heads of a farm household and the average farm size. We calculate this at the county-level. In 1920, the number of acres being used to produce wheat exceeds the number of Russian German-farmed acres in over 95% of treated counties.

We will conservatively assume that all Russian German-farmed acres are used for wheat production.[42] We will then relax the assumption that the average Russian German farm size is equal to the county-level average. To that end, we calculate how much larger Russian German farms must be in order for all additional wheat acreage to have come directly from Russian German farmers. By "additional", we are referring to the amount of wheat acreage in treated counties above and beyond what would have been but for the influx of Russian German farmers. The latter can be proxied by wheat acreage in our control counties. If we take the average number of wheat acres in treated counties in 1920, and then subtract the average number of wheat acres in control counties in the same year, we get a difference of 43,904 acres. The average number of Russian German-farmed acres in treated counties, assuming that Russian German farms are of average size, is approximately 17,096. And so, Russian German farms would have to be, on average, 3.6 times the size of the county-average in order to account for all additional wheat acreage. This would mean that Russian German acres, on average, account for over 21% of all farmland in a county despite Russian Germans being, on average, only 2.4% of the population.

This is an incredibly conservative estimate given our assumptions that 100% of male Russian German household heads of farm households were farm owners who used 100% of their land for wheat cultivation. We now want to construct a less conservative, and perhaps more realistic, estimate with farm-level data that we have for Clay County, Nebraska. There, we know that in 1908 only 60% of Russian Germans farmers were farm owners and that in 1900 only 42% of land was used for wheat cultivation. While these estimates need not be representative of treated counties more broadly, they are the only available farm-level data we have. And so, we will repeat our back-of-the-envelope calculations with these new assumptions. Now, we find that the number of acres being used to produce wheat exceeds the number of Russian German-farmed wheat acres in almost 99% of treated counties. Moreover,

[41] Given farm-level data that we have for Clay County, Nebraska, we know that in 1908 approximately 60% of all Russian German farmers were farm owners (Baltensperger, 1983). This county, of course, need not be representative of all treated counties. However, this statistic does potentially shed light on just how conservative our assumption is.

[42] Just as with our other assumption, we will again turn to our farm-level data for Clay County, Nebraska (Baltensperger, 1983). In 1900, only 42% of Russian German farmland was used to produce wheat, suggesting that our assumption is in fact conservative.

the average number of Russian German-farmed acres, assuming that Russian German farms are of average size, is now approximately 4,308. This means that Russian German farms would have to be, on average, 11.2 times the size of a non-Russian German farm in order to account for all additional wheat produced.

While neither of these scaling factors are technically infeasible, we do believe they are unlikely. In the first exercise, it is difficult to believe that, on average, over 20% of a county's farmland is owned by the niche group of Russian Germans that account for, on average, just over 2% of the county's population. And in the second exercise, it seems improbable that a Russian German farm is, on average, almost 12 times the county's average farm size. Given our same farm-level data for Clay County, Nebraska, we know that in 1900 Russian German farms were approximately three quarters of the size of American farms (Baltensperger, 1983). Once again, we acknowledge that this need not be representative of all treated counties. However, this does at least suggest that Russian German farms were likely *not* larger than the average farm in their county, never mind *substantially* larger. To this end, we have found suggestive evidence that the increased wheat acreage in treated counties is unlikely to be entirely explained directly by Russian Germans. This, in turn, suggests that spillovers must be present.

7.3 Evidence of Spillovers

We now want to find evidence of the spillovers that we have just demonstrated to exist. Upon arrival, "Russian Germans encountered a corn-based market economy" (Baltensperger, 1983). And so, we would expect a spillover to appear in the form of a non-Russian German farmer switching, at least partially, from corn production to wheat production. A potential link between an increase in wheat production and a decrease in corn production was actually proposed in a contemporaneous report from the Agricultural Census:

> "The acreage of corn harvested...decrease appears to have been mainly the result of a transfer of acreage from corn to winter wheat. At any rate, practically all of the decrease in corn acreage occurred in states where both corn and winter wheat are important crops; and where there were decided increases in the winter wheat acreage" (United States Bureau of the Census, 1921).

To demonstrate this with our data, we can plot average corn production, by treatment status, over our time frame of interest. Figure 7 shows that treated counties saw a relatively smaller increase in corn production relative to control counties. And if we look outside of our restricted sample, Figure A16 shows that the trend in the control counties very much mimics the overall trend in the country at the time. And so, the smaller increase in corn production in our treated counties appears to be a meaningful deviation.

To test for a causal relationship, we will once again conduct the same set of analyses presented in Section 4, but now with corn production as our outcome variable. Table 3 presents the results. A statistically significant and negative coefficient of interest corresponding to the treated group in the post-period would be evidence that a spillover, as outlined, occurred. And that is exactly what we find across most specifications.

7.4 Factors Driving Spillovers

Now that we have concrete evidence of the occurrence of spillovers, we want to understand *how* they occurred. The historical literature suggests three main modes: seed distribution, social learning, and the active spread of knowledge.

In terms of seed distribution, there is evidence of Russian Germans shipping seeds from the Russian Empire to the United States.[43] While this was for their own use and for use within their own (Russian German) communities, there is also reference to the seeds being distributed "to the general public" (Moon, 2020).

There was likely demand in the general public for these seeds as a result of social learning. In fact, these new varieties had "gained a reputation for resilience in the face of droughts, harsh winters, pests, and disease, and for yielding better harvests than other varieties" (Moon, 2020). But, knowledge gained purely by observation, while necessary, was likely not sufficient for the *successful* diffusion. Important details regarding the cultivation of these new wheat varieties were difficult to observe. The kernels of winter wheat, for example, were much harder compared to any wheat variety to which the general pool of farmers would have been accustomed. As such, their mills were unable to efficiently grind these new varieties. But, we see evidence of the active diffusion of knowledge surrounding this very topic. A Russian German farmer became president of the Kansas Miller's Association and promoted not only the cultivation of these new wheat varieties, but also the knowledge that farmers "could minimize their costs by equipping their mills to grind mostly this sort of wheat" (Moon, 2020).

8 Conclusion

The expansion of American agriculture between the second half of the nineteenth and the first half of the twentieth centuries has been primarily treated as a story of the adoption of biological innovations (Olmstead and Rhode, 2002). In this paper, we supplement this perspective by examining the role of immigrants in contributing to agricultural development. We focus on the historical case of the Russian German immigration to the US and their effect on the transition from corn to wheat farming on the Great Plains.

Russian Germans, who migrated to the Russian Empire in the mid-eighteenth century under the colonization policies of the Russian government, settled in the southern steppe frontier and quickly developed burgeoning wheat production in a seemingly hostile steppe climate. In the 1870s, when the Russian government abolished their privileges, thousands of Russian Germans migrated to the US, bringing over their experience in steppe agriculture. The historical narrative suggests that Russian Germans contributed to the spread of American wheat cultivation and the introduction of new wheat varieties (Baltensperger, 1983; Moon, 2020). For the first time in the literature, this paper brings the historical narrative to data and quantifies the effect of Russian-German immigration on the expansion of wheat farming.

[43] Moon (2020), for example, speaks of the following: "From the late 1870s, [Bernhard] Warkentin was shipping wheat from the steppes to Halstead, Kansas."

We demonstrate that Russian Germans settled in areas that they were dominated by corn farming, or even deemed unsuitable for agricultural production all together (Olmstead and Rhode, 2011). But their experience of farming in the Russia Steppe gave Russian German immigrants an acute advantage over local homesteaders, whose agricultural experience was restricted to the much more humid areas in the East. We show that the inflow of Russian German immigrants caused a shift in agricultural practices from corn production to wheat production in the counties to which they migrated. In fact, wheat production increased by approximately 300,000 bushels in counties that received an influx of Russian Germans, relative to those that did not, after their arrival. This is a substantial treatment effect given that this relative *increase* is approximately equal to the *total* wheat cultivation that is estimated to have occurred in these counties had it not been for the arrival of Russian German farmers.

These findings show that even a relatively small immigrant group can have a transformative impact on economic development. By transferring specialized agricultural knowledge, Russian Germans altered both the crop mix and beliefs about the feasibility of wheat farming on the Great Plains. More broadly, the results highlight the importance of the match quality between immigrants and their receiving locations and the role of knowledge diffusion across group boundaries in augmenting the economic impact of immigration.

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Tables

Table 1: Russian Germans and Wheat Cultivation in the US

	Wheat Production (Bushels, Thousands)				
	(1)	(2)	(3)	(4)	(5)
Panel A.					
$RG_c^{0.25} \cdot Post_t$	349.6***	223.8***	112.8***		204.0***
	(57.8)	(57.5)	(69.4)		(61.2)
Panel B.					
$RG_c^{0.5} \cdot Post_t$	350.4***	255.0***	207.8***		270.1***
	(68.6)	(68.4)	(82.3)		(82.6)
$RG_c^{1} \cdot Post_t$	364.0***	255.8***	249.7***		307.0***
	(89.7)	(88.6)	(106.5)		(108.8)
$RG_c^{2} \cdot Post_t$	465.2.***	359.6***	374.2***		435.2***
	(120.2)	(119.2)	(142.1)		(146.4)
Panel C.					
$RG_c^{Cont} \cdot Post_t$	40.5***	28.5***	21.3**		27.4***
	(9.1)	(9.1)	(9.0)		(9.5)
Panel D.					
$PostInflux_{ct}^{0.25}$				536.5***	424.7***
				(42.7)	(39.7)
$PostInflux_{ct}^{0.5}$				546.3***	427.8***
				(111.0)	(103.6)
$PostInflux_{ct}^{1}$				577.0***	452.6***
				(121.6)	(114.0)
$PostInflux_{ct}^{2}$				673.2***	540.8***
				(155.4)	(145.2)
Controls		✓	✓		✓
State Fixed Effects			✓	✓	✓
Year Fixed Effects				✓	✓
Observations	4329	3975	3975	4329	3975

Notes: This table presents the estimated coefficient of interest corresponding to the treated group in the post-period across a series of regressions. In all specifications the outcome variable is wheat production (in thousands of bushels). Panel (A) is a simple difference-in-differences regression where a county is considered treated if at any point in time it has a share of Russian Germans that exceeds 0.25%. Panel (B) alternatively defines treatment status according to other non-zero thresholds, as reported in the *RG* superscript. Panel (C) uses a continuous treatment measure (the maximum share of Russian Germans in the county over the post-period). Panel (D) is a standard two-way fixed-effects model using the various definitions of treatment status as reported in the $PostInflux$ superscript. Column (1) reports the difference-in-differences model without any further controls or fixed effects. Column (2) adds county-level characteristics. Columns (3) and (5) add in, one-by-one, county and year fixed effects. Column (4) reports the TWFE model without controls. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

Table 2: Russian Germans and Wheat Cultivation in the US, Mechanisms

	Wheat Farmland (Acreage, Thousands)		Wheat Yield (Bushels per Acre)	
	(1)	(2)	(3)	(4)
$PostInflux^{0.25}_{it}$				
	35.5***	30.0***	14.8	17.4
	(5.2)	(5.6)	(13.1)	(15.2)
$PostInflux^{0.5}_{it}$				
	35.2***	29.4***	22.2	24.8
	(6.1)	(6.7)	(19.4)	(21.5)
$PostInflux^{1}_{it}$				
	39.8***	34.2***	4.7	5.9
	(7.2)	(7.8)	(13.3)	(13.2)
$PostInflux^{2}_{it}$				
	50.7***	45.2***	−7.2	−6.4
	(9.1)	(9.8)	(6.6)	(6.0)
Controls		✓		✓
State Fixed Effects	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓
Observations	3524	3501	3293	3293

Notes: This table presents the estimated coefficient of interest corresponding to the treated group in the post-period across a series of regressions. In specifications (1) and (2) the outcome variable is wheat acreage (in thousands of acres). In specifications (3) and (4) the outcome variable is wheat yield (in bushels per wheat acre). We employ a standard two-way fixed-effects model using the various definitions of treatment status as reported in the *PostInflux* superscript. Columns (1) and (3) include county and year fixed effects without controls. Columns (2) and (4) add in controls. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

Table 3: Russian Germans and Corn Cultivation in the US

	Corn Production (Bushels, Thousands)				
	(1)	(2)	(3)	(4)	(5)
Panel A.					
$RG_c^{0.25} \cdot Post_t$	-361.8***	-423.9***	-417.2***		-372.6***
	(82.6)	(92.0)	(108.6)		(109.6)
Panel B.					
$RG_c^{0.5} \cdot Post_t$	-338.4***	-382.0***	-381.8***		-341.2***
	(84.1)	(93.7)	(109.6)		(108.5)
$RG_c^{1} \cdot Post_t$	-334.4***	-423.9***	-395.1***		-345.5***
	(92.1)	(101.9)	(120.7)		(119.9)
$RG_c^{2} \cdot Post_t$	-308.1***	-397.0***	-371.4***		-317.4***
	(107.4)	(118.0)	(138.2)		(137.2)
Panel C.					
$RG_c^{Cont} \cdot Post_t$	-48.5***	-62.8***	-54.9***		-48.1***
	(8.4)	(9.7)	(10.1)	(11.8)	(9.7)
Panel D.					
$PostInflux_{ct}^{0.25}$				77.6	89.8
				(59.5)	(60.2)
$PostInflux_{ct}^{0.5}$				37.8	42.0
				(68.1)	(69.2)
$PostInflux_{ct}^{1}$				-7.1	-17.2
				(64.4)	(61.9)
$PostInflux_{ct}^{2}$				-5.9	-15.9
				(79.1)	(72.7)
Controls		✓	✓		✓
State Fixed Effects			✓	✓	✓
Year Fixed Effects				✓	✓
Observations	4336	3982	3982	4336	3982

Notes: This table presents the estimated coefficient of interest corresponding to the treated group in the post-period across a series of regressions. In all specifications the outcome variable is corn production (in thousands of bushels). Panel (A) is a simple difference-in-differences regression where a county is considered treated if at any point in time it has a share of Russian Germans that exceeds 0.25%. Panel (B) alternatively defines treatment status according to other non-zero thresholds, as reported in the RG superscript. Panel (C) uses a continuous treatment measure (the maximum share of Russian Germans in the county over the post-period). Panel (D) is a standard two-way fixed-effects model using the various definitions of treatment status as reported in the $PostInflux$ superscript. Column (1) reports the difference-in-differences model without any further controls or fixed effects. Column (2) adds county-level characteristics. Columns (3) and (5) add in, one-by-one, county and year fixed effects. Column (4) reports the TWFE model without controls. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

Figures

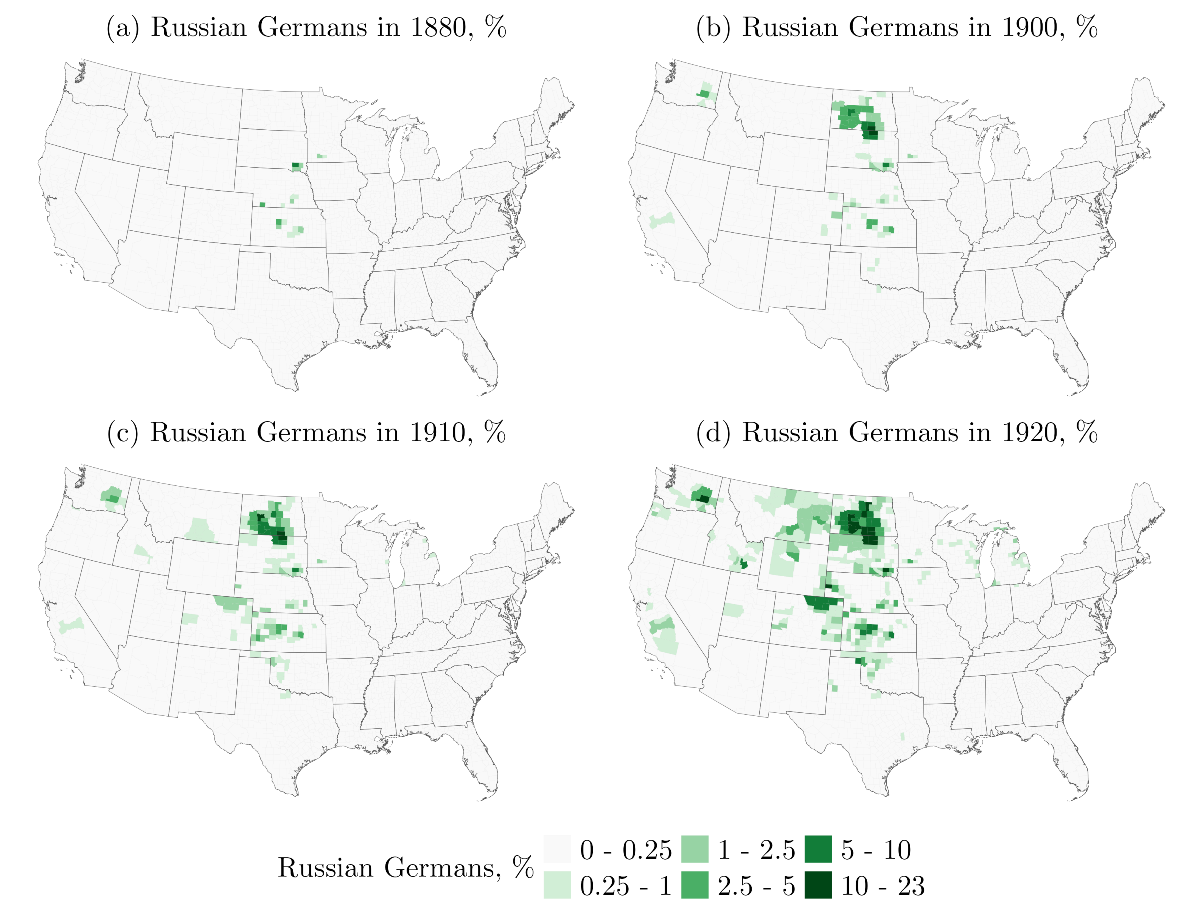
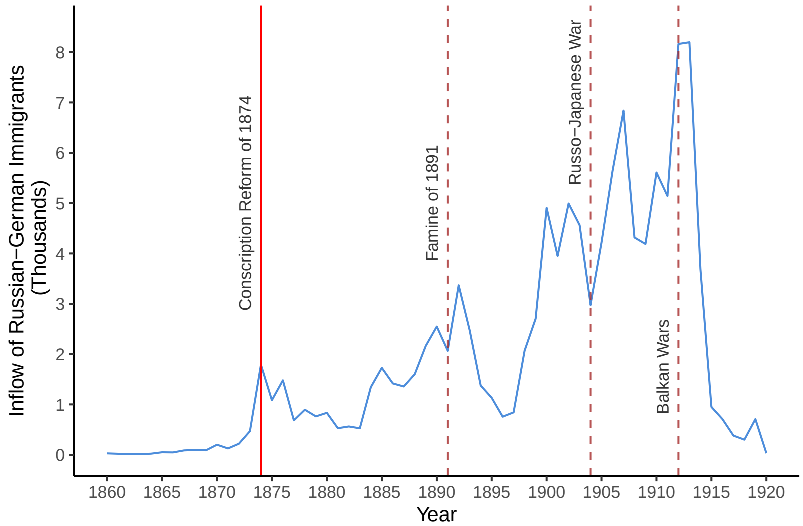


Figure 1: Russian German Settlement in the US, 1880-1920

Notes: This figure plots the share of each county's population that is Russian German in 1880 (Panel A), 1900 (Panel B), 1910 (Panel C), and 1920 (Panel D). For consistency, the unit of observation is a county defined by 1920 borders. For the sake of comparison, all maps have the same legend. Russian Germans were directly identified in the 1920 US Population Census, and then were identified in all previous censuses via census-to-census linking. There is no panel for 1890, as the full-count 1890 census is unavailable.

(a) Annual Inflow of Russian German Immigration



(b) Cumulative Russian German Immigration

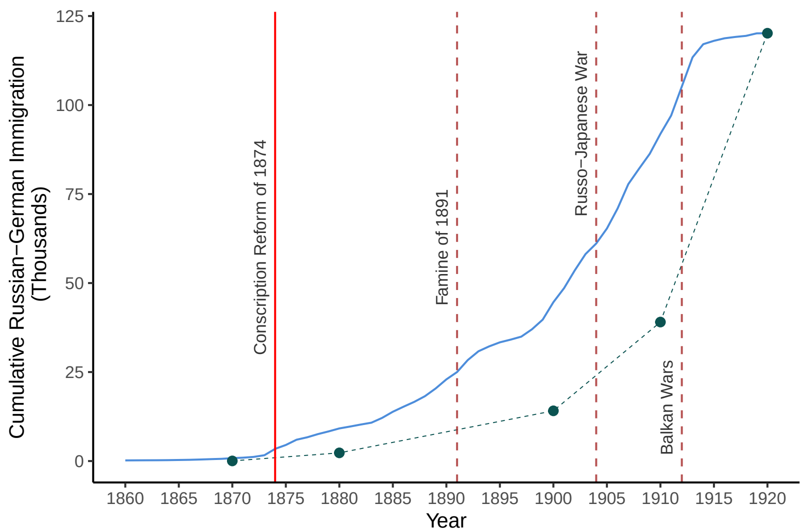


Figure 2: Timing of Russian German Immigration to the US, 1860-1920

Notes: Panel (A) is an *estimation* of the annual inflow of Russian German immigration to the US between 1860 and 1920. Panel (B) is an *estimation* of the total number of Russian Germans in the US between 1860 and 1920. These estimates are based on the sample of Russian Germans present in the US in 1920, and use the reported number of years that each has resided in the US. The black dots represent the number of Russian Germans that we have identified in the 1870, 1880, 1900, 1910, and 1920 censuses. Russian Germans are directly identified in the 1920 US Population Census, and then were identified in all previous censuses via census-to-census linking. The vertical line at 1874 represents the year of the conscription reform, that is, the first influx of Russian German immigration. The subsequent dashed vertical lines represent the other major push-factors: the 1891 famine, the start of the Russo-Japanese War in 1904, and the outbreak of the Balkan Wars in 1912.

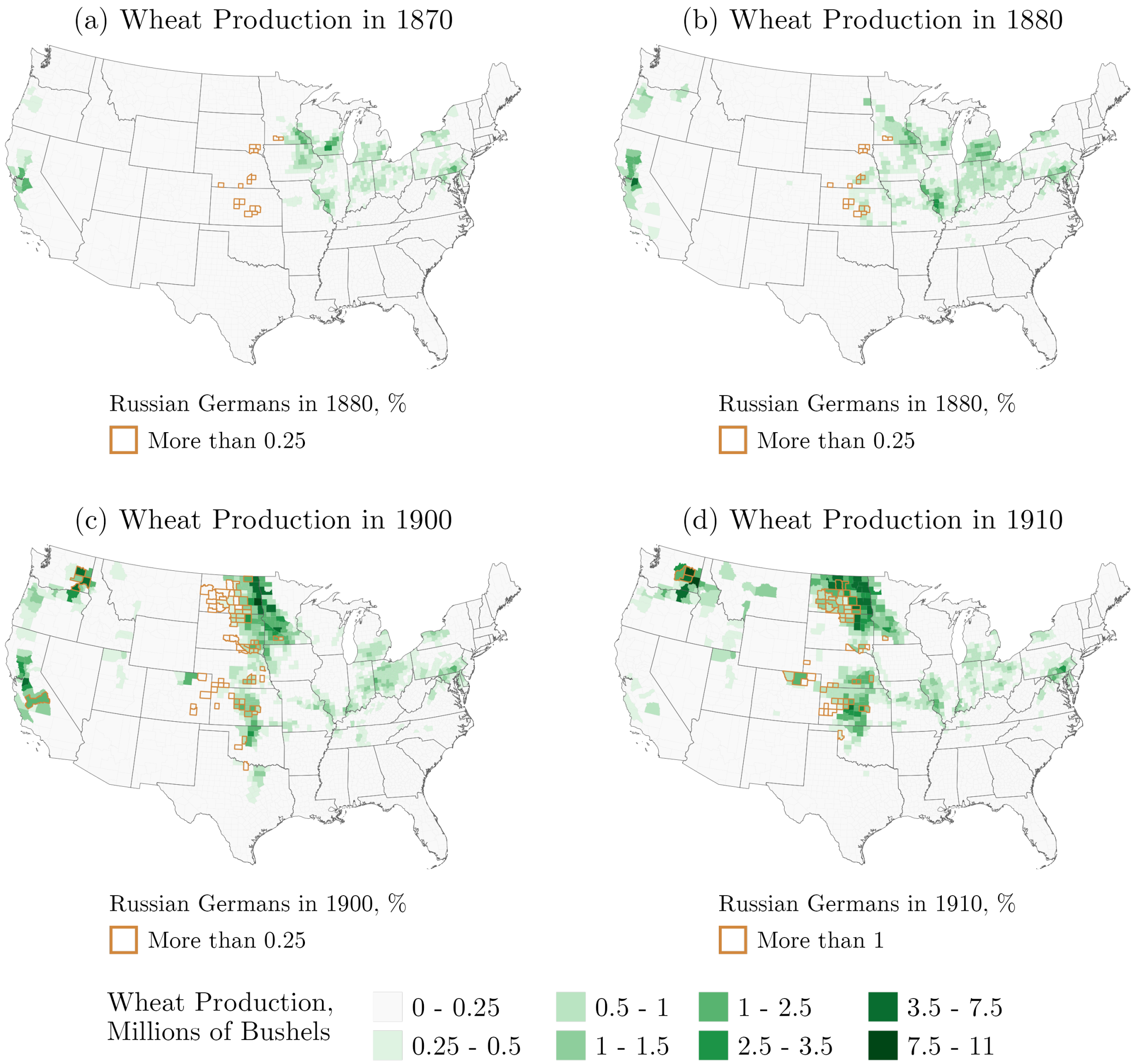


Figure 3: Russian German Settlement and Wheat Production in the US, 1870-1910

Notes: This figure plots the total production of wheat (in millions of bushels) in the US for 1870-1910. These data are from the US agricultural census. In Panels (A)-(C), a county is outlined in orange if the share of the county's population that is Russian German in that year is greater than 0.25%. (That is, the least restrictive threshold in our empirical analysis.) In Panel (D), a county is outlined in orange if the county's population that is Russian German in that year is greater than 1%. The threshold is larger in this panel in order to show that the highest concentrations of Russian Germans overlap with the highest concentrations of wheat production. As Russian Germans were not present in the US in 1870, Panel (A) includes 1880 settlement for reference. Our identification of Russian Germans is subject to census-to-census linking from 1920. For consistency, the unit of observation is a county defined by 1920 borders. For the sake of comparison, all maps have the same legend. There is no panel for 1890, as the full-count 1890 US Population Census is unavailable. There is no panel for 1920, as the 1920 US Agricultural Census does not include data on wheat production (in bushels).

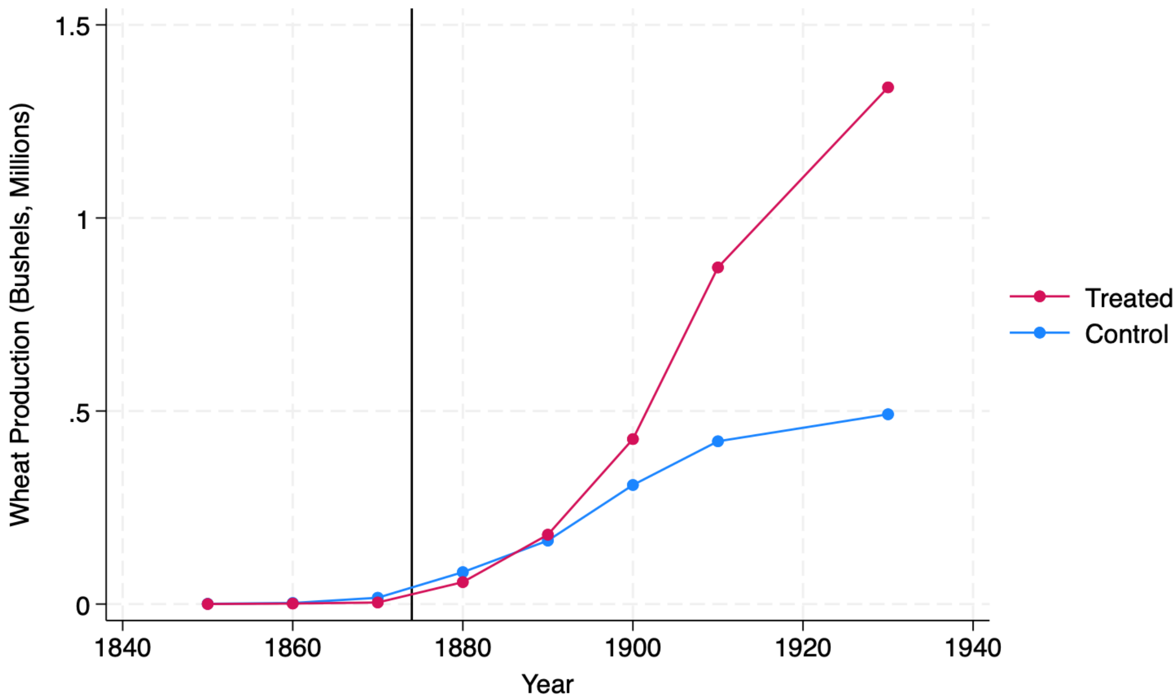


Figure 4: Wheat Production in the US, by Treatment Status, 1850-1930

Notes: This figure presents mean wheat production (in millions of bushels) in treated and control counties between 1850 and 1930. Treated counties are defined by our baseline strategy in Model 1. That is, we define a county to be treated if at any point in time it has a share of Russian German immigrants that exceeds 0.25%. Control counties are thus defined to be a county that at no point in time had a share of Russian German immigrants above this threshold. The vertical line at 1874 represents the initial influx of Russian German immigration. Data are at the decade-level and from the US agricultural census.

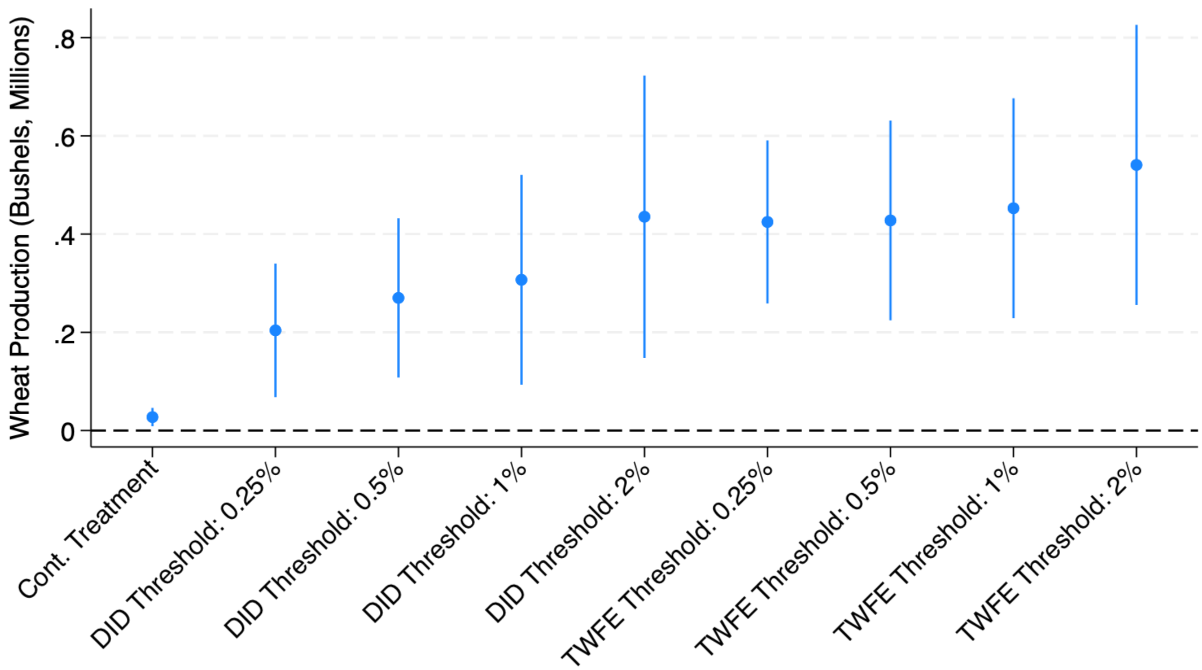
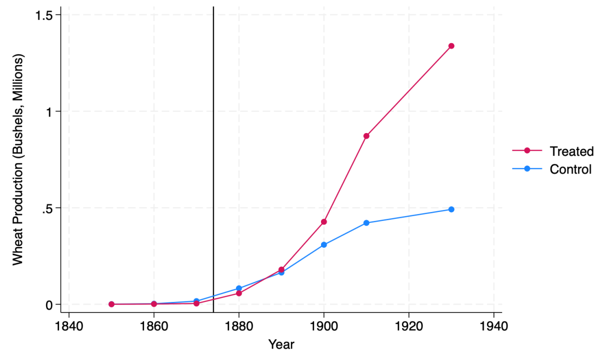


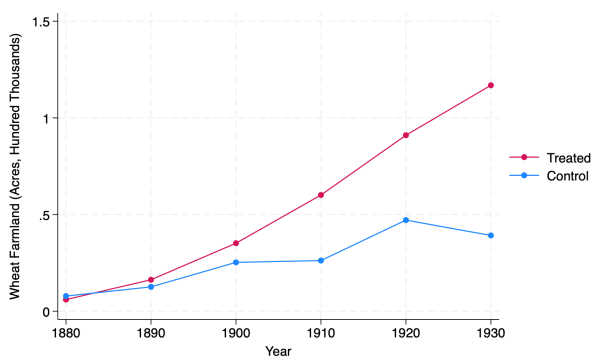
Figure 5: Russian Germans and Wheat Cultivation in the US

Notes: This figure presents the estimated coefficient of interest (and corresponding 95% confidence interval) for the treated group in the post-period across a series of regressions. In all specifications the outcome variable is wheat production (in millions of bushels). A series of controls, as well as county and year fixed effects are included. Standard errors are clustered at the county-level. "DID" refers to the basic difference-in-differences models presented in Equations 1 and 2. "Cont. Treatment" refers to the use of a continuous treatment measure as in Equation 3. "TWFE" refers to the two-way fixed-effects model presented in Equation 4.

(a) Wheat Production (Bushels, Millions)



(b) Wheat Farmland (Acres, Hundred Thousands)



(c) Wheat Production / Wheat Farmland

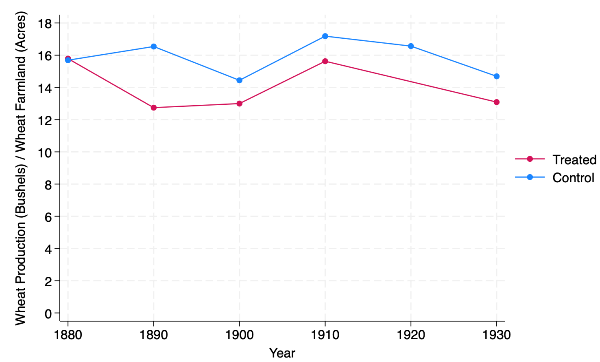


Figure 6: Wheat Cultivation in the US, by Treatment Status, 1850-1930

Notes: This figure presents mean wheat production (in millions of bushels) in Panel (A), mean wheat farmland (in hundred thousands of acres) in Panel (B), and mean yield of wheat cultivation (in bushels per wheat acre) in Panel (C). These are all plotted separately for treated and control counties. Treated counties are defined by our baseline strategy in Model 1. That is, we define a county to be treated if at any point in time it has a share of Russian German immigrants that exceeds 0.25%. Control counties are thus defined to be a county that at no point in time had a share of Russian German immigrants above this threshold. The dashed vertical line at 1874 represents the initial influx of Russian German immigrants. Data are at the decade-level and from the US agricultural census. Data for wheat farmland (in acres) are only available starting in 1880.

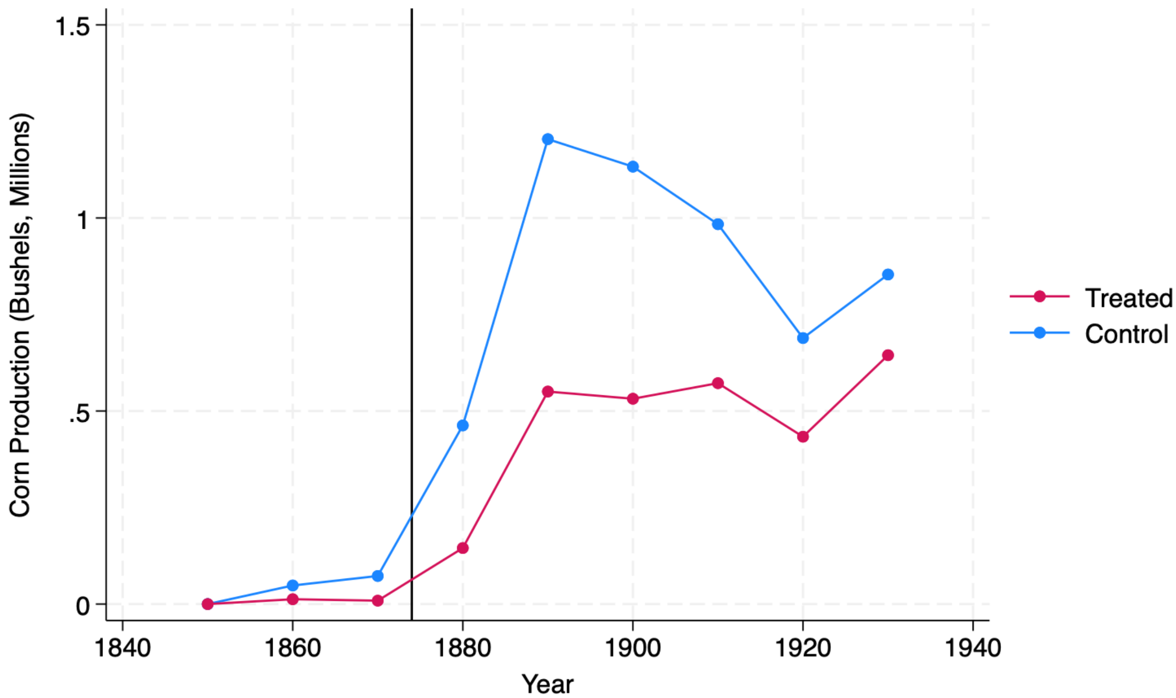


Figure 7: Corn Production in the US, by Treatment Status, 1850-1930

Notes: This figure presents mean corn production (in millions of bushels) in treated and control counties between 1850 and 1930. Treated counties are defined by our baseline strategy in Model 1. That is, we define a county to be treated if at any point in time it has a share of Russian German immigrants that exceeds 0.25%. Control counties are thus defined to be a county that at no point in time had a share of Russian German immigrants above this threshold. The vertical line at 1874 represents the initial influx of Russian German immigrants. Data are at the decade-level and from the US agricultural census.

A Appendix

A.1 Tables

Table A1: Crop Suitability, by State

State	(1) Share of Russian Germans, 1920 (%)	(2) Average Wheat Suitability	(3) Average Corn Suitability
North Dakota	4.39	52.45	42.09
South Dakota	1.63	67.17	52.11
Washington	0.73	31.48	2.42
Kansas	0.72	66.81	55.28
Colorado	0.71	21.21	5.57
Montana	0.60	41.02	7.28
Nebraska	0.53	71.90	60.40
Wyoming	0.47	32.23	4.35
Idaho	0.31	33.28	0.50
Oklahoma	0.21	64.30	50.31

Notes: This table includes the 10 states with the highest share of first-generation Russian Germans in terms of each state's total 1920 population. Data on the share of Russian Germans comes from the full-count 1920 US Population Census. Data on crop suitability comes from FAO GAEZ.

Table A2: Russian Germans and Wheat Cultivation in the US, Specification with 0.25% Treatment Threshold

	Wheat Production (Bushels, Thousands)			
	(1)	(2)	(3)	(4)
$Treated_c^{0.25}$	-7.0***	63.1*	429.6***	-0.7
	(1.5)	(35.6)	(63.9)	(81.5)
$Post_t$	322.7***	-275.6***	-363.4***	317.6***
	(26.8)	(45.9)	(50.3)	(82.9)
$Treated_c^{0.25} \cdot Post_t$	349.6***	223.8***	112.8***	204.0***
	(57.8)	(57.5)	(69.4)	(61.2)
Constant	10.0***	1,933***	4,222***	-907.0**
	(1.3)	(238.8)	(379.8)	(460.7)
Controls		✓	✓	✓
State Fixed Effects			✓	✓
Year Fixed Effects				✓
R^2	0.081	0.228	0.584	0.612
Observations	4329	3975	3975	3975

Notes: This table presents, for a series of specifications, each estimated coefficient. In all specifications, the outcome variable is wheat production (in thousands of bushels). A county is considered treated if at any point in time the county's share of Russian Germans exceeds 0.25%. Column (1) reports the simple difference-in-differences model without any further controls or fixed effects. Column (2) adds county-level characteristics. Columns (3) and (4) add in, one-by-one, county and year fixed effects. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

Table A3: Russian Germans and Wheat Cultivation in the US, Specification with 0.5% Treatment Threshold

	Wheat Production (Bushels, Thousands)			
	(1)	(2)	(3)	(4)
$Treated_c^{0.5}$	-6.1***	29.5	348.7***	-53.6
	(1.4)	(33.4)	(75.5)	(93.3)
$Post_t$	362.4***	-260.4***	-378.9 ***	314.8***
	(1.4)	(32.7)	(40.8)	(66.4)
$Treated_c^{0.5} \cdot Post_t$	350.4***	255.0***	207.8***	270.1***
	(68.6)	(68.4)	(82.3)	(82.6)
Constant	8.9***	1,991***	4,235***	945.0**
	(1.1)	(239.2)	(380.6)	(460.3)
Controls		✓	✓	✓
State Fixed Effects			✓	✓
Year Fixed Effects				✓
R^2	0.077	0.225	0.585	0.612
Observations	4329	3975	3975	3975

Notes: This table presents, for a series of specifications, each estimated coefficient. In all specifications, the outcome variable is wheat production (in thousands of bushels). A county is considered treated if at any point in time the county's share of Russian Germans exceeds 0.5%. Column (1) reports the simple difference-in-differences model without any further controls or fixed effects. Column (2) adds county-level characteristics. Columns (3) and (4) add in, one-by-one, county and year fixed effects. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

Table A4: Russian Germans and Wheat Cultivation in the US, Specification with 1% Treatment Threshold

	Wheat Production (Bushels, Thousands)			
	(1)	(2)	(3)	(4)
$Treated_c^1$	-6.2***	-35.3	184.9**	-126.2
	(1.5)	(33.4)	(89.7)	(105.4)
$Post_t$	396.6***	-232.4***	-366.2***	331.6***
	(25.5)	(43.6)	(46.2)	(81.6)
$Treated_c^1 \cdot Post_t$	364.0***	255.8***	249.7***	307.0***
	(89.7)	(88.6)	(106.5)	(108.8)
Constant	8.3***	2,038***	4,455***	1,034**
	(1.0)	(238.5)	(395.3)	(479.2)
Controls		✓	✓	✓
State Fixed Effects			✓	✓
Year Fixed Effects				✓
R^2	0.071	0.222	0.585	0.612
Observations	4329	3975	3975	3975

Notes: This table presents, for a series of specifications, each estimated coefficient. In all specifications, the outcome variable is wheat production (in thousands of bushels). A county is considered treated if at any point in time the county's share of Russian Germans exceeds 1%. Column (1) reports the simple difference-in-differences model without any further controls or fixed effects. Column (2) adds county-level characteristics. Columns (3) and (4) add in, one-by-one, county and year fixed effects. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

Table A5: Russian Germans and Wheat Cultivation in the US, Specification with 2% Treatment Threshold

	Wheat Production (Bushels, Thousands)			
	(1)	(2)	(3)	(4)
$Treated_c^2$	-5.4***	5.9	201.5*	-194.4
	(1.8)	(33.8)	(121.8)	(144.7)
$Post_t$	407.8***	-222.7***	-365.4***	337.0***
	(24.9)	(42.1)	(44.1)	(80.7)
$Treated_c^2 \cdot Post_t$	465.2***	359.6***	374.2***	435.2***
	(120.2)	(119.2)	(142.1)	(146.4)
Constant	7.9***	2,069***	3,299***	624.2**
	(0.9)	(239.6)	(316.9)	(377.0)
Controls		✓	✓	✓
State Fixed Effects			✓	✓
Year Fixed Effects				✓
R^2	0.076	0.224	0.586	0.613
Observations	4329	3975	3975	3975

Notes: This table presents, for a series of specifications, each estimated coefficient. In all specifications, the outcome variable is wheat production (in thousands of bushels). A county is considered treated if at any point in time the county's share of Russian Germans exceeds 2%. Column (1) reports the simple difference-in-differences model without any further controls or fixed effects. Column (2) adds county-level characteristics. Columns (3) and (4) add in, one-by-one, county and year fixed effects. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

Table A6: Russian Germans and Wheat Cultivation in the US, Specification with Continuous Treatment

	Wheat Production (Bushels, Thousands)			
	(1)	(2)	(3)	(4)
$Treated_c^{cont}$	-0.8***	-2.6	141.3***	32.6*
	(0.2)	(2.9)	(14.6)	(18.7)
$Post_t$	424.6***	-197.9***	-343.5***	351.8***
	(27.3)	(33.5)	(40.1)	(83.5)
$Treated_c^{cont} \cdot Post_t$	40.5***	28.5***	21.3**	27.4***
	(9.1)	(9.1)	(9.0)	(9.5)
Constant	8.1***	2,077***	3,882***	864.3**
	(0.9)	(243.3)	(357.2)	(432.0)
Controls		✓	✓	✓
State Fixed Effects			✓	✓
Year Fixed Effects				✓
R^2	0.062	0.213	0.584	0.611
Observations	4329	3975	3975	3975

Notes: This table presents, for a series of specifications, each estimated coefficient. In all specifications, the outcome variable is wheat production (in thousands of bushels). The treatment measure is continuous, defined by the maximum share of Russian Germans present in a county between 1880 and 1930. Column (1) reports the simple difference-in-differences model without any further controls or fixed effects. Column (2) adds county-level characteristics. Columns (3) and (4) add in, one-by-one, county and year fixed effects. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

Table A7: Russian Germans and Wheat Cultivation in the US, Sun and Abraham HTE-Robust Estimator

	Wheat Production (Bushels, Thousands)	
	(1)	(2)
Lag_{50}	-277.2***	-198.1**
	(78.9)	(90.9)
Lag_{40}	-296.7***	-166.8**
	(71.4)	(80.8)
Lag_{30}	-253.2***	-257.0***
	(69.9)	(82.6)
Lag_{20}	-340.7***	-336.0***
	(60.0)	(65.5)
Lag_{10}	-283.8***	-284.8***
	(48.3)	(47.0)
$Lead_{10}$	155.1***	102.1*
	(53.0)	(51.9)
$Lead_{20}$	463.3***	442.9***
	(95.4)	(97.2)
$Lead_{30}$	382.9***	379.0***
	(98.9)	(99.7)
Controls		✓
State Fixed Effects	✓	✓
Year Fixed Effects	✓	✓
R^2	0.62	0.65
Observations	4329	3975

Notes: This table presents the estimation of dynamic treatment effects using the interaction weighted (IW) estimator proposed by Sun and Abraham (2021). The outcome variable for this two-way fixed-effects event study specification is wheat production (in thousands of bushels), and the regression includes 5 lags and 3 leads. The control group is defined to be counties that were never treated. Column (2) adds a series of county-level controls. Year and county fixed effects are included. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

Table A8: Russian Germans and Buckwheat Cultivation in the US

	Buckwheat Production (Bushels)				
	(1)	(2)	(3)	(4)	(5)
Panel A.					
$RG_c^{0.25} \cdot Post_t$	10.0	-95.6	-132.6		-173.1*
	(64.6)	(76.0)	(102.4)		(95.1)
Panel B.					
$RG_c^{0.5} \cdot Post_t$	27.9	-45.7	-66.5		-97.2
	(62.6)	(65.1)	(85.6)		(82.2)
$RG_c^{1} \cdot Post_t$	7.6	-99.8*	-126.6*		-159.5**
	(50.2)	(58.6)	(72.9)		(71.0)
$RG_c^{2} \cdot Post_t$	45.6	-69.5	-86.5		-121.9*
	(53.8)	(62.6)	(75.5)		(73.7)
Panel C.					
$RG_c^{Cont} \cdot Post_t$	3.9	-12.4*	-11.3		-15.4**
	(5.2)	(7.0)	(7.3)		(7.3)
Panel D.					
$PostInflux_{ct}^{0.25}$				-85.7	-178.0
				(119.5)	(128.1)
$PostInflux_{ct}^{0.5}$				-23.9	-92.1
				(120.8)	(127.5)
$PostInflux_{ct}^{1}$				-40.4	-101.0
				(103.7)	(105.2)
$PostInflux_{ct}^{2}$				28.8	-12.4
				(119.5)	(121.6)
Controls		✓	✓		✓
State Fixed Effects			✓	✓	✓
Year Fixed Effects				✓	✓
Observations	4336	3982	3982	3982	3982

Notes: This table presents the estimated coefficient of interest corresponding to the treated group in the post-period across a series of regressions. In all specifications the outcome variable is buckwheat production (in bushels). Panel (A) is a simple difference-in-differences regression where a county is considered treated if at any point in time it has a share of Russian Germans above 0.25%. Panel (B) alternatively defines treatment status according to other non-zero thresholds, as reported in the *RG* superscript. Panel (C) uses a continuous treatment measure (the maximum share of Russian Germans in the county over the post-period). Panel (D) is a standard two-way fixed-effects model using the various definitions of treatment status as reported in the $PostInflux$ superscript. Column (1) reports the difference-in-differences model without any further controls or fixed effects. Column (2) adds county-level characteristics. Columns (3) and (5) add in, one-by-one, county and year fixed effects. Column (4) reports the TWFE model without controls. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

Table A9: Germans and Wheat Cultivation in the US

	Wheat Production (Bushels, Thousands)				
	(1)	(2)	(3)	(4)	(5)
Panel A.					
$RG_c^3 \cdot Post_t$	126.7**	-86.2	-18.9		90.0*
	(49.7)	(57.6)	(62.5)		(53.2)
Panel B.					
$RG_c^{Cont} \cdot Post_t$	6.8	-7.7*	-10.4**		1.0
	(4.7)	(4.1)	(4.7)		(4.5)
Panel C.					
$PostInflux_{ct}^3$				0.000	0.000
				(.)	(.)
Controls		✓	✓		✓
State Fixed Effects			✓	✓	✓
Year Fixed Effects				✓	✓
Observations	4329	3975	3975	3975	3975

Notes: This table presents the estimated coefficient of interest corresponding to the treated group in the post-period across a series of regressions. In all specifications the outcome variable is wheat production (in bushels). Panel (A) is a simple difference-in-differences regression where a county is considered treated if at any point in time it has a share of *German* immigrants above 3%. Panel (B) uses a continuous treatment measure (the maximum share of German immigrants in the county over the post-period). Panel (C) is a standard two-way fixed-effects model using the same treatment definition as in Panel (A). Column (1) reports the simple difference-in-differences model without any further controls or fixed effects. Column (2) adds county-level characteristics. Columns (3) and (5) add in, one-by-one, county and year fixed effects. Column (4) reports the TWFE model without controls. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

Table A10: Russian Germans and Wheat Cultivation in the US, Specification with Control Counties *Not* Adjacent to Treated

	Wheat Production (Bushels, Thousands)				
	(1)	(2)	(3)	(4)	(5)
Panel A.					
$RG_c^{0.25}$	510.1***	315.5***	153.5**		203.7***
	(56.4)	(53.6)	(67.6)		(66.5)
Panel B.					
$RG_c^{0.5} \cdot Post_t$	503.6***	364.2***	280.3***		314.9***
	(67.0)	(64.2)	(77.5)		(77.6)
$RG_c^{1} \cdot Post_t$	490.2***	346.0***	323.4***		355.3***
	(89.2)	(87.0)	(103.9)		(106.0)
$RG_c^{2} \cdot Post_t$	551.6***	421.2***	432.0***		471.4***
	(120.2)	(118.6)	(141.5)		(145.5)
Panel C.					
$RG_c^{Cont} \cdot Post_t$	37.2***	28.9***	20.7**		274.3**
	(9.5)	(9.7)	(101.8)		(106.5)
Panel D.					
$PostInflux_{ct}^{0.25}$				565.4***	475.6***
				(87.7)	(85.7)
$PostInflux_{ct}^{0.5}$				623.7***	553.9***
				(99.0)	(101.8)
$PostInflux_{ct}^{1}$				621.2***	562.1***
				(99.8)	(113.0)
$PostInflux_{ct}^{2}$				664.7***	613.5***
				(125.7)	(145.7)
Controls		✓	✓		✓
State Fixed Effects			✓	✓	✓
Year Fixed Effects				✓	✓

Notes: This table presents the estimated coefficient of interest corresponding to the treated group in the post-period across a series of regressions. In all specifications the outcome variable is wheat production (in thousands of bushels). Panel (A) is a simple difference-in-differences regression where a county is considered treated if at any point in time it has a share of Russian Germans above 0.25%. Panel (B) alternatively defines treatment status according to other non-zero thresholds. Panel (C) uses a continuous treatment measure (the maximum share of Russian Germans in the county over the post-period). Panel (D) is a standard two-way fixed-effects model using the various definitions of treatment status. Control groups are restricted to untreated counties *not* adjacent to treated counties. Column (1) reports the simple difference-in-differences model without any further controls or fixed effects. Column (2) adds county-level characteristics. Columns (3) and (5) add in, one-by-one, county and year fixed effects. Column (4) reports the TWFE model without controls. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

Table A11: Russian Germans and Wheat Cultivation in the US, Specification with Zero Influx to Control Counties

	Wheat Production (Bushels, Thousands)				
	(1)	(2)	(3)	(4)	(5)
Panel A.					
$RG_c^{0.25} \cdot Post_t$	609.6***	434.2***	257.7***		485.8***
	(57.6)	(117.6)	(125.9)		(83.5)
Panel B.					
$RG_c^{0.5} \cdot Post_t$	650.1***	421.3***	328.2**		558.2***
	(68.7)	(127.9)	(132.7)		(95.7)
$RG_c^{1} \cdot Post_t$	698.0***	397.4***	379.4***		611.8***
	(90.2)	(143.1)	(149.0)		(124.3)
$RG_c^{2} \cdot Post_t$	810.4***	449.4***	453.3**		703.5***
	(121.1)	(165.0)	(174.1)		(167.4)
Panel C.					
$RG_c^{Cont} \cdot Post_t$	40.5***	28.5***	21.3**		27.4***
	(9.1)	(9.1)	(9.0)		(9.5)
Panel D.					
$PostInflux_{ct}^{0.25}$				518.2***	406.5***
				(93.4)	(84.7)
$PostInflux_{ct}^{0.5}$				528.0***	410.2***
				(111.2)	(103.7)
$PostInflux_{ct}^{1}$				558.7***	435.3***
				(121.6)	(114.1)
$PostInflux_{ct}^{2}$				655.5***	524.0***
				(155.3)	(145.2)
Controls		✓	✓		✓
State Fixed Effects			✓	✓	✓
Year Fixed Effects				✓	✓

Notes: This table presents the estimated coefficient of interest corresponding to the treated group in the post-period across a series of regressions. In all specifications the outcome variable is wheat production (in bushels). Panel (A) is a simple difference-in-differences regression where a county is considered treated if at any point in time it has a share of Russian Germans above 0.25%. Panel (B) alternatively defines treatment status according to other non-zero thresholds. Panel (C) uses a continuous treatment measure (the maximum share of Russian Germans in the county over the post-period). Panel (D) is a standard two-way fixed-effects model using the various definitions of treatment status. Control groups are restricted to counties that *never* have a positive share of Russian Germans. Column (1) reports the simple difference-in-differences model without any further controls or fixed effects. Column (2) adds county-level characteristics. Columns (3) and (5) add in, one-by-one, county and year fixed effects. Column (4) includes county and year fixed effects without controls, that is, the base case for the TWFE model. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

Table A12: Russian Germans and Wheat Cultivation in the US, Specifications with Robustness to Treatment Definition

	Wheat Production (Bushels, Thousands)	
	(1)	(2)
$RG^{Cont}_{ct} \cdot Post_{ct}$	103.5***	85.3***
	(21.8)	(20.6)
Controls		✓
State Fixed Effects	✓	✓
Year Fixed Effects	✓	✓
Observations	4329	3975

Notes: This table presents the estimated coefficient of interest corresponding to the treated group in the post-period across a series of regressions. In all specifications the outcome variable is wheat production (in thousands of bushels). Panel (A) is a standard two-way fixed-effects model with continuous treatment defined by the share of a county's population that is Russian German at time t. Both columns include county and year fixed effects, and Column (2) additionally adds controls. Standard errors are clustered at the county-level and shown in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$

A.2 Figures

(a) Germans in 1897, %　　　　(b) Steppe Land Cover, %

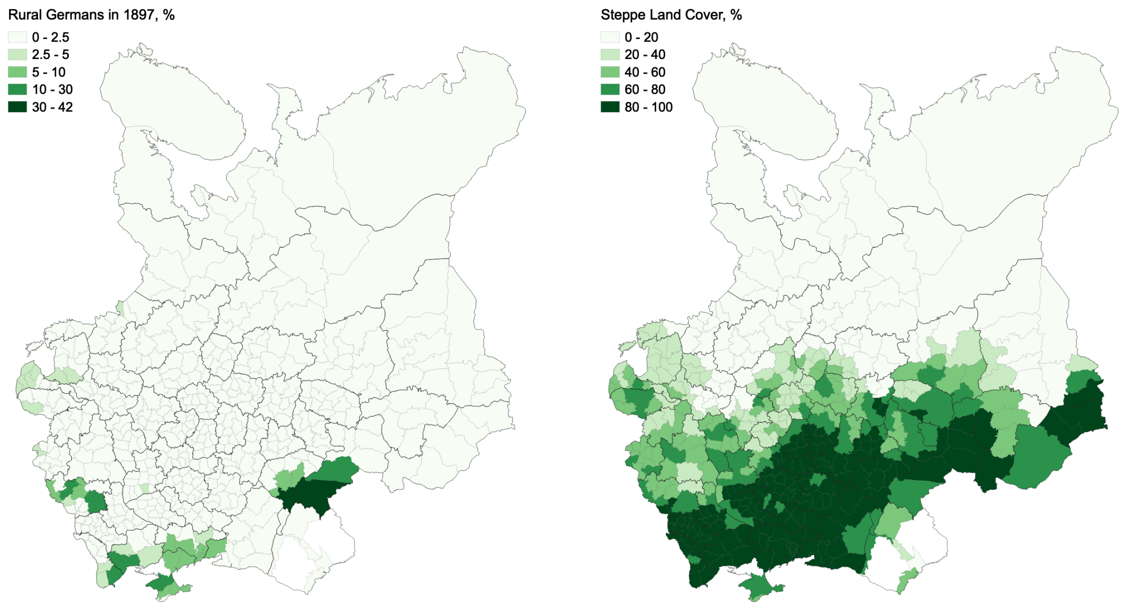
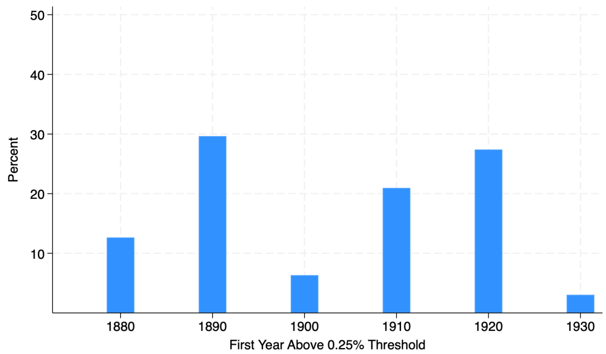


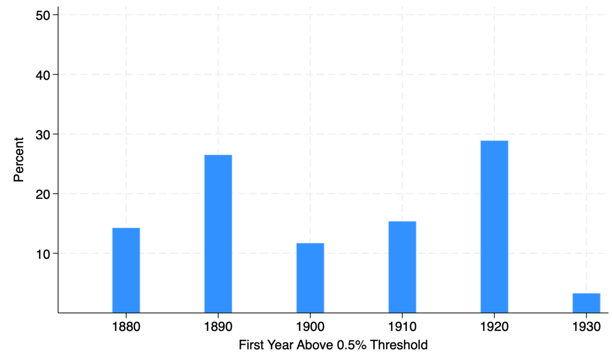
Figure A1: German Settlement and the Geo-Climatic Environment of the Russian Empire

Notes: These maps of the Russian Empire show the unconditional spatial distributions of (a) the German population and (b) steppe land cover. Population data come from the 1897 Imperial Census and land cover data are constructed from Shaver et al. (2019). Gray lines represent district (*uezd*) boundaries and black lines represent provincial (*gubernia*) boundaries. For reference, the Black Sea is directly below the southern-most part of the Empire and the Baltic Sea is on the western coast of the central Empire.

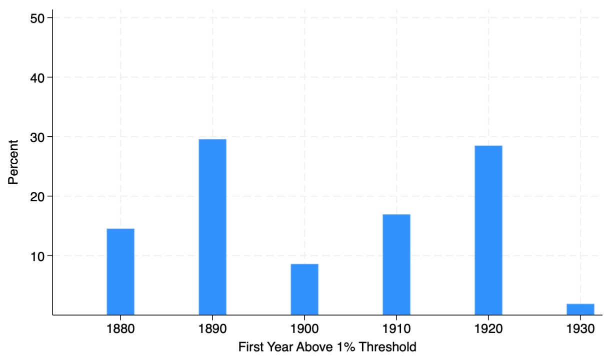
(a) 0.25% Treatment Threshold



(b) 0.5% Treatment Threshold



(c) 1% Treatment Threshold



(d) 2% Treatment Threshold

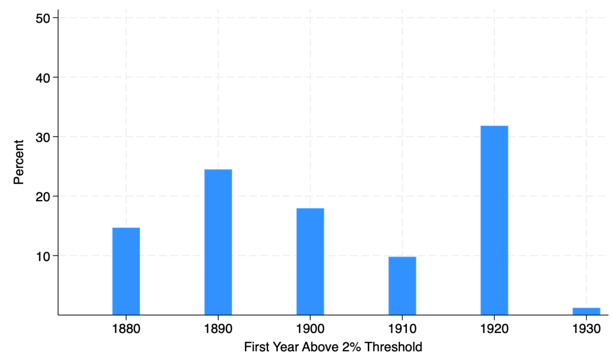


Figure A2: Staggered Adoption Timing

Notes: This figure plots the share of counties in our sample that had a Russian German population exceed the threshold to be considered treated in each year. Panel (A) reports the adoption distribution for the 0.25% treatment threshold, Panel (B) for the 0.5% treatment threshold, Panel (C) the 1% treatment threshold, and Panel (D) the 2% threshold. The total number of treated counties in each panel is as follows: (a) 230, (b) 165, (c) 113, and (d) 76. Russian Germans are directly identified in the 1920 US Population Census, and are identified in all previous censuses via census-to-census linking.

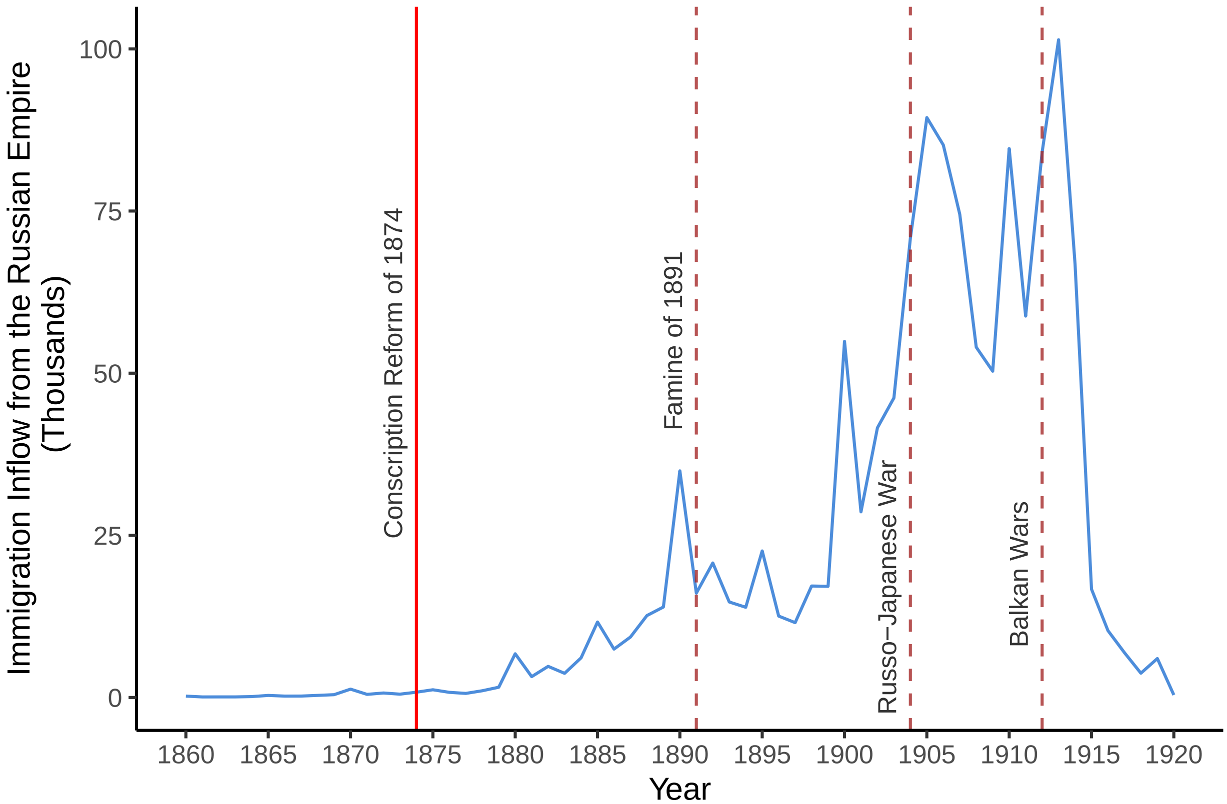


Figure A3: Timing of Russian Immigration to the US, 1860-1920

Notes: This figure is an *estimation* of the annual inflow of immigrants from the Russian Empire to the US between 1860 and 1920. We restrict the sample to those who do *not* report German as their mother tongue. These estimates are based on the sample of Russians present in the US in 1920, and use the reported number of years that each has resided in the US. The vertical line at 1874 represents the year of the conscription reform, that is, the first influx of *Russian German* immigrants. The subsequent dashed vertical lines represent the other major push-factors for *Russian Germans*: the 1891 famine, the start of the Russo-Japanese War in 1904, and the outbreak of the Balkan Wars in 1912.

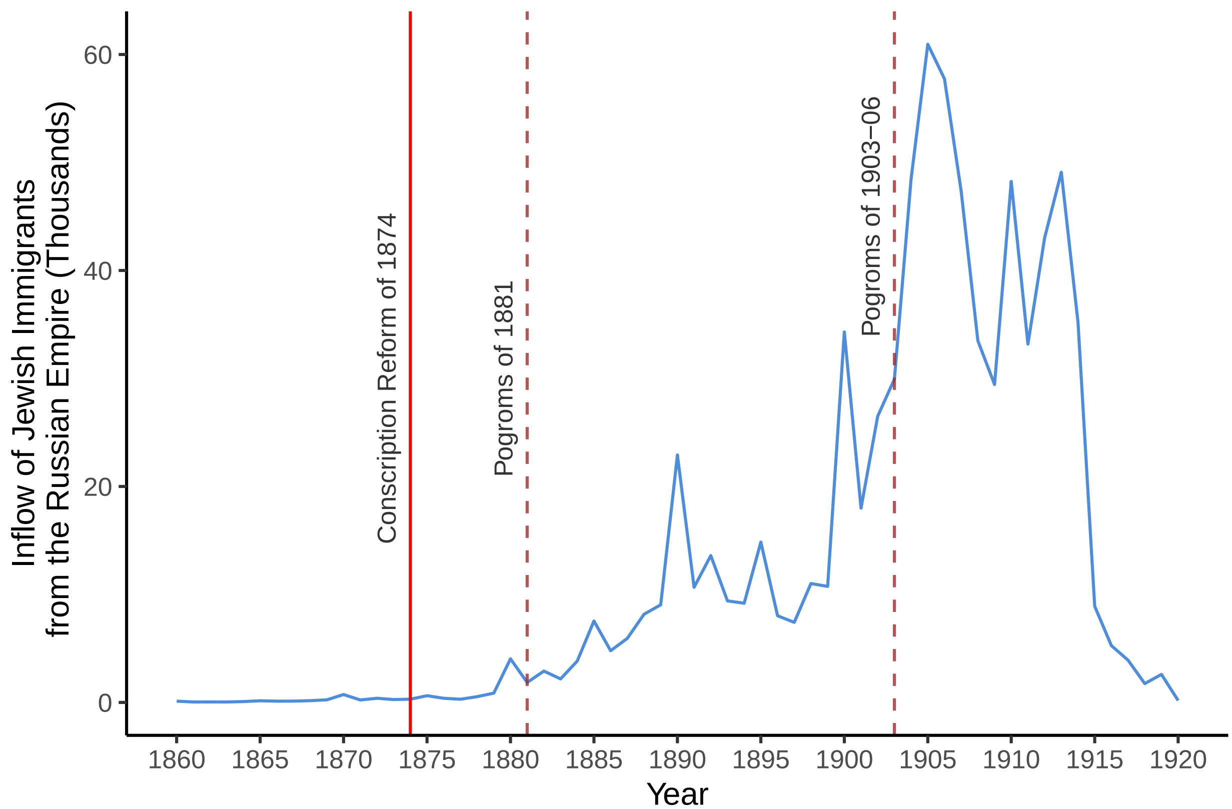


Figure A4: Timing of Jewish Immigration from the Russian Empire to the US, 1860-1920

Notes: This figure is an *estimation* of the annual inflow of Jewish immigration from the Russian Empire to the US between 1860 and 1920. These estimates ares based on the sample of Russian Jews present in the US in 1920, and use the reported number of years that each has resided in the US. We identify Russian Jews by selecting the subset of immigrants from Russia who report Hebrew or Yiddish as their mother tongue. The vertical line at 1874 represents the year of the conscription reform, that is, the first influx of *Russian German* immigrants. The subsequent dashed vertical lines represent the other major *Russian Jew* push-factors: the pogroms of 1881 and 1903-1906.

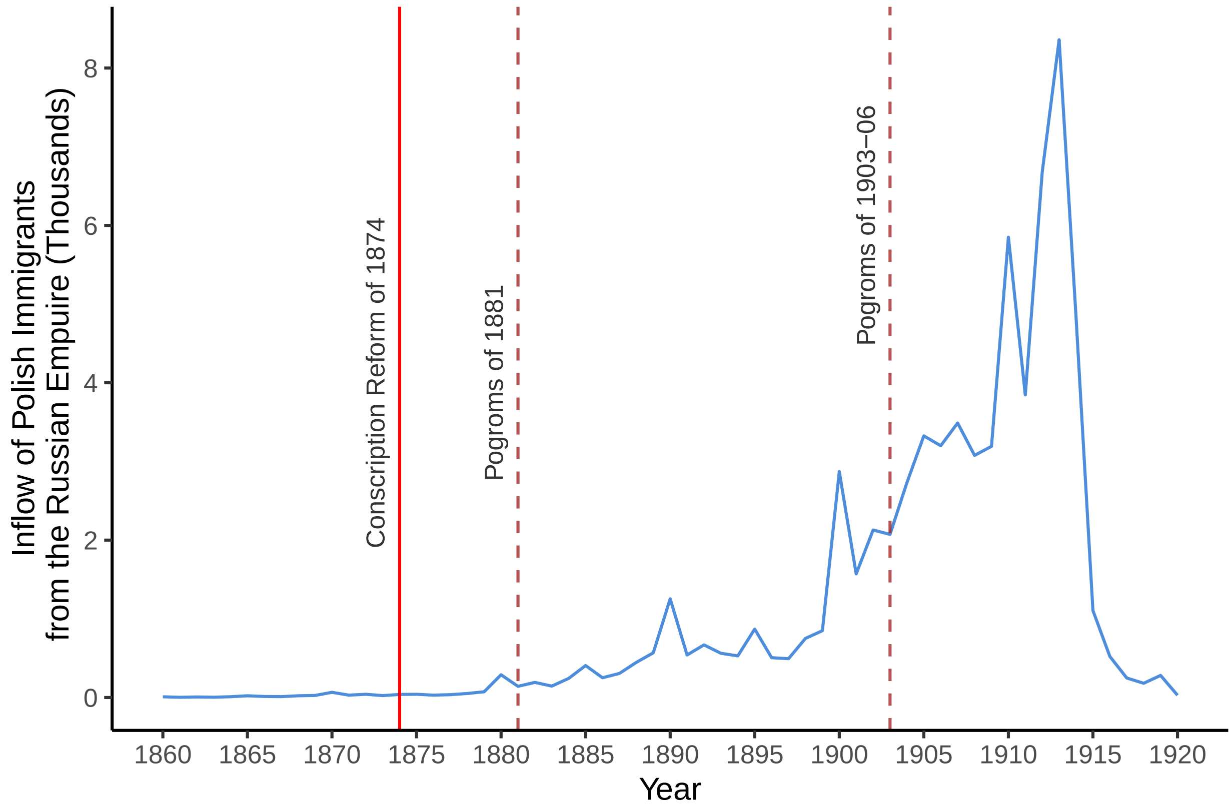


Figure A5: Timing of Polish Immigration from the Russian Empire to the US, 1860-1920

Notes: This figure is an *estimation* of the annual inflow of Polish immigration from the Russian Empire to the US between 1860 and 1920. These estimates are based on the sample of Russian Poles present in the US in 1920, and use the reported number of years that each has resided in the US. We identify Russian Poles by selecting the subset of immigrants from Russia who report Polish as their mother tongue. The vertical line at 1874 represents the year of the conscription reform, that is, the first influx of *Russian German* immigrants. The subsequent dashed vertical lines represent the other major *Russian Jew* push-factors: pogroms of 1881 and 1903-1906.

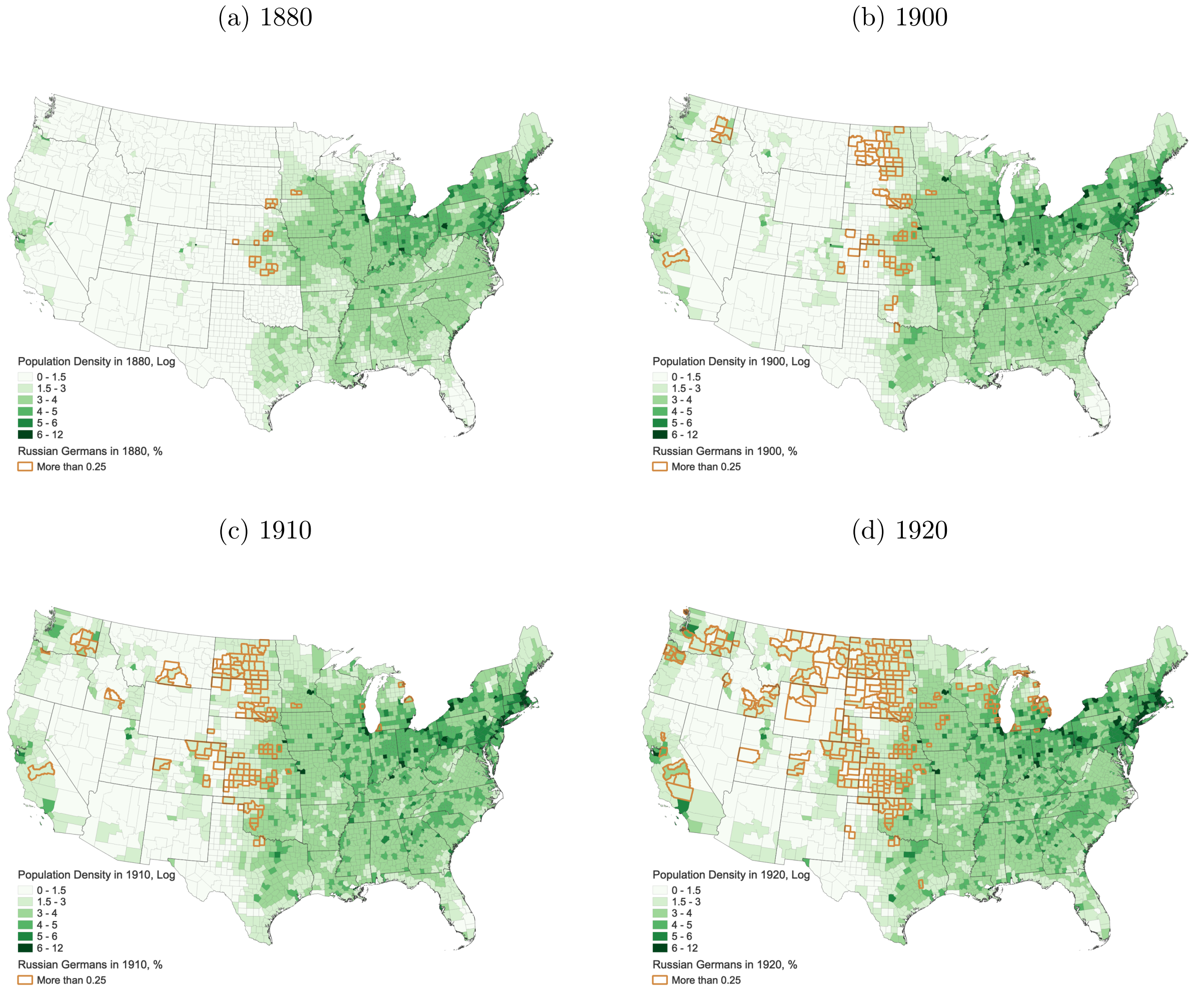
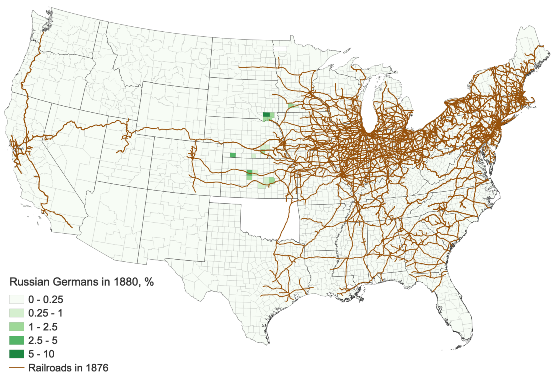


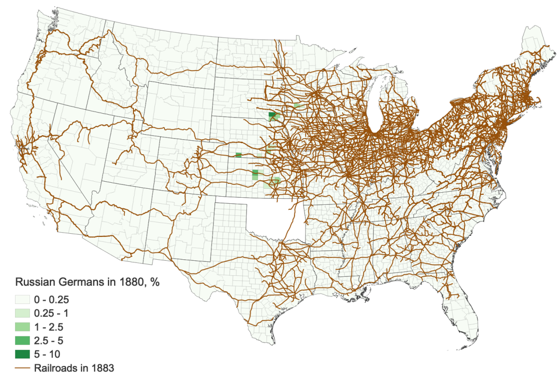
Figure A6: Russian German Settlement in the US and Population Density, 1880-1920

Notes: This figure plots the population density in each US county in 1880 (Panel A), 1900 (Panel B), 1910 (Panel C), and 1920 (Panel D). A county is outlined in orange if the share of the county's population that is Russian German in that year is greater than 0.25%. (That is, the least restrictive threshold in our empirical analysis.) Data on population density are from the US population census. Russian Germans were directly identified in the 1920 US Population Census, and then were identified in all previous censuses via census-to-census linking. For consistency, the unit of observation is a county defined by 1920 borders. For the sake of comparison, all maps have the same legend. There is no panel for 1890, as the full-count 1890 census is unavailable.

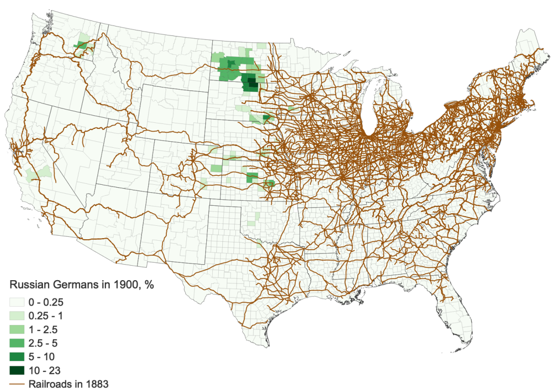
(a) 1880 Settlement, 1876 Railroads



(b) 1880 Settlement, 1883 Railroads



(c) 1900 Settlement, 1883 Railroads



(d) 1900 Settlement, 1898 Railroads

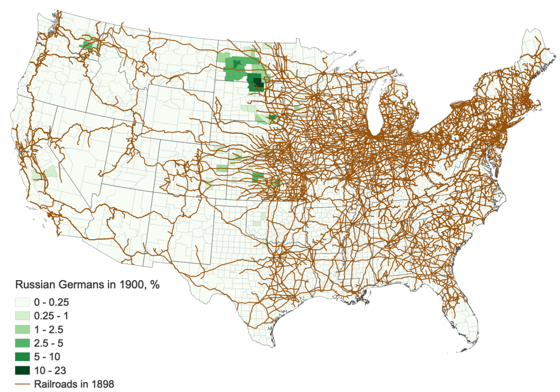


Figure A7: Russian German Settlement in the US and Railroad Connectivity, 1880-1900

Notes: These figures plot the share of each county's population that is Russian German in 1880 (Panels A and B) and 1900 (Panels B and C). Panel (A) overlays the railroad network as of 1876, Panels (B) and (C) show the railroad network as of 1883, and Panel (D) includes the railroad network as of 1898. Data on railroad networks come from Sequeira et al. (2020). Russian Germans were directly identified in the 1920 US Population Census, and then were identified in all previous censuses via census-to-census linking. For consistency, the unit of observation is a county defined by 1920 borders. For the sake of comparison, all maps have the same legend.

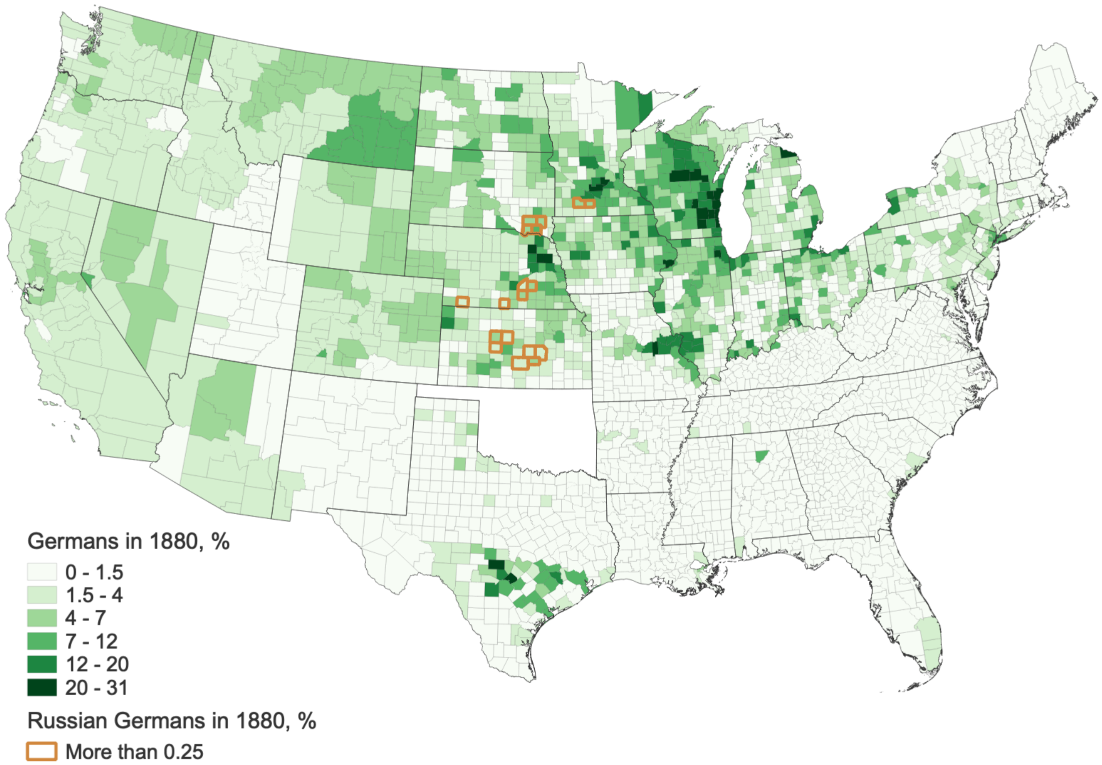
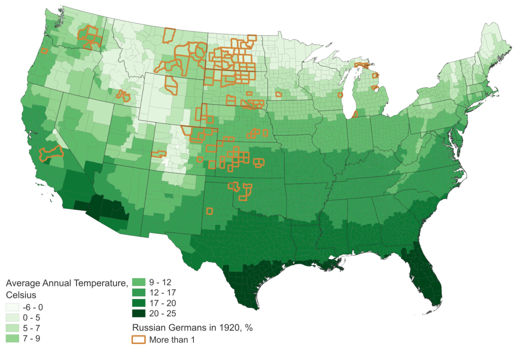


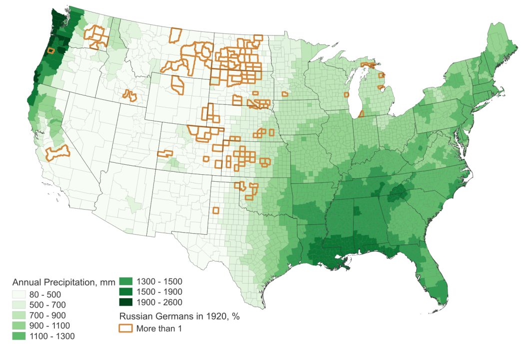
Figure A8: German and Russian German Settlement in the US, 1880

Notes: This figure plots the share of each county's population that is German as of the 1880 US Population Census. A county is outlined in orange if the share of the county's 1880 population that is Russian German is greater than 0.25%. (That is, the least restrictive threshold in our empirical analysis.) Our identification of Germans in the 1880 census is direct, but our identification of Russian Germans is subject to census-to-census linking from 1920. For consistency, the unit of observation is a county defined by 1920 borders. For the sake of comparison, all maps have the same legend.

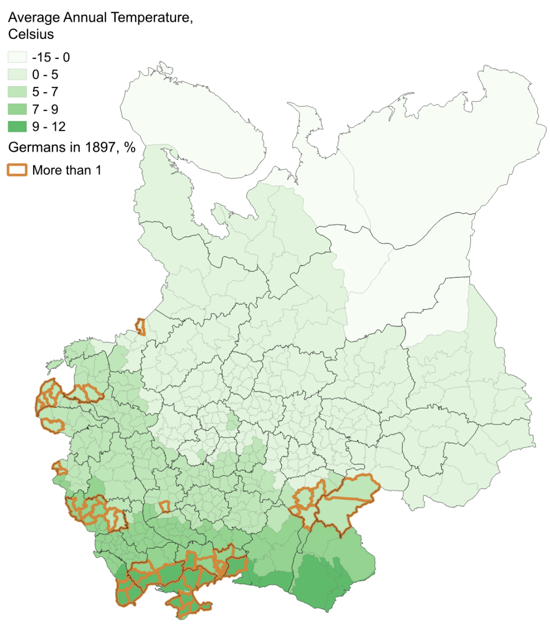
(a) Temperature, US



(b) Precipitation, US



(c) Temperature, Russian Empire



(d) Precipitation, Russian Empire

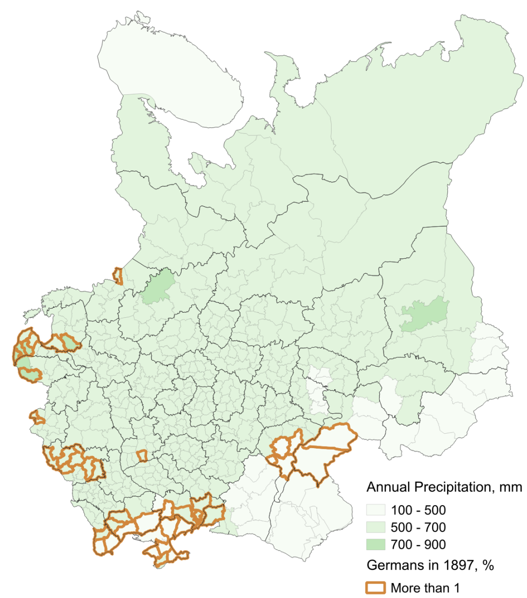


Figure A9: Russian German Immigration to the US and Climate Matching

Notes: Panels (A) and (B) show the mean county-level precipitation and temperature, respectively, for the US. Panels (C) and (D) show the same, at the district-level, for the Russian Empire. Data are annual averages over the 1960-1990 period and are from WorldClim.

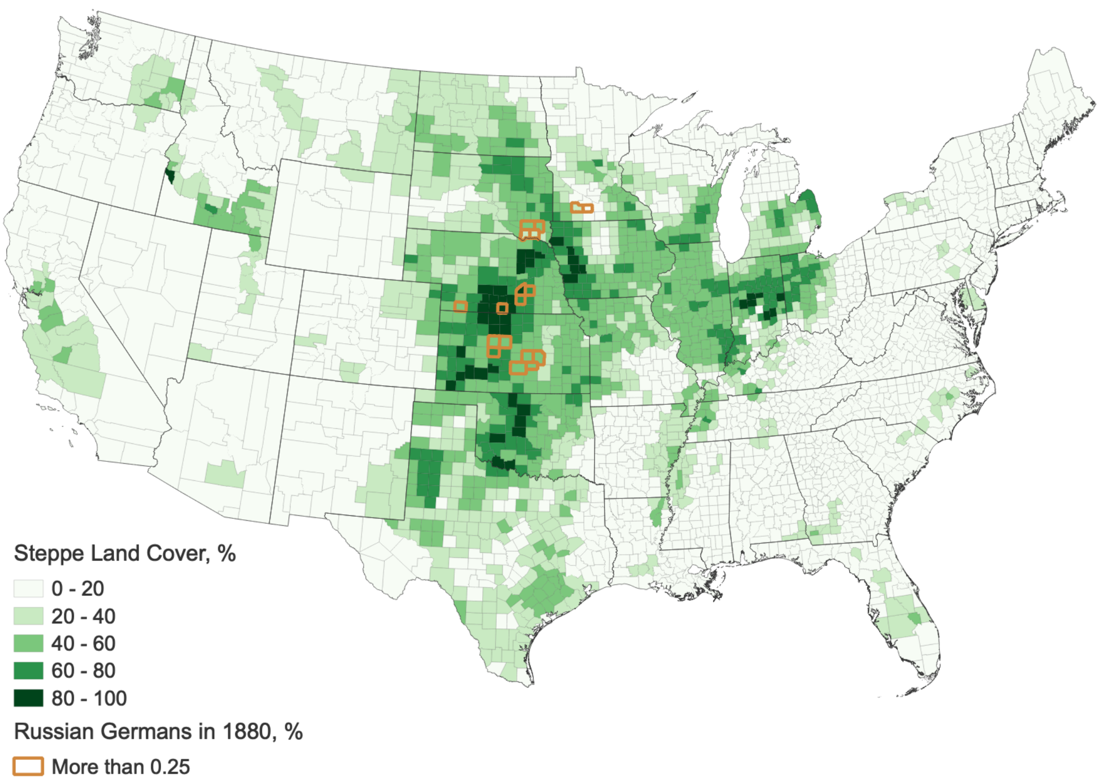


Figure A10: Steppe Land Cover in the US

Notes: This map plots the spatial distribution of steppe land cover across US counties. Land cover data are from Shaver et al. (2019). A county is outlined in orange if the share of the county's 1880 population that is Russian German is greater than 0.25%. (That is, the least restrictive threshold in our empirical analysis.) Our identification of Russian Germans in 1880 is subject to census-to-census linking. The unit of observation is a county defined by 1920 borders.

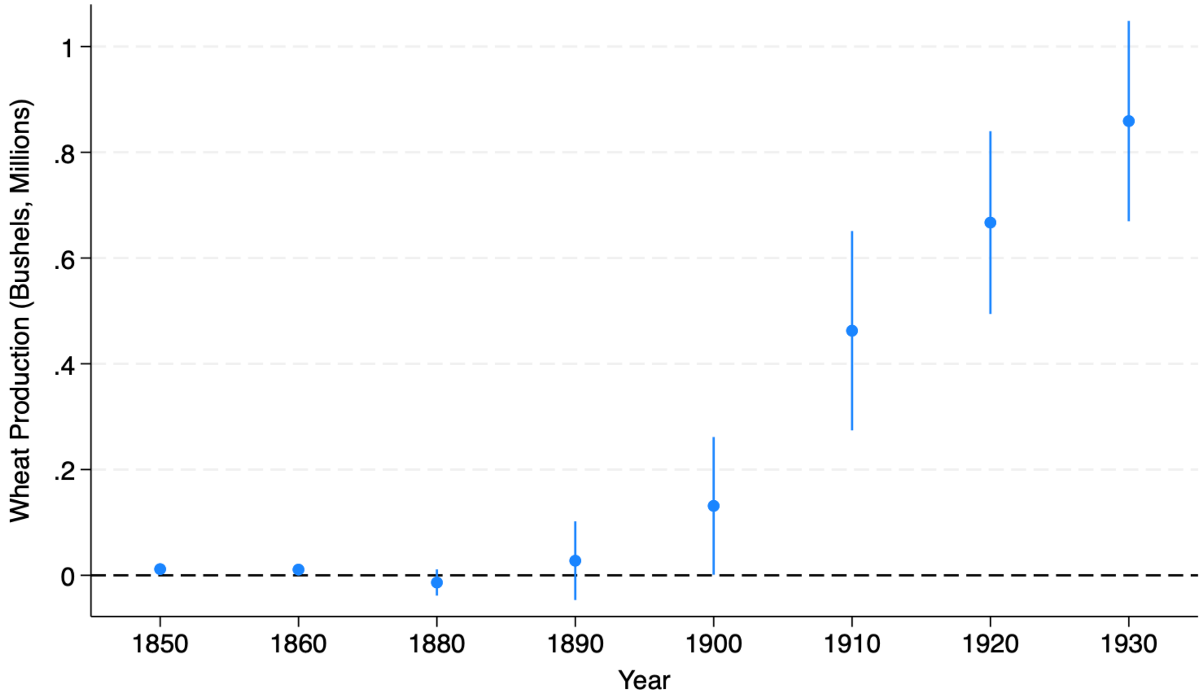


Figure A11: Placebo Exercise for Parallel Trends Assumption

Notes: This figure presents the estimated coefficients of interest (and their corresponding 95% confidence intervals) for the treated group in each period. We regress our outcome variable (wheat production, in millions of bushels), on pairwise interactions between our treatment indicator and year-specific dummy variables. A county is considered treated if at any point in time it has a share of Russian Germans above 0.25%. For completeness, the regression also includes the treatment indicator and year fixed effects. The coefficients of each pairwise interaction are shown in the figure, along with their 95% confidence intervals. 1870, the year immediately prior to the transition into the treatment phase, is omitted for comparison. This is the typical practice.

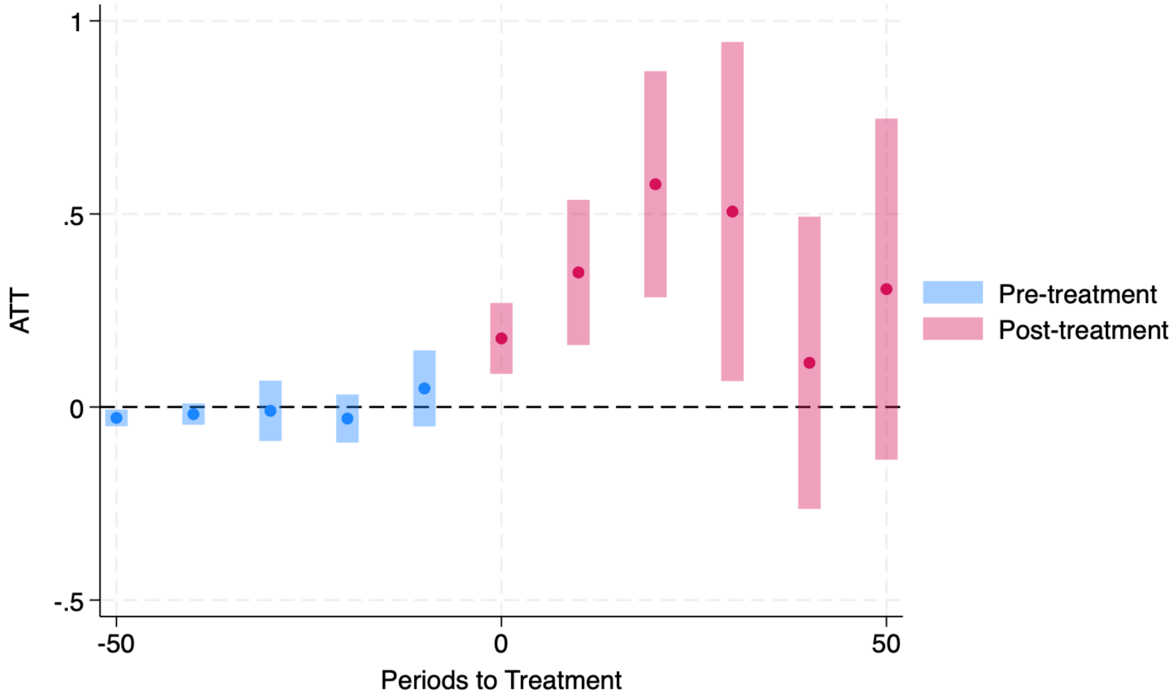


Figure A12: Dynamic Treatment Effects Using HTE-Robust Estimator

Notes: This figure presents the estimation of dynamic treatment effects and their accompanying 95% confidence intervals using the heterogeneous treatment effect robust estimator proposed in Callaway and Sant'Anna (2021). The outcome variable for this two-way fixed effects event study specification is wheat production (in millions of bushels). The control group is defined to be counties that were never treated. Year and county fixed effects are included, as well as a series of county-level controls.

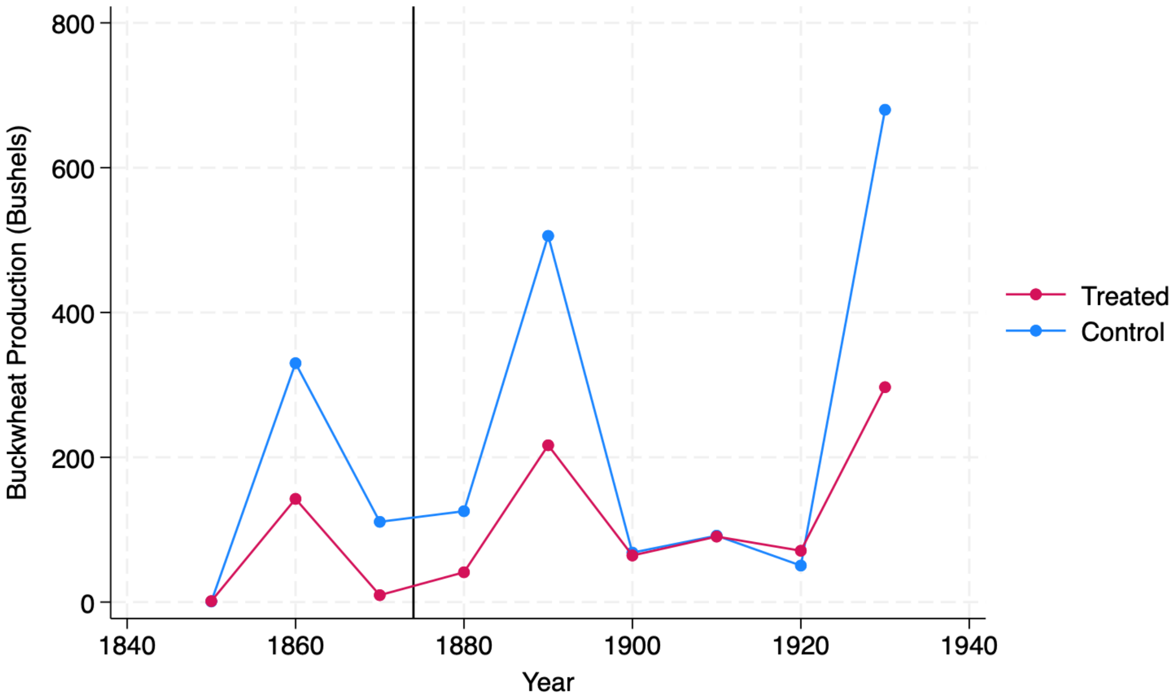


Figure A13: Buckwheat Production in the US, by Treatment Status, 1850-1930

Notes: This figure presents mean buckwheat production (in bushels) in treated and control counties between 1850 and 1920. Treated counties are defined by our baseline strategy in Model 1. That is, we define a county to be treated if at any point in time it has a share of Russian German immigrants that exceeds 0.25%. Control counties are thus defined to be a county that at no point in time had a share of Russian German immigrants above this threshold. The vertical line at 1874 represents the initial influx of Russian German immigration. Data are at the decade-level and from the US agricultural census.

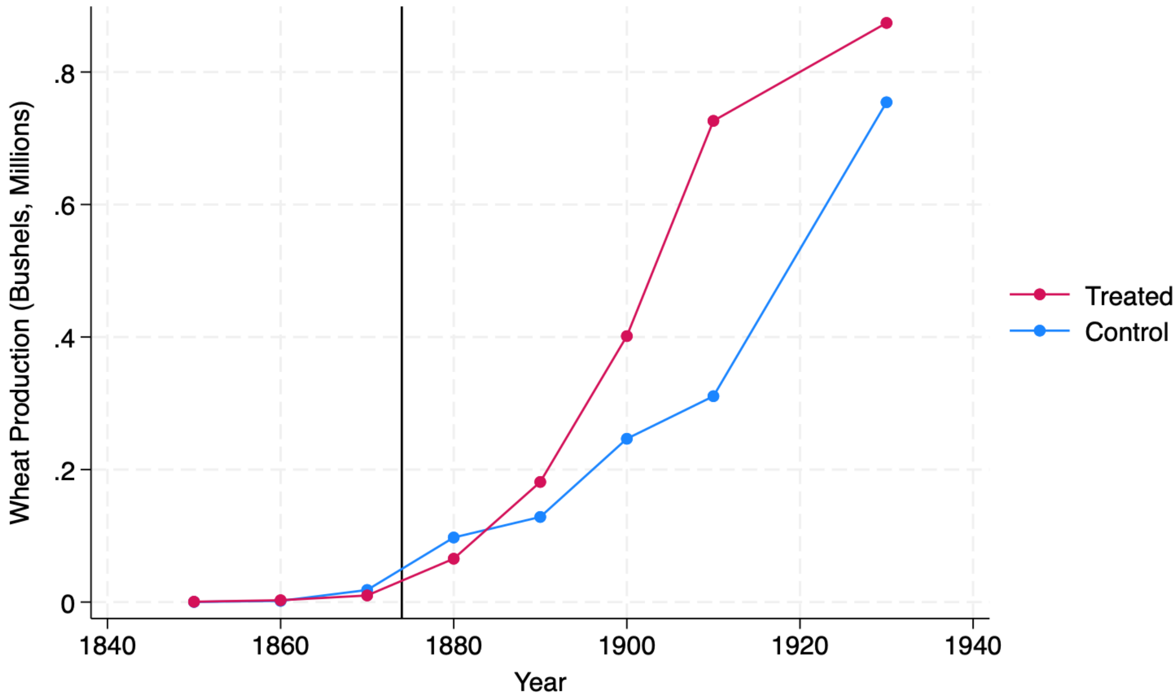


Figure A14: Wheat Production in the US, by German Treatment Status, 1850-1930

Notes: This figure presents mean wheat production (in millions of bushels) in treated and control counties between 1850 and 1930. We define a county to be treated if at any point in time it has a share of *German* immigrants that exceeds 3%. Control counties are thus defined to be a county that at no point in time had a share of German immigrants above this threshold. The vertical line at 1874 represents the initial influx of Russian German immigration. Data are at the decade-level and from the US agricultural census.

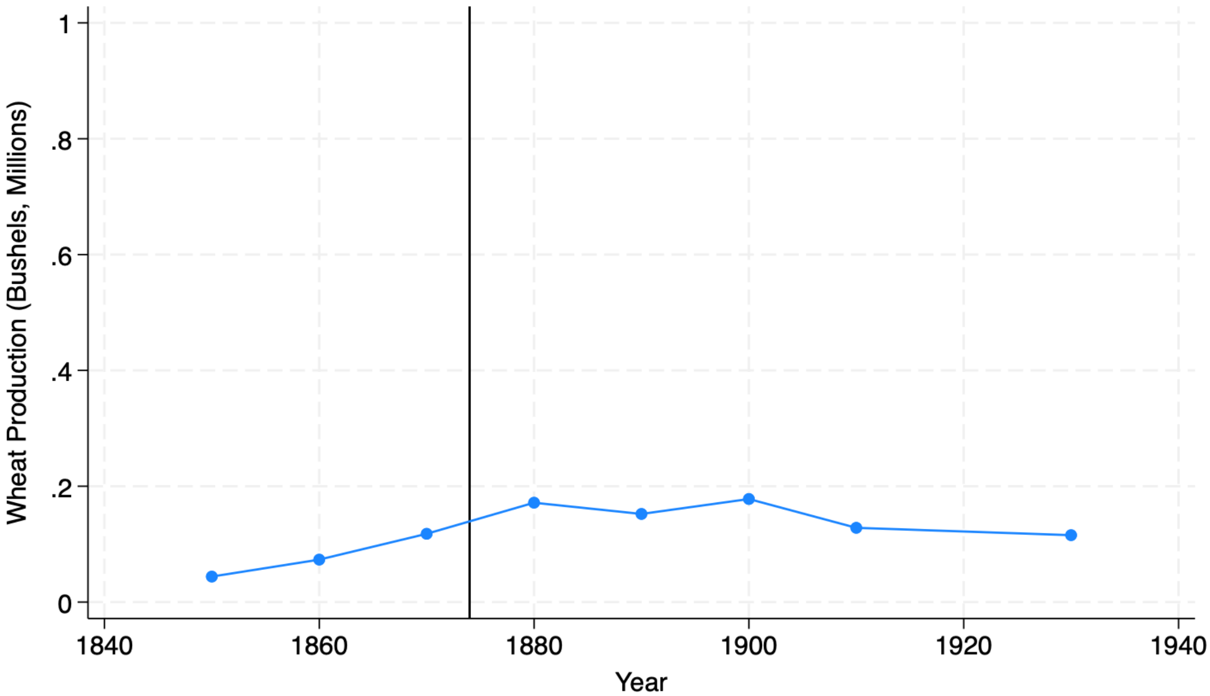


Figure A15: Wheat Production in the US, Outside of Restricted Sample, 1850-1930

Notes: This figure presents, for each year, the mean wheat production (in millions of bushels) in all counties of the US *excluding* our restricted sample. That is, all US counties *not* in the following 10 states: Colorado, Idaho, Kansas, Oklahoma, Montana, Nebraska, North Dakota, South Dakota, Washington, and Wyoming. The vertical line at 1874 represents the initial influx of Russian German immigration. Data are at the decade-level and from the US agricultural census.

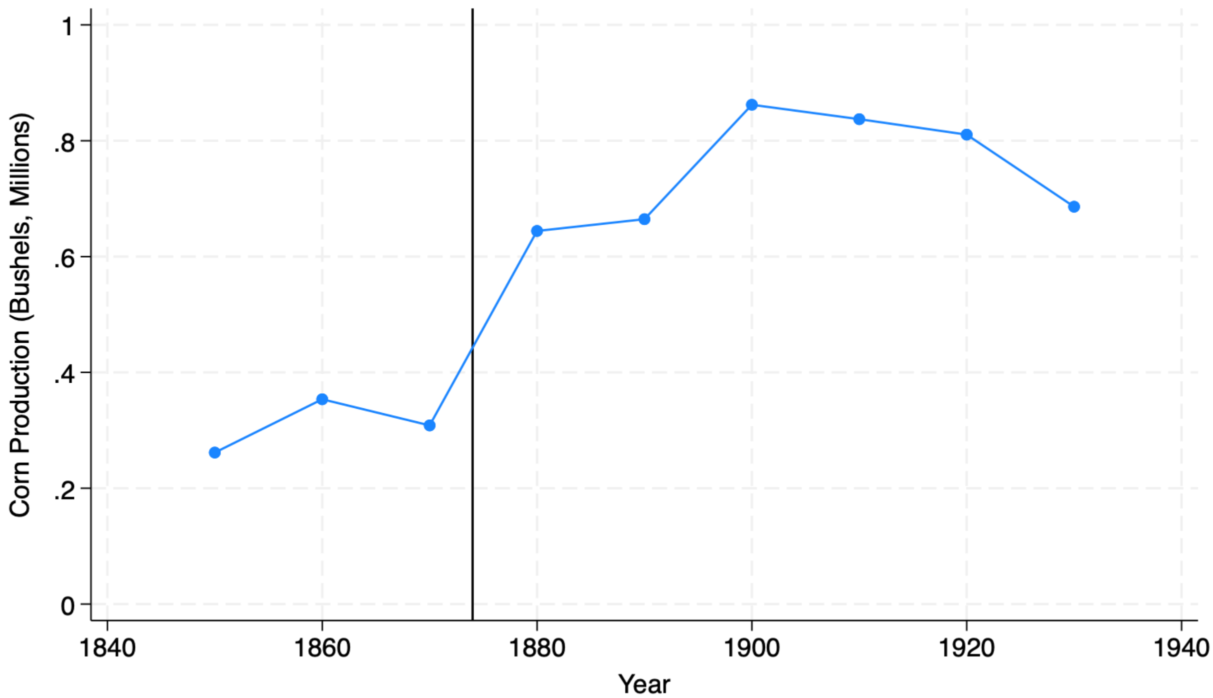


Figure A16: Corn Production in the US, Outside of Restricted Sample, 1850-1930

Notes: This figure presents mean corn production (in millions of bushels) in all counties of the US *excluding* our restricted sample. That is, all US counties *not* in the following 10 states: Colorado, Idaho, Kansas, Oklahoma, Montana, Nebraska, North Dakota, South Dakota, Washington, and Wyoming. The vertical line at 1874 represents the initial influx of Russian German immigration. Data are at the decade-level and from the US agricultural census.