Does Moving Kill? The Effect of Migration on Older-Age Mortality

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Abstract

Migration and its effects on both migrants and non-migrants has been a focus of social, demographic, and economic research in both developed and developing countries. A major problem faced by all researchers studying the effects of migration is the tendency of migrants to differ from non-migrants on many important characteristics. This paper employs an instrumental variables strategy and a unique source of data to estimate the causal impact of long-distance migration on mortality over age 65. To do so, we consider individuals born in the states of North Dakota, South Dakota, and Montana over the period 1916-1927. This group migrated out of these three rural states at a very high rate, and the vast majority migrated out of the area before the age of 40. We show that migrants have systematically higher education and earnings than non-migrants, two characteristics shown in the literature to increase longevity. To control for the selection on these characteristics as well as other, unobserved ones, we instrument for migration using distance of an individual's place of birth from a railroad line. Our results show that given that one has reached age 65, migrating out of these three states reduces the probability of living to age 75 by 16% compared to those who remain in their area of origin. This finding has implications for countries currently experiencing high internal migration as well as for research investigating the causal relationship between education and health.

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1 Introduction

Migration and its effects on both migrants and non-migrants has been a focus of social, demographic, and economic research in both developed and developing countries. Previous research has focused primarily on employment and earnings returns to migration (Greenwood, 1997). However, regardless of the outcome considered, a major difficulty faced by all researchers studying migration is the tendency of migrants to be different on many important characteristics than non-migrants, characteristics that often influence the outcome of interest. This selective nature of migration has long been acknowledged. Marshall (1948) remarks on English internal migration that "the large towns and especially London absorb the very best blood from all the rest of England; the most enterprising, the most highly gifted, those with the highest physique and strongest characters go there to find scope for their abilities." As Marshall indicates, the usual direction of this selection is positive, meaning that if a researcher wants to isolate the causal effect of migration, she must find a way to control for the fact that migrants on average have underlying characteristics that would result in them having better outcomes than non-migrants, even if they did not migrate. Recognition of this selection bias has made its way into studies of migration and health through formulation of the "healthy migrant" hypothesis, which states that migrants are on average healthier than non-migrants in their origin areas.[1]

This paper attempts to isolate the causal effect of migration on health by estimating the effect of migration on the old-age longevity of internal migrants in the United States. To control for the fact that the individuals who choose to migrate are likely different from non-migrants on characteristics that could affect old-age mortality, we use an instrumental

[1]The healthy migrant hypothesis stems primarily from the observation that Hispanic immigrants in the United States have relatively low rates of mortality compared to non-Hispanics (Sorlie et al., 1993; Palloni and Morenoff, 2001), although it has also emerged in studies of Turkish immigrants in Germany (Razum et al., 1998). Other work has also documented positive health selection of internal migrants in Indonesia (Lu, 2008, 2010). Halliday and Kimmitt (2008) find that for men under age 60 in the United States, a movement from the middle to the bottom of the health distribution reduces geographical mobility by 32-40 percent.

variables strategy. Our instrument for migration is the distance of one's place of birth to a railroad. We are able to leverage this instrument due to our unique data source containing exact place of birth information. We find that given that one has reached the age of 65, migrating out of the three states of North Dakota, South Dakota, and Montana reduces the probability of living to age 75 by 16% compared to those who remain in the area. This finding runs counter to the healthy migrant hypothesis, as well as the positive selection we document for migrants on education and earnings, both of which would lead one to expect migrants to live longer than non-migrants. We will show that migrants out of these three states are indeed positively selected on both health and earnings, but despite this fact, we find migration to have a negative impact on longevity, both when we control for selection and when we do not.[2]

We consider white individuals born in the states of Montana, North Dakota, and South Dakota between the years 1916-1927, and compare the mortality over age 65 of migrants and non-migrants. As we wish to study the effect of long-distance migration, migrants are defined as individuals who left not only the Dakotas and Montana, but the surrounding states of Idaho, Wyoming, Nebraska, Iowa, and rural Minnesota. These states are similar to the Dakotas and Montana in their rural nature and agriculture-based economies, with the exception of Minnesota, for which we exclude the relatively large metropolitan area of Minneapolis/St. Paul. Together, we define this area to be the "Northern Great Plains". A map of the area can be found in Figure 1. Ideally, we would like to estimate mortality differences at younger ages and for more birth cohorts, but unfortunately data limitations do not allow us to do so.

Our finding of a negative impact of migration on mortality has two potential explanations that we can see. The first could have to do with a negative impact of urban living on health, as

[2] Black et al. (2012) examine the effect of the Great Migration of African-Americans out of the Deep South on older-age mortality. Although a similar methodology is employed, our results indicate the effect of migration on longevity for our sample of whites to be much more negative than what they find for blacks.

the vast majority of the migrants in our study located in a metropolitan area. City residents have historically had lower life expectancy than rural residents (Szreter and Mooney, 1998), and the "urban penalty" to longevity has been documented even into the 20th century, although it has decreased substantially (House et al., 2000; Eberhardt and Pamuk, 2004). In light of this evidence, our results could be explained by a negative impact of urban living on health. However, modern cites have also been touted as having features that positively contribute to the health of their populations (Glaeser, 2011). Whether or not the urban location of migrants contributed to their decreased longevity compared to non-migrants is unclear. The second explanation arises from research documenting the relationship between social ties and mortality. Sociological research has shown that personal networks in rural areas are stronger and more supportive than those in urban areas (Beggs et al., 1996). Other research has shown that increased social interaction and decreased feelings of loneliness are associated with decreased mortality risk, especially among the elderly (Steinbach, 1992; Penninx et al., 1997; Patterson and Veenstra, 2010). The increased risk of mortality we find among migrants could be due to a lack of social support relative to their non-migrant peers. Unfortunately, our methods and data do not allow us to definitively test either of these hypotheses.

There are several reasons why we choose to look at natives of the Dakotas and Montana. First, the three states were very homogeneous at the time, both demographically and economically, ideal as we wish to control for differences in longevity across race and birthplace characteristics. In the 1930 Census, 97% of the population of the three states identified as non-Hispanic white, compared to 87% of the entire U.S. population. Agriculture was the dominant sector of the economy in the Dakotas and Montana, with 51% of the population living on farms in 1930 and 58% of the male labor force employed in farming occupations.[3]

[3]Note that these values were much higher in North and South Dakota (58% and 55% on farms, respectively, and 65% and 64% employed in farming) than in Montana (38% and 41%). This was due to mining playing a significant role western Montana's economy, while eastern Montana was much similar to the Dakotas in

These values for the entire U.S. in 1930 were 24% and 28%, respectively. Second, the population of the three states was almost entirely rural, with 78% residing in rural areas in 1930, compared to 45% in the rest of the U.S.[4] This implies that anyone born in the Dakotas and Montana prior to 1930 was born in a non-metropolitan area, and anyone migrating out of the three states can therefore be considered as originating in a rural area.[5] Third, as we will document, the three states experienced massive out-migration during the mid-20th Century that resulted in over half of the birth cohorts in our sample leaving both their state of birth and the surrounding rural states before 1960. As we have mentioned, more than 80% of our our cohorts of interest were living in a metropolitan area by the time they reached old age, allowing us to interpret migration out of the Dakotas and Montana as primarily rural to urban migration.

Although the magnitude of the movement out of North Dakota, South Dakota, and Montana was large, there are reasons to suspect that out-migrants were inherently different from those who remained behind on many characteristics that could affect late-life mortality. Standard economic theory predicts that individuals who choose to migrate are those for whom the move has the largest potential gain.[6] While we cannot directly document the "healthy migrant" effect, we can show that migrants are on average better educated and earn more than those who stay behind. In the 1960 Census, when individuals in birth cohorts 1916-1927 were between 33-44 years of age, mean years of schooling for male migrants was 12.0 years and for male non-migrants was 10.8.[7] Migrants did seem to gain from leaving the

the importance of agriculture.

[4]This is using the Census Bureau definition of rural, which is residing outside of cities of 2,500 inhabitants. Note that in 1930 there were no Metropolitan Statistical Areas (MSAs) in the Dakotas or Montana, and the smallest MSA at the time was Columbus, GA with a population of 58,000.

[5]For the purposes of our analysis we do not use the Census definition of rural and define rural to be outside of a MSA. According to this definition, North Dakota, South Dakota, and Montana were entirely rural until the 1950 Census, when Sioux Falls, SD was identified as a MSA.

[6]See, for example, Sjaastad (1962).

[7]Female migrants and non-migrants also differed in years of schooling (11.9 for migrants and 11.2 for non-migrants), although the difference is not as pronounced as that for males. Dakota and Montana natives were on average better educated compared to others in their cohort. Mean years of schooling for U.S. -born

Northern Great Plains in terms of earnings. Basic OLS earnings regressions using Census microdata show that male migrants had earnings that were on average 56% higher than non-migrants in 1960, controlling for age and education. Due to the well-documented empirically positive correlation between earnings/education and longevity, the fact that migrants were on average better educated and earned more than non-migrants leads us to suspect that migrants would live longer than non-migrants, even without the healthy migrant hypothesis. This positive selection on both health and earnings would lead estimates of the effect of migration on longevity to be upward biased if we did not control for it. We will explore this selection more formally in a later section of this paper. Fortunately, we are able to employ an empirical strategy that allows us to control for this bias.

To estimate the causal impact of migration out of the Northern Great Plains on the old-age mortality of individuals born in the Dakotas and Montana between 1916-1927, we employ an instrumental variables (IV) strategy using the distance of one's place of birth from a railroad line as an instrument for migration. We are able to leverage this instrument due to our unique dataset of Medicare Part B records matched to the SSA NUMIDENT file, which contains exact place of birth information. Distance of place of birth to a railroad is strongly positively correlated with migrating out of the Northern Great Plains, and we will provide evidence that it is unlikely correlated with old-age longevity, leading us to believe it to be a valid instrument for migration. Measuring longevity as the probability of reaching age 75 given living to age 65 (a requirement for being in our dataset), we find that moving out of the Northern Great Plains reduces the probability of living to age 75 by 16 percentage points, which is a reduction of nearly 20%.

The remainder of this paper proceeds as follows. In Section 2 we provide background on the population history of the northern Great Plains, including the influence of agriculture and railroads on settlement and out-migration. The third section describes our data sources.

non-Hispanic whites in the same birth cohorts in the 1960 Census was 11.2 for men and 11.1 for women.

We discuss in detail the selection problem we face when studying the effect of migration on old-age mortality in Section 4, and Section 5 covers our empirical framework including our instrument. We present the results of our estimation in the sixth section. Our results show that mortality risk increased for migrants out of the Dakotas and Montana compared to those who remained in the northern Great Plains. The concluding section discusses possible explanations for this finding as well as future extensions of this research.

2 Historical Setting

2.1 The Importance of Agriculture

The shift of the United States from a largely rural nation to a mostly urban one over the last hundred years can be largely attributed to the decreasing importance of agriculture in the U.S. economy. Agriculture employed close to 40% of the male labor force in 1900, and less than 2% in 2000. Mechanization and advancements in farm production technology increased both labor and land productivity over the period. Between 1940 and 1989, farm output per hour of work increased 1,300%, and productivity per acre of farmland doubled. This led to bigger farms and fewer farmers, and hence decreased employment opportunities in rural areas compared to urban areas (Johnson and Rathge, 2006). The resulting population loss was especially felt in the agriculture-dependent Northern Great Plains.

The economies of North Dakota, South Dakota, and Montana were even more dependent on agriculture than the country as a whole in 1900, as can be seen in Figure 2. Through 1930 agriculture employed over 60% of the male labor force in the Dakotas, and agricultural employment peaked in Montana in 1920 at 45% of the male labor force. Agriculture still employed more of the population in these states than the U.S. average in 2000, around 10% of the male labor force.

The shift of employment away from agriculture had striking effects on the populations of

North Dakota, South Dakota, and Montana. The population of the Dakotas and Montana from 1870 to 2010 is shown in Table 1. In 1870 the population of the three states was very low, with Montana having the largest population of just over 20,000 people. Starting around that time, settlers from the eastern United States and abroad flooded the area after the passage of the Homestead Act in 1864, which allowed them to claim 120 acres of federal land for their own as long as they lived there for 5 years and showed evidence of land "improvement" (which often involved planting trees on a few acres). The vast majority of these in-migrants used the land to grow wheat, which remains the primary agricultural crop to this day. Just how fast the population increased is apparent in Figure 3, which shows the population of the three states and the entire United States relative to 1870. By 1920, the population of North Dakota had increased more than 250 times its 1870 population, and South Dakota and Montana's population increased 50 and 25 times, respectively. Over that same time period the total U.S. population only tripled. Since that time, however, the area has experienced very little population growth. Figure 4 shows the population of the three states from 1920 to 2010 relative to 1920. Over those 90 years, the population of South Dakota increased less than 25%, Montana grew 80%, and the population of North Dakota did not increase at all.[8] Again, the U.S. total population tripled over the time period.

The force responsible for the rapid increase and then stagnation of the population of the Dakotas and Montana was migration. Net intercensal migration rates for the three states from 1900-2000 are displayed in Figure 5.[9] At the beginning of the 20th century, the three areas were gaining around 300 people due to migration for every 1000 inhabitants in a decade.

[8] The population of Montana grew significantly faster over the time period than that of the Dakotas. However, when divides Montana into the western mountainous part and the eastern plains part, the western part's population increased more than 2.5 times while the eastern part grew only 30%.

[9] Net intercensal migration rates are calculated using the forward survival method for five-year age categories. The forward survival method involves starting with a Census estimate of population in a state, subtracting off the number of deaths that occurred during the next decade, and comparing the number of surviving individuals in the next Census year to the actual Census population estimate. The difference is net intercensal migration, which is standardized by the starting population to form the net intercensal migration rate.

The combination of falling wheat prices and severe drought caused many farmers to flee the area starting in the 1910s for the Dakotas and the 1920s for Montana. World War II and the increased wheat prices it brought with it was not enough to reverse the exodus from farming communities. The mechanization of agriculture and the resulting scarcity of employment in the area further contributed to the high out-migration rate through the 1960s, when the Dakotas were losing close to 300 inhabitants per 1000 due to out-migration over 10 years and Montana 200. Since then, net migration rates have hovered around zero, with a slight positive increase in the 1990s.

The movement of population out of the Dakotas and Montana is apparent when we consider our cohorts of interest. Using Census data, we can trace out the location of those born in the Dakotas and Montana over their lifetimes. The fraction of birth cohorts 1916-1927 located outside the Northern Great Plains and the fraction within the Northern Great Plains but outside their state of birth by age is shown in Figure 6. The majority of individuals who migrated outside of the Northern Great Plains did so between the ages of 18 and 35, by which point around half of these cohorts were living outside of the area. A small but constant fraction remained in the area but moved outside of their state of birth. Note that the fraction located outside the Northern Great Plains remains constant after age 40, indicating that those who moved did not return to their area of birth at older ages, and those who remained in the Northern Great Plains did not migrate later in life in large numbers. The location of individuals born in 1916-1927 in the 1960 Census, when they were between the ages of 33-44, is shown in Table 2. Of the 52% of the cohort that was living outside of the area, the majority were in the western states of California (28%), Washington (22%), and Oregon (9%), and over 67% of these migrants were located in an urban area.[10] These locations are very similar to those of the individuals in our analysis dataset, shown in Table 3, with the exceptions of an increase in the fraction of migrants in the popular retirement

[10]The 1960 IPUMS does not identify specific metropolitan areas.

states of Arizona and Florida and a decrease in the fraction in metropolitan Minnesota. Unfortunately, our dataset only contains information on place of birth and location at old age, so we cannot know exactly when these individuals moved to their reported location in the Medicare records. However, the similarity between the locations reported in the 1960 Census and in our data suggests that there was not much return migration to the Northern Great Plains or additional out-migration at older ages.

2.2 The Influence of Railroads

The settlement of the Dakotas and Montana was made possible by the construction of railroads. Two major transcontinental railroads were built through North Dakota and Montana, bringing with them thousands of new settlers. The Northern Pacific Railway crossed the North Dakota border in 1872, reached the Missouri River at Bismarck in 1873, and finally reached the Montana border in 1881 after a long delay due to financial difficulties brought on by the nationwide 1870s depression. The Northern Pacific was completed in 1883 when the eastern and western sections were joined to connect Minneapolis with Puget Sound. The competing Great Northern Railroad was built to the north of the Northern Pacific, reaching Devils Lake, ND in 1883, Great Falls, MT in 1887, and Seattle in 1893. These railroads provided North Dakota and Montana with connections with the major grain market in Minneapolis and as a result the population of the area skyrocketed. The railroads promoted the fertile land of the Dakotas heavily in New England cities as well as overseas in Germany and Scandinavia, resulting in the vast majority of settlers being of Northern European descent.

South Dakota did not have a transcontinental railroad connection through its territory until much later due to the very large Great Sioux Indian Reservation dividing the state. However, a connection from the (transcontinental) Union Pacific in Nebraska reached the Black Hills in the western part of the state in 1886, and an extensive network of railroads was in place in the eastern half of the state by the early 1880s. After the partitioning of the Great Sioux Reservation in 1889, two railroad lines, the Chicago and Northwestern and the Chicago, Milwaukee, and St. Paul (known as the "Milwaukee Road") connected the Black Hills with the eastern part of the state by 1907. The Milwaukee Road completed its transcontinental line to Seattle through the northern part of the state and then almost parallel to the Northern Pacific through Montana in 1911.[11]

These three railroads, along with smaller regional lines, were the primary mode of long-distance transport for both people and goods from the Dakotas and Montana to the rest of the country (as well as across the country) until the construction of the interstate highway system after World War II.[12]

3 Data

Our main empirical analysis uses the Duke SSA/Medicare dataset. This unique source of data contains Master Beneficiary Records from the Supplementary Medical Insurance Program (Medicare Part B) merged by Social Security Number to records from the Numerical Identification Files (NUMIDENT) of the Social Security Administration (SSA). The data contain over 70 million records over the period 1976-2001, covering a very high proportion of the population aged 65 years and older. We estimate that the total coverage rate for our cohorts of interest is 86%. Because enrollment requires proof of age, the age validity of the records is high compared with other data sources for the U.S. elderly population. In addition to race, sex and age, information includes entitlement status (primary versus auxiliary beneficiary), zip code of the place of residence, exact date of death, and, importantly, detailed place of birth information. Specifically, the data include either town and state of birth or town, county and state of birth for all U.S.-born respondents, key for the construction of our

[11]Most of the Milwaukee Road's transcontinental line was abandoned in 1980, and the Great Northern and Northern Pacific lines through North Dakota and Montana are still used today by their current owner, the BNSF Railway, known as the Burlington Northern and Santa Fe until 2005.

[12]Historical information from Malone et al. (1991), Schell and Miller (2004), Robinson (1995).

instrument. Due to decreased coverage rates for earlier birth cohorts, we limit our analysis sample to birth cohorts 1917-1927.[13]

In addition to the SSA/Medicare data, we also rely on the Integrated Public Use Samples (IPUMS) of the U.S. Census (Ruggles et al., 2010) to compare education and earnings of migrants and non-migrants in 1960, as well as to trace out the age of migration for our selected cohorts over the years 1920-2000.

4 Selection and Migration

To illustrate how the healthy migrant hypothesis complicates the estimation of the effect of migration on mortality, consider estimating the following model:

$$Y_i = X_i\phi + \gamma D_i + \nu_i \tag{1}$$

where Y_i is a measure of mortality, X_i is a vector of observed characteristics, D_i is an indicator of migration, and ν_i is an unobservable error term. Selection bias arises in the above model if individuals base their migration decision on another variable unobserved to the researcher. This causes correlation between D_i and ν_i through omitted variable bias. In the case of the healthy migrant hypothesis, this omitted variable is underlying mortality risk. The healthy migrant hypothesis predicts the correlation between D_i and ν_i to be positive, meaning we would expect a negative bias in estimates of γ. Due to this bias, we would find migrants to live longer on average than non-migrants even if there were no causal effect of migration on mortality. However, even if the healthy migrant hypothesis was not true, we would still face bias when estimating the effect of migration on late-life mortality due to the correlation between education and health.

Individuals may base their migration decisions on other factors besides their underlying

[13]For more information on the Duke SSA/Medicare dataset, see Black et al. (2012).

health. Returning to Marshall's example from the introduction, migrants are often "the most enterprising, the most highly gifted" besides being "those with the highest physique and strongest characters". Migrants out of the Northern Great Plains may also have differing abilities as well as better underlying health than those who remain in the area. To see how this selection can also cause problems when estimating the effect of migration on mortality, first consider selection on expected earnings, the most common case of migration selection considered in the literature.[14] Using a model first postulated by Roy (1951), assume individuals born in the northern Great Plains face two potential earnings outcomes, that realized if they stay in the area (W_0) and that if they migrate (W_1). We can write earnings in the two regimes as functions of both observed (X) and unobserved (U) characteristics as follows:

$$\begin{aligned} W_1 &= \mu_1(X) + U_1 \\ W_0 &= \mu_0(X) + U_0 \end{aligned} \tag{2}$$

The expected earnings gains to migration are defined as $D^* = W_1 - W_0 - C$, where C is the direct cost of migrating (travel costs, etc.). We assume that the direct cost C is fixed for all individuals. Note we do not observe D^*, but we do observe $D = \mathbb{1}[D^* > 0]$. We also only observe earnings in one of the two states, defined as $W = DW_1 + (1 - D)W_0$. If we wanted to estimate the effect of migration on earnings we could estimate the following equation for individuals i:

$$W_i = X_i\beta + \delta D_i + \varepsilon_i \tag{3}$$

Selection bias arises in the above model if individuals base their migration decision on another variable unobserved to the researcher, such as ability or motivation. This causes

[14] See, for example, Sjaastad (1962); Harris and Todaro (1970), and for an excellent review of research on internal migration in the U.S., Greenwood (1997).

correlation between D_i and ε_i through omitted variable bias. With this correlation, migrants and non-migrants are inherently different and their earnings do not serve as appropriate counterfactuals for each other, causing bias in the estimate of the effect of migration on earnings.

Note that in many cases the direction of this selection bias is assumed to be positive, as in Marshall's example, meaning that those who migrate are of generally higher ability than those who remain in the origin area, and would have had higher earnings than stayers even if they had not migrated. This does not necessarily have to be the case, as pointed out by Robinson and Tomes (1982). If, for example, the relative job market conditions in cities and rural areas were such that lower-skilled individuals were more likely to migrate than those with higher skills, migrant selection would be negative, meaning we would have a downward bias in our estimation of the returns to migration.

Although the direction of the selection bias could be either positive or negative, we can provide some evidence that it is positive in our case. Our main analysis dataset contains very limited information on migrants and non-migrants out of the Dakotas and Montana, but we can use data from the Census to see if there is evidence of selection on observed characteristics. Figure 7 shows the education distribution of male migrants and non-migrants out of the Dakotas and Montana for the birth cohorts used in our study (1916-1927) from the 1960 Census, when they were between the ages of 33-44. While there appears to not be much evidence of selection in the middle of the education distribution, we can see strong evidence of positive selection on education for migrants at the upper and lower ends. About twice as many individuals with a grade 8 or lower education remain in the northern Great Plains than migrate out, while the reverse is true for those with some college and above. As migrants out of the Dakotas and Montana appear to be positively selected on education, it is not much of a leap to suspect they are also positively selected on other traits that could also increase expected earnings, like ability and motivation.

We have shown evidence that migrants out of the Dakotas and Montana could be positively selected on expected earnings, and we also have considered the possibility that they are also positively selected on health due to the healthy migrant hypothesis. To see how the positive selection on expected earnings can contribute to the positive selection of migrants on longevity, we turn to the well-documented empirical correlation between education/earnings and mortality.

A large literature documents the negative correlation between education (and earnings) and mortality. For example, Sorlie et al. (1992) show that mortality rates are lower for those with higher family income. Elo and Preston (1996) use data from the National Longitudinal Mortality Study to document that adult mortality is lower for higher educational levels, and the difference persists but is reduced in magnitude after controlling for income, marital status, and place of residence. Fewer studies have attempted to resolve the difficult problem of determining the causal relationship between education and mortality, although Lleras-Muney (2005) uses changes in compulsory schooling laws to show that education has a causal negative impact on mortality.

To illustrate how this correlation between education and mortality implies positive selection in our estimation of the effect of migration on mortality, consider again our model of mortality in Equation (1) and that of expected earnings in Equation (3). We have shown that the selection bias in the earnings equation arises from correlation between D_i and the unobservable ε_i due to migrants being inherently different than non-migrants on some characteristic unobservable to the researcher. From the education distribution of non-migrants and migrants out of the Dakotas and Montana, we predict that the selection on earnings is positive in our case ($Cov(D_i, \varepsilon_i) > 0$). The literature on the negative association between education/earnings and mortality makes us suspect that the error terms in the mortality and earnings equations contain common elements, such as ability and motivation, since those who earn more and/or are more highly educated tend to live longer than others. This implies $Cov(\varepsilon_i, \nu_i) > 0$ and therefore $Cov(D_i, \nu_i) > 0$, meaning selection bias is present in the mortality equation even if the healthy migrant hypothesis does not hold. In either case, to estimate the causal effect of migration on mortality we must turn to an empirical strategy that controls for this selection.

5 Empirical Framework

To control for the selective nature of migration, we employ an instrumental variables (IV) approach to estimate the causal effect of migration out of the Dakotas and Montana on old-age mortality. We instrument for migration using distance of one's place of birth from a railroad. We calculate the distance using the written place of birth (usually town) on the SSA file and the location of railroad lines as of 1900. A map of the railroad network in the western United States is shown in Figure 8. Using GIS software, we calculate the distance between the railroad line and the geographic coordinates of the town center. Although we calculate a continuous measure of distance, for our main analysis we define a dichotomous instrument, equal to 1 if the town center is located within 2 miles of the railroad line and 0 otherwise. The identifying assumption for this instrument is the distance of one's place of birth must impact the probability of migration out of the Dakotas and Montana, but it must not be correlated with old-age mortality. We will show it satisfies the first, testable part of the assumption, and will seek to provide evidence that it satisfies the untestable instrument assumption by examining several potential violations.

One way the instrument assumption could be violated is if being born on a railroad increases one's earning potential. This could occur if higher-ability parents tend to live closer to railroad lines or if schools located close to the railroad line are of higher quality. In this case, those individuals born close to railroad lines would both have higher earnings and/or education, resulting in increased longevity, and be more likely to migrate. This violation of the instrument assumption would cause an upward bias in our IV estimate of the effect of migration on old-age longevity. However, as we find that migration out of the northern Great Plains *decreases* longevity after age 65, the presence of upward bias in our estimate would mean that the true effect is even more negative than what we find.

If being born close to a railroad line is correlated with one's underlying health, the instrument assumption could also be violated. Two scenarios are possible: one where being born on a railroad line is positively correlated with underlying health, and one where the two are negatively correlated. The first situation could arise if residents of railroad towns were on average healthier than those in outlying areas. In the early to mid-20th century, access to healthcare was likely to be better in these towns than in more rural areas, making it quite plausible that those born on the railroad had the potential to receive better and more healthcare than those born away from it. In this case, individuals born close to the railroad would have both higher underlying levels of health and a higher propensity to migrate than their peers born farther away from it. Note that the presence of this bias would cause an upward bias in the estimation of the effect of migration on longevity. However, we find the a negative effect, indicating that the true impact of migration on longevity is even more negative if this positive correlation between begin born on the railroad line and underlying health exists. In contrast, if those on the railroad line have lower levels of underlying health, then our estimate is downward biased, meaning our estimate of a negative impact of migration on longevity could simply be a product of this correlation. While we cannot rule out the presence of this bias, there are several reasons why we believe it not to be too much of a concern. First, there is little reason to suspect that railroad towns were much more unhealthy places than areas located farther away. All of these towns in the Dakotas and Montana were small, making it unlikely that they suffered from the sanitation and pollution problems that plagued cities of larger size. Second, the presence of this correlation would violate the healthy migrant hypothesis and indicate that unhealthy individuals have a higher probability of migrating than healthy individuals, a situation that would run contrary to the empirical evidence cited in the first section of this paper.

A major threat to the validity of our instrument comes from a form of dynamic selection, present even if initially the instrument is not correlated with underlying health. To illustrate, consider the distribution of underlying health, referred to for simplicity as "hardiness". Individuals experience mortality in reverse order of hardiness, meaning the least hardy die earlier in life than those who are hardier. If the distribution of hardiness at the time of migration is equivalent for those born on and off the railroad, and those on the railroad migrate at random with respect to hardiness, then the initial distribution of hardiness between non-migrants and migrants is equivalent. If migration has no effect on mortality risk, then the hardiness distribution remains the same between migrants and non-migrants even as the less healthy die off. In this case, there is no correlation between being born on the railroad and mortality even as individuals age and the mean level of hardiness increases for both groups. However, if migration has a negative effect on longevity for individuals at all ages, as I find for those over age 65, the hardiness distribution, while initially equivalent across both migrants and non-migrants, changes differently across the two groups as time goes on. While individuals continue to die in reverse order of hardiness, if migrants die at a faster rate than non-migrants, by the time both groups have reached age 65 the mean hardiness of migrants is higher than that for non-migrants. As migrants were more likely to be born on the railroad than non-migrants, this means that we have a negative correlation between being born on the railroad and mortality risk at age 65, and our instrument is no longer valid. However, note that despite this potential bias, we find a positive effect of migration on mortality over age 65. If this dynamic selection bias is present, the true causal effect of migration on mortality is even more positive than our findings indicate.

However, dynamic selection may not work in the manner described above. If we are in a world of heterogeneous treatment effects, that is, if migration affects individuals' mortality risk differently depending on that person's characteristics, the mean hardiness level at age

65 may not be higher for migrants than non-migrants. If, for example, moving to a city keeps those with lower levels of underlying health alive longer than they would have been if they had stayed in their place of origin, through perhaps better access to medical care, those migrants still alive at age 65 may actually have lower hardiness than non-migrants. If the life-extending effect of cities for these individuals decreases with age, we could actually observe migrants experiencing increased mortality compared to non-migrants over age 65, even though migrating actually extended their lives. Of course, both effects could be operating simultaneously, meaning migration could have a positive effect on some individuals' life expectancies and a negative effect on others. In this case, the correlation between being born on the railroad and mortality risk at age 65 could on average be positive or negative. As we cannot observe the joint distribution of outcomes for migrants and non-migrants, we cannot tell which is the case. Our instrument helps control for selection into migration, but it cannot control for the dynamic selection of individuals after they migrate.

6 Results

Table 4 shows our main results for the causal effect of migration out of the Northern Great Plains on mortality. Recall that individuals enter our sample at age 65, so all results are conditional on living to that age. The first column shows OLS results for the effect of migration on mortality. This specification is subject to the selection bias we covered in Section 4. The coefficient on migration is negative and statistically significant at the 1% level. Without controlling for selection, migrants out of the Northern Great Plains have a 1.6% *lower* chance of living to age 75 than non-migrants. This is a surprising result, since we suspect these migrants to be positively selected on characteristics correlated with increased longevity.

Column (2) shows the first stage of the IV estimation, regressing the probability of migration on the indicator of proximity of one's place of birth to a railroad line. Being born close to a railroad line increases the probability of migrating outside the Northern Great Plains by 5 percentage points, an increase of about 9%. This effect is strongly significant, with an F-stat of over 30, so there is no cause for concern due to a weak instrument.

The third column shows the IV result. Due to the positive selection into migration, we would expect this result to be smaller (in this case, more negative) than the OLS estimate. Indeed this is true, with an estimated coefficient on migration of -0.132. Moving out of the Northern Great Plains decreases the probability of living to age 75 by 16.2%, conditional on surviving to age 65. Given that our instrument is valid, this is a causal effect.

The main results control for gender, but do not allow the effect of migration to vary between men and women. Table 5 shows the OLS and IV results for men and women separately. Both the OLS and IV estimates of the effect of migration on longevity are more negative for women than men, indicating that the longevity penalty over age 65 to migration out of the Northern Great Plains is greater for women than men. In percentage terms, migrating out of the Northern Great Plains reduces the probability of living to age 75 by 11% for men and 21% for women.[15] Note that distance to railroad is about equally strongly correlated with the probability of migration for both men and women.

It is important to keep in mind that IV estimates a Local Average Treatment Effect (LATE) of migration out of the Northern Great Plains on longevity. It is the effect only for those whose decision to migrate was affected by the proximity of their place of birth to a railroad line (the "compliers"). This is not necessarily equal to the effect for those who will always leave the area (the "always takers") or those who will remain (the "never takers") regardless of the value of their instrument. We are in the process of estimating the Marginal Treatment Effect (MTE) of migration on mortality to see whether the longevity penalty to

[15] Stating the results in terms of changes in ten-year mortality risk is far from ideal. In order to generate more interpretable results, we estimated Gompertz hazard regressions for mortality over age 65. Our results showed a decrease in life expectancy for migrants of several years. However, we are cautious about this finding as the Gompertz specification requires projection of mortality risk outside of our observed data, and we have no way to test how well this model fits the complete mortality experience of our sample.

migration varies with the probability of migration (Heckman et al., 2006). This will allow us to determine if the effect of migration is equal for all individuals, or varies according to individual characteristics.

7 Discussion

This paper indicates that migrating outside of the northern Great Plains increases old-age mortality risk compared to those who stay in the area. This finding directly conflicts with the "healthy migrant" hypothesis, that migrants are on average of better health than non-migrants in their origin locations. We also document that migrants are positively selected on education and earnings. The combination of this evidence with the predicted positive selection of migrants on health leads us to predict an upward bias in our estimate of the effect of migration on longevity. However, even in the OLS regression, which does not control for this selection, we find that migrants have a significantly *lower* probability of living to age 75 than non-migrants. The negative effect of migration on longevity appears to be so strong that it is not overcome by the positive selection bias. Comparison of the OLS and IV results shows that the selection was indeed positive, as the IV estimate is much more negative than the OLS estimate.

Our results are subject to a few limitations. Our data unfortunately does not contain the age at which the individual migrated, or where they lived between their date of birth and date of death. We attempted to address this fact by using Census data to trace out the location of individuals in the same birth cohorts over their lifetime, which shows that the majority migrated in their 20s and few migrants moved back to the rural northern plains as they aged. Note also that the nature of our dataset allows us to analyze mortality over age 65 only, and so we cannot draw any conclusions on mortality risk differences at younger ages. We also estimate the effect of migrating outside of the Northern Great Plains only, regardless of destination. Although it would be nice to distinguish between the effects of migration destination on health, such as rural versus urban or moving to California from moving to the East Coast, doing so would require controlling for selection bias on destination as well as on the decision to migrate at all. Our identification strategy does not allow us to do this, as our instrument is only valid for migration versus non-migration, and not for the choice of destination.

In the introduction we discussed two possible mechanisms that could explain our results. As over 80% of migrants out of the Northern Great Plains were located in an urban area at death, the negative effect we find on longevity could be due to a negative effect of city residence on health, due to pollution, stress, decreased physical activity, or some other factor. In contrast, instead of having to do with the destination of migrants, the explanation for our findings could lie in the fact they migrated at all. Migrants leave their families and communities behind, and in doing so could have weaker social networks and less community support than if they had stayed in their home area. As research has shown that stronger personal networks are associated with lower mortality rates, this mechanism could also explain our results. Unfortunately, we cannot directly test either mechanism with our data, but we can provide some suggestive evidence that both explanations may have a role to play by considering migrants to non-urban destinations.

Table 6 shows results of OLS regressions comparing the longevity of Dakota and Montana natives who remain in the Northern Great Plains to those who are residing outside of a metropolitan area in old age. We term these individuals "rural-rural migrants". Results are shown for all rural-rural migrants as well as for men and women separately. The original OLS regressions for all migrants compared to non-migrants are also shown for comparison. If the negative effect of migration on longevity was purely due to the urban destination choice of these migrants, we would expect the effect of migration on longevity for rural-rural migrants to be zero. Instead, the OLS coefficients for rural-rural migrants and for all migrants are very similar for all three groups, although the coefficient for male rural-rural migrants is no longer statistically significant. However, note that all three coefficients for rural-rural migrants are less negative than those for all migrants. In the absence of selection, this would indicate that the majority of the effect of migration on mortality is unrelated to destination, but the effect is slightly more negative for those who locate in metropolitan areas. Unfortunately, we are unable to use our instrument to control for selection on destination, and it is easy to imagine that migrants to rural areas outside of the Northern Great Plains are quite different from those moving to urban areas. While we cannot draw any conclusions from these results, they do indicate that the our results are not purely due to an "urban effect", and suggest that some other mechanism, like the social network hypothesis we proposed, is at play. We can, however, rule out one other potential cause: the effects of military service during World War II.

The cohorts in our study, in addition to experiencing the large out-migration out of the Northern Great Plains, also comprise the majority of the "Greatest Generation" who served in World War II (WWII). In the 1960 census, 72% of white men born in the United States between 1916 and 1927 report serving in the military, almost all of them during WWII. For those born in the Dakotas and Montana, military veterans are much more likely to move outside of the Northern Great Plains. In the 1960 Census, 53% of veterans born in these states had migrated while only 39% of non-veterans had. As it is clear military service is correlated with migration, the negative impact of migration on longevity we find could be attributable to a negative impact of military service on health.

Several studies have investigated the effect of military service on later-life health.[16] Most relative to this paper is a recent study by Bedard and Deschenes (2006), which uses Vital Statistics and Census data to analyze the effect of military service on later-life mortality.

[16]See, for example, Seltzer and Jablon (1974), who show that WWII veterans have lower age-adjusted mortality rates than nonveterans due to the positive selection into military service on mental and physical characteristics. Hearst et al. (1986) use the Vietnam draft lottery to show that men with low lottery numbers had higher mortality rates immediately after the wars end, primarily due to suicides and motor vehicle accidents.

Using an IV approach and cohort-level data, they find that cohorts with higher rates of military service during the Second World War and the Korean War experience higher mortality rates between the ages of 40-75, mostly due to increased rates of death due to lung and heart disease, which they attribute to military-induced smoking.

The evidence provided by Bedard and Deschênes that military service in World War II and Korea increased the mortality of veterans is concerning. If true, it suggests that the negative effect of migration on longevity we find could simply be due to the effect of military service on longevity, as military veterans are more likely to be migrants. Our instrument would not solve this problem if those born on the railroad were more likely to serve in the military than those born farther away. In this case, the instrument would be correlated both with migration and military service, making it invalid. Unfortunately, the Duke Medicare/SSA data does not contain any information on veteran status, so we cannot tell if the increased mortality we find in migrants is attributable to their movement out of the Northern Great Plains or the fact that more of them served during WWII. However, note that our results are much stronger for women, who did not serve in the military during this time period. The fact that the negative impacts of migration on mortality are much larger for women than men is strong evidence that the effect we find is not purely due to the increased tendency of migrants to be veterans.

The biggest limitation on our results comes from the dynamic selection of the individuals who reach age 65. Although our instrument controls for selection into migration, it cannot control for the underlying difference in mortality risk in our sample stemming from the effect of migration on mortality at ages under 65, which we cannot estimate. As we do not know the exact nature of this dynamic selection as to whether it makes the underlying mortality risk of migrants higher or lower than non-migrants at age 65, we urge caution in interpreting our results as directly causal. However, note that despite this selection and the positive selection of migrants on unobservable characteristics, we still get a negative impact of migration on mortality even in our OLS estimation, which does nothing to control for any sort of selection bias.

The fact that migrating out of a rural area decreases longevity in old age has implications for development policy. While the United States experienced its period of rapid rural out-migration in the twentieth century, for many developing countries such as China and India, urbanization is very much a current and growing phenomenon. The share of China's population living in urban areas increased from 18% in 1978 to 47.5% in 2010, mostly due to very high rates of rural-urban migration (Zhang and Song, 2003; Steinbock, 2010). The urbanization rate is expected to increase for the foreseeable future. The rate of rural out-migration has been slower in India, with only 29% of its population in urban areas by 2005, but this rate is also expected to grow quickly (Dobbs and Sankhe, 2010). The effects of migration on mortality and health in the United States could inform policy makers in countries like these as they cope with the mostly rural-urban migration currently underway.

Our results also have implications for the literature exploring the links between education, earnings, and health. We have documented how migrants in the cohorts we examine are positively selected on education and earnings, and many studies have shown that higher educated individuals tend to locate in urban areas (Moretti, 2004; Glaeser and Resseger, 2010). The more educated are also more geographically mobile than their less educated peers (Long, 1973; DaVanzo, 1983). As we have found that migrating causally decreases longevity, studies that do not control for this selective migration could actually *underestimate* the effect of education on longevity and other measures of health. This means that the true effect of education on health could actually be larger than that currently shown in the literature, as the highly educated are more likely to live in urban areas.

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8 Tables and Figures

Table 1: Population of the United States, the Dakotas, and Montana, 1870-2010

Year	North Dakota	South Dakota	Montana	United States
1870	2,405	11,776	20,595	38,558,371
1880	36,909	98,268	39,159	50,189,209
1890	190,983	348,600	142,924	62,979,766
1900	319,146	401,570	243,329	76,212,168
1910	577,056	583,888	376,053	92,228,496
1920	646,872	636,547	548,889	106,021,537
1930	680,845	692,849	537,606	123,202,624
1940	641,935	642,961	559,456	132,164,569
1950	619,636	652,740	591,024	151,325,798
1960	632,446	680,514	674,767	179,323,175
1970	617,792	666,257	694,409	203,211,926
1980	652,717	690,768	786,690	226,545,805
1990	638,800	696,004	799,065	248,709,873
2000	642,200	754,844	902,195	281,421,906
2010	672,591	814,180	989,415	308,745,538

Source: U.S. Census Bureau.

Table 2: Location of Dakota and Montana Natives, Birth Cohorts 1916-1927, 1960

Of all surviving, percent:	
In birth state	36.3
In rest of Northern Great Plains	11.6
Outside of Northern Great Plains	52.1
Of migrants, percent in:	
California	28.0
Washington	22.0
Oregon	9.1
Minnesota	7.5
Illinois	3.9
Wisconsin	3.9
Colorado	2.2
Michigan	2.2
Texas	2.1
Other states	19.1
Of migrants, percent in:	
Metropolitan area	67.5
Non-metropolitan areas	32.5

Note: Population includes non-Hispanic Whites born in the Dakotas and Montana between 1916-1927. Migrants defined as those residing outside of the Northern Great Plains. See notes to Figure 1.
Source: Authors' calculations using U.S. Census data.

Table 3: Location of Dakota and Montana Natives in Old Age, Birth Cohorts 1916-1927

Of all surviving, percent:	
In birth state	34.4
In rest of Northern Great Plains	12.5
Outside of Northern Great Plains	53.1
Of migrants, percent in:	
California	25.0
Washington	20.2
Oregon	10.4
Minnesota	5.8
Arizona	5.7
Colorado	3.3
Wisconsin	3.1
Florida	3.0
Illinois	3.0
Texas	2.8
Other states	17.9
Of migrants, percent in:	
Seattle, WA	10.8
Los Angeles, CA	9.5
Portland, OR	6.9
Minneapolis-St. Paul, MN	6.1
San Francisco, CA	4.9
Other MSAs	45.1
Non-metropolitan areas	16.7

Note: Population includes non-Hispanic Whites born in the Dakotas and Montana between 1916-1927. Migrants defined as those residing outside of the Northern Great Plains. See notes to Figure 1.
Source: Authors' calculations using Duke SSA/Medicare data.

Table 4: Impact of Migration Outside of the Northern Great Plains on Survival to Age 75 Conditional on Survival to Age 65, Non-Hispanic Whites Born in the Dakotas or Montana, Birth Cohorts 1917-1927

Explanatory Variable	(1) OLS	(2) First Stage	(3) IV
Migrate out of Northern Great Plains	-0.013***		-0.132***
	(0.001)		(0.035)
Born on Railroad Line		0.051***	
		(0.002)	
Instrument F-statistic		32.49	
Dependent Variable Mean	0.816	0.534	0.816
Observations	333,894	333,894	333,894

*** $p < 0.01$

Notes: Standard errors in parentheses. Standard errors clustered on town of birth. Also included are dummy variables for birth cohort/sex combinations and state of birth. Migrants defined as those residing outside of the Northern Great Plains. See notes to Figure 1.
Source: Authors' calculations using Duke SSA/Medicare data.

Table 5: Impact by Gender of Migration Outside of the Northern Great Plains on Survival to Age 75 Conditional on Survival to Age 65, Non-Hispanic Whites Born in the Dakotas or Montana, Birth Cohorts 1917-1927

	(1) OLS	(2) First Stage	(3) IV
		Men	
Migrate out of Northern Great Plains	-0.010***		-0.089*
	(0.002)		(0.047)
Born on Railroad Line		0.056***	
		(0.003)	
Instrument F-statistic		34.48	
Dependent Variable Mean	0.766	0.523	0.766
Observations	160,035	160,035	160,035
	(1) OLS	(2) First Stage	(3) IV
		Women	
Migrate out of Northern Great Plains	-0.016***		-0.179***
	(0.002)		(0.042)
Born on Railroad Line		0.046***	
		(0.002)	
Instrument F-statistic		28.33	
Dependent Variable Mean	0.862	0.545	0.862
Observations	173,859	173,859	173,859

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Notes: Standard errors in parentheses. Standard errors clustered on town of birth. Also included are dummy variables for birth cohort/sex combinations and state of birth. Migrants defined as those residing outside of the Northern Great Plains. See notes to Figure 1.
Source: Authors' calculations using Duke SSA/Medicare data.

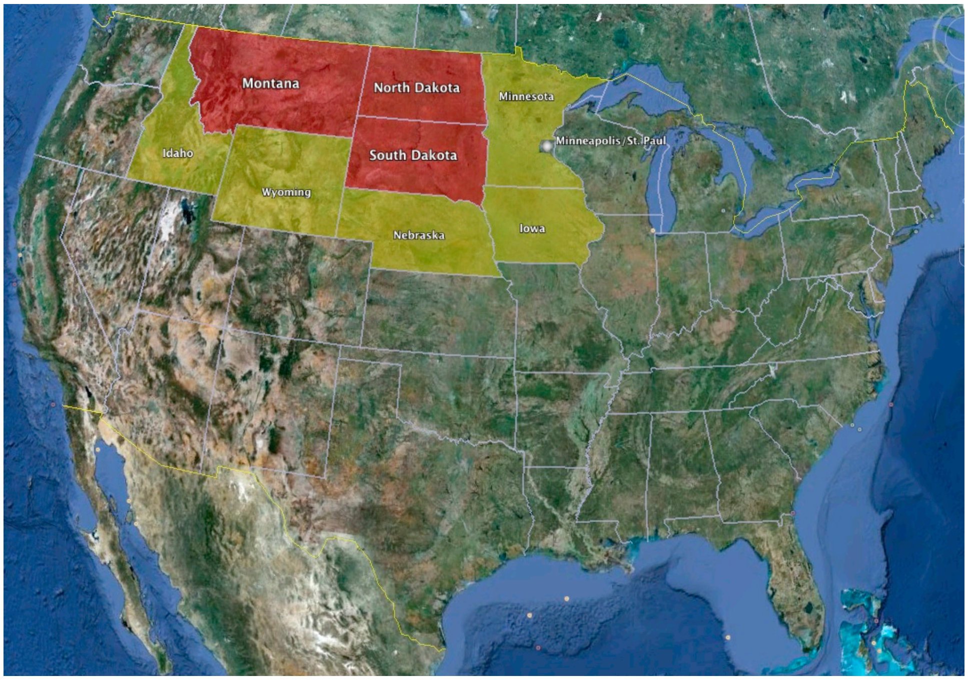
Table 6: OLS Estimates of the Impact by Destination of Migration Outside of the Northern Great Plains on Survival to Age 75 Conditional on Survival to Age 65, Non-Hispanic Whites Born in the Dakotas or Montana, Birth Cohorts 1917-1927

	All Migrants		
	(1) All	(2) Men	(3) Women
Migrate out of Northern Great Plains	-0.013***	-0.010***	-0.016***
	(0.001)	(0.002)	(0.002)
Dependent Variable Mean	0.816	0.766	0.862
Observations	333,894	160,035	173,859
	Rural-Rural Migrants		
	(1) All	(2) Men	(3) Women
Migrate out of Northern Great Plains	-0.009***	-0.005	-0.013***
	(0.003)	(0.004)	(0.004)
Dependent Variable Mean	0.817	0.768	0.867
Observations	138,994	68,988	70,006

*** $p < 0.01$

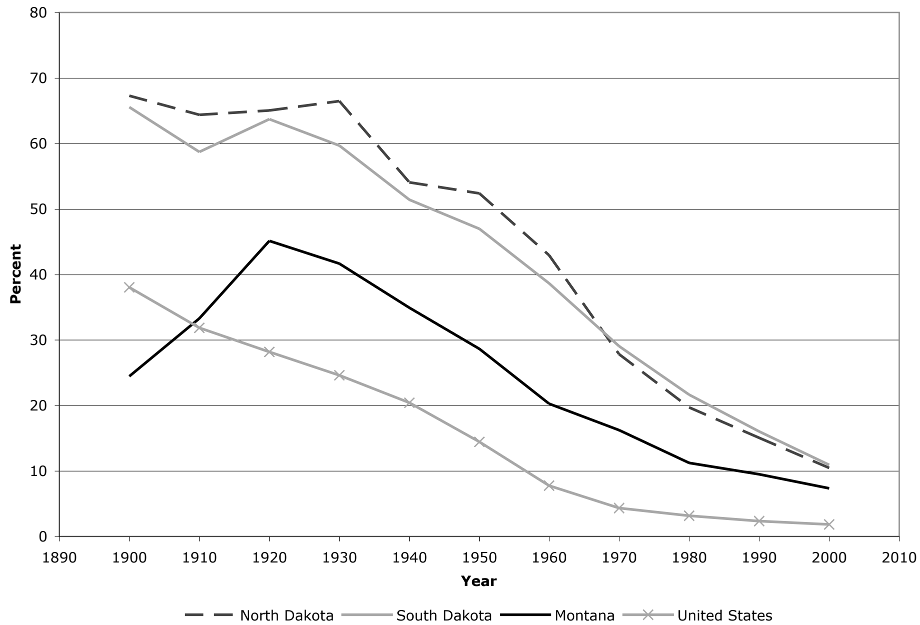
Notes: Standard errors in parentheses. Standard errors clustered on town of birth. Also included are dummy variables for birth cohort/sex combinations and state of birth. Migrants defined as those residing outside of the Northern Great Plains. Rural-rural migrants defined as those residing outside of the Northern Great Plains not in a metropolitan area. See notes to Figure 1.
Source: Authors' calculations using Duke SSA/Medicare data.

Figure 1: Map of the Northern Great Plains



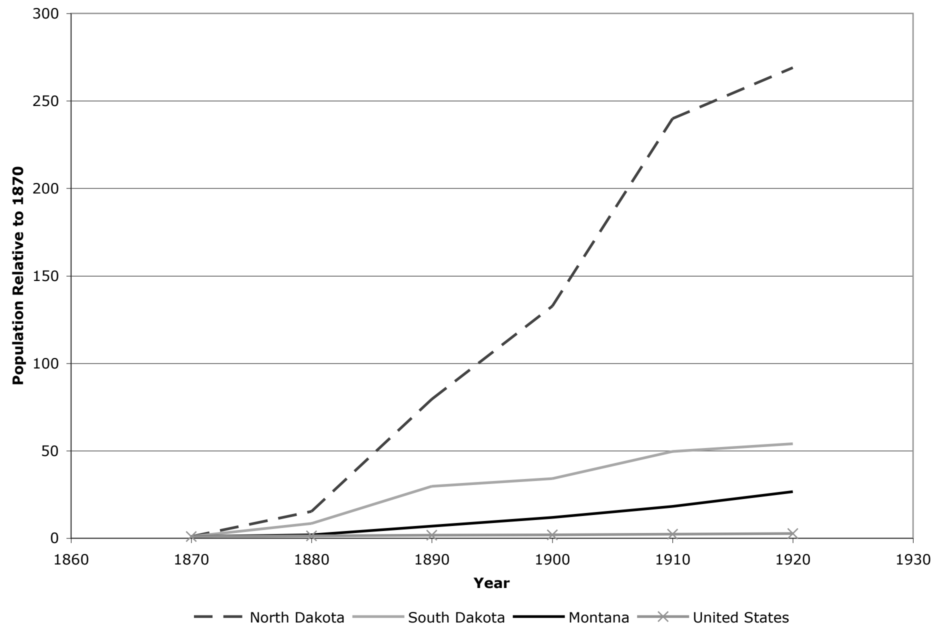
Note: We use individuals born in the states of North Dakota, South Dakota, and Montana, highlighted in red, in our analysis. We consider these individuals to be migrants if they are residing outside of these states as well as the yellow-highlighted states of Idaho, Wyoming, Nebraska, Iowa, and rural Minnesota in old age (the "Northern Great Plains"). Note that the large urban area of Minneapolis/St. Paul, although located in Minnesota, is excluded from the Northern Great Plains, and those who report living in Minneapolis/St. Paul are considered migrants. For more details see text.

Figure 2: Percent of Male Labor Force Employed in Agriculture, 1900-2000



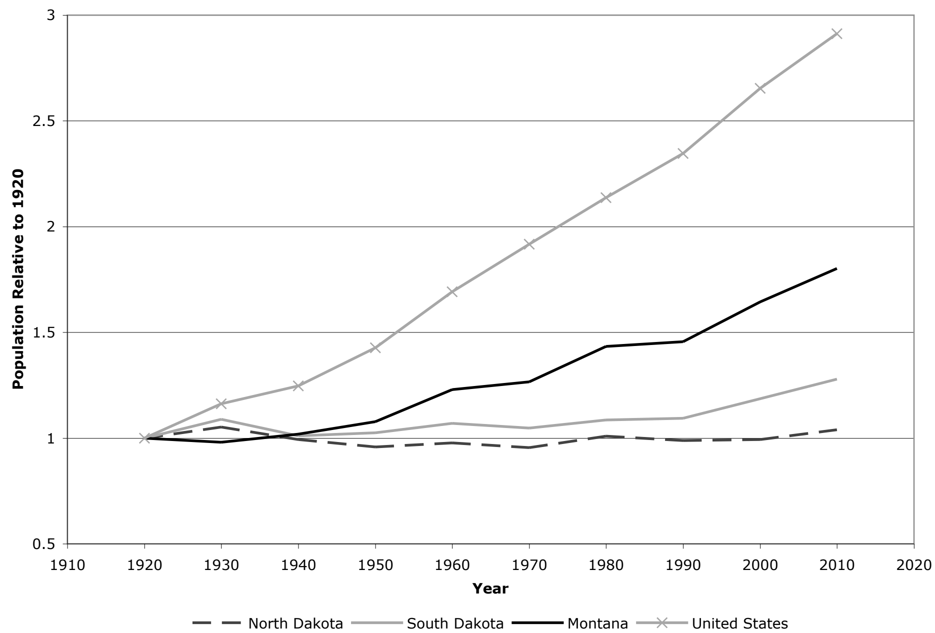
Note: Agricultural employment defined on occupational basis (farmers, farm laborers, and farm advisors).
Source: Authors' calculations using U.S. Census data.

Figure 3: Population Relative to 1870, 1870-1920



Source: Authors' calculations using U.S. Census data.

Figure 4: Population Relative to 1920, 1920-2010

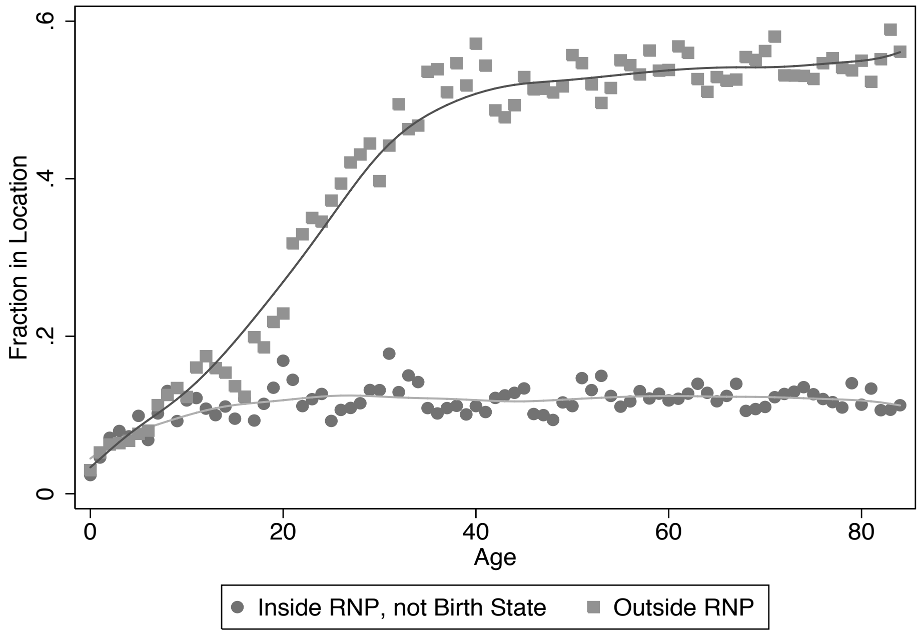


Source: Authors' calculations using U.S. Census data.

Figure 5: Net Intercensal Migration Rates, 1900-2000

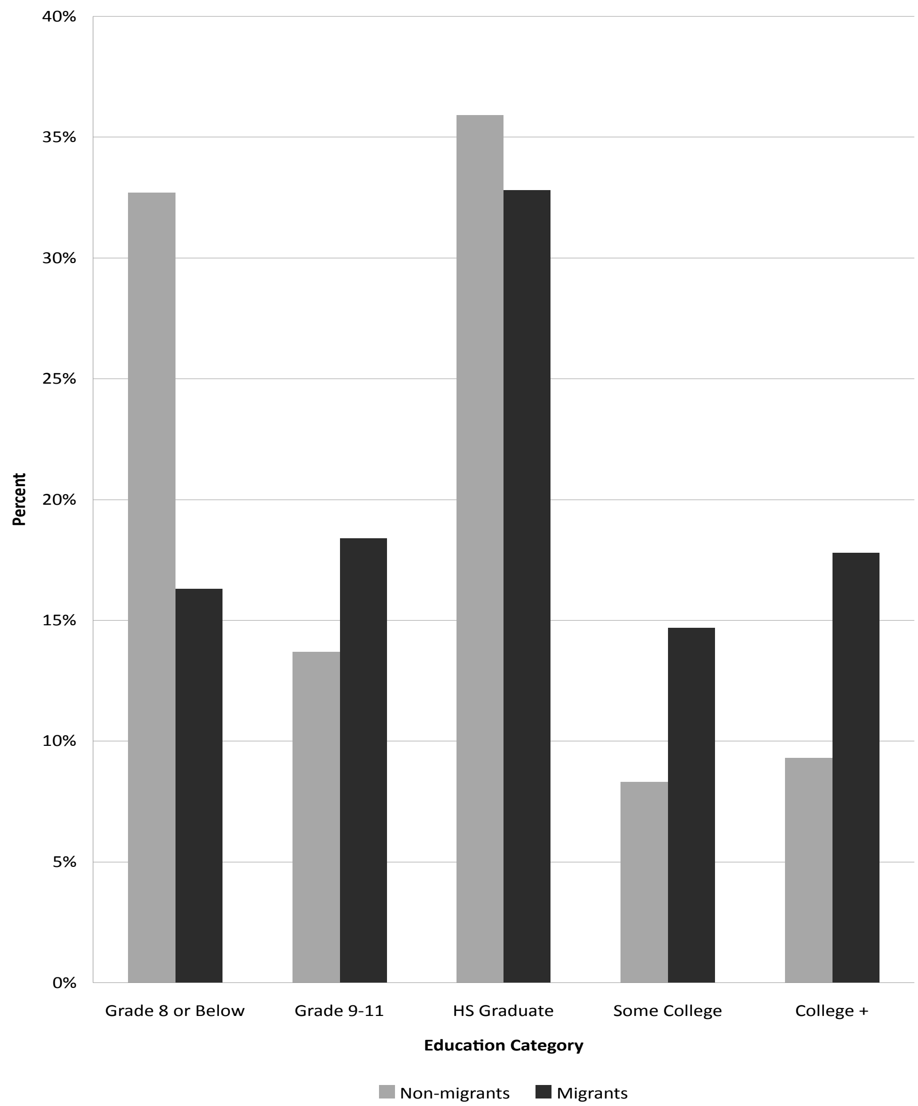
Note: Net intercensal migration rates calculated using the forward survival method for five-year age categories. The forward survival method involves starting with a Census estimate of population in a state, subtracting off the number of deaths that occurred during the next decade, and comparing the number of surviving individuals in the next Census year to the actual Census population estimate for that state. The difference is net intercensal migration, which is standardized by the starting population to form the net intercensal migration rate.
Source: Authors' calculations using U.S. Census data.

Figure 6: Location By Age, Non-Hispanic Whites, Birth Cohorts 1916-1927, 1920-2000 Census



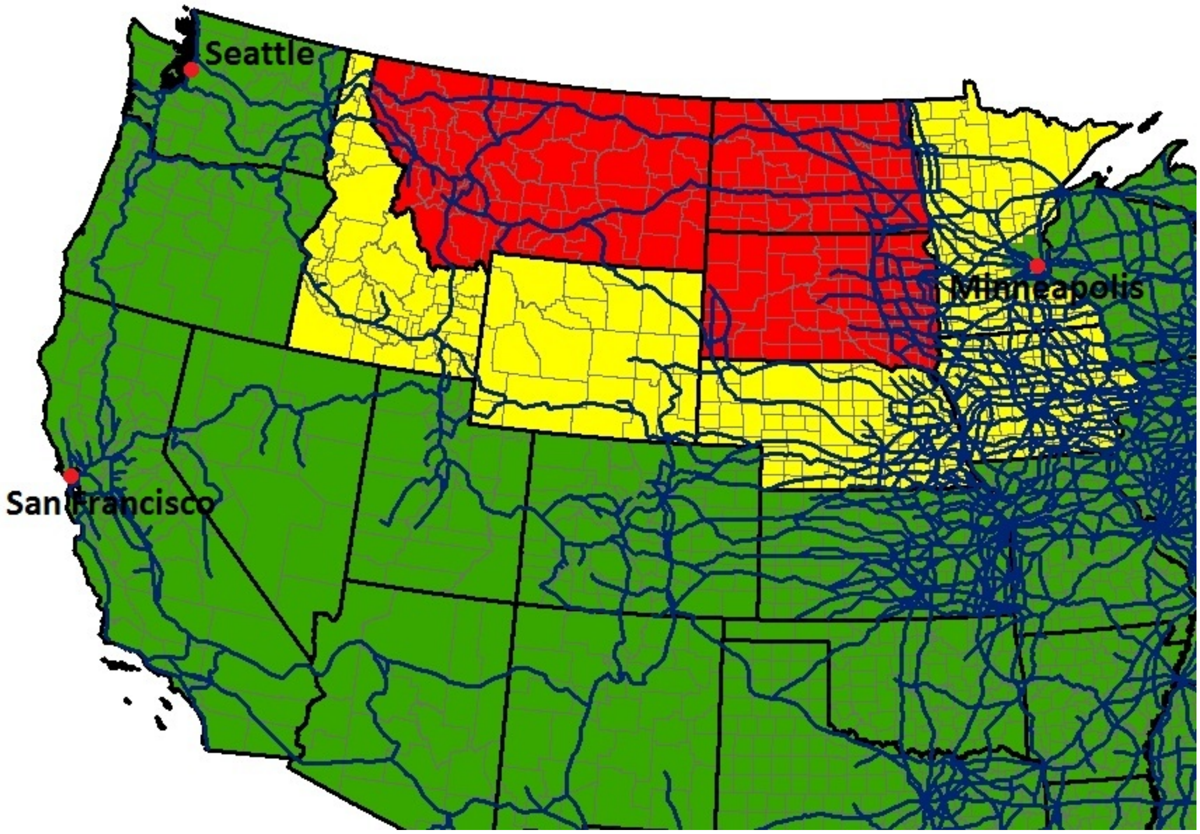
Note: "RNP" defined as the states of ND, SD, MT, ID, WY, NE, IA, and MN excluding Minneapolis/St. Paul.
Source: Authors' calculations using U.S. Census data.

Figure 7: Education Distribution of Migrants out of the Northern Great Plains and Non-migrants, Males, Birth Cohorts 1917-1927, 1960 Census



Note: Population includes non-Hispanic Whites born in the Dakotas and Montana between 1916-1927. Migrants defined as those residing outside of the Northern Great Plains. See notes to Figure 1.
Source: Authors' calculations using U.S. Census data.

Figure 8: Railroads as of 1900



Source: Authors' calculations using ARCGIS.