THE IMPACT OF MIGRATION ON INFANT HEALTH:
EVIDENCE FROM THE GREAT MIGRATION[1]

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Abstract: The Great Migration of African Americans from the rural South to the urban North entailed a significant change in the health environment, particularly of infants, during a time when access to medical care and public health infrastructure became increasingly important. We create a new dataset that links individual infant death certificates to parental characteristics to assess the impact of parents' migration to Northern cities on infant mortality. The new dataset allows a number of key innovations. First, we construct infant mortality rates specific to migrants and also for a period (1915-1920) prior to the registration of births. Second, the microdata allow us to control for the selection into migration and assess a number of potential mechanisms for the migrant health effect. Conditional on parents' pre-migration observable characteristics and county-of-origin fixed effects, we find that black infants were more likely to die in the North relative to their southern-born counterparts. We do not find any evidence of migrant selection. Given that infant health has a long-lasting impact on adult outcomes, the results shed light on whether and how the Great Migration contributed to African Americans' secular gains in health and income during the 20th century.

I. Introduction

Between 1910 and 1970, roughly 6 million African Americans left the South in a mass exodus dubbed the "Great Migration," dramatically altering the geographic distribution of the black population. In 1900, 90 percent of blacks lived in the South, which dropped to 53 percent by 1970. Over the same period, receiving regions experienced an increase in the share of the population that was black: four to 19 percent in the Northeast, six to 20 percent in the Midwest, and one to nine percent in the West (McHugh 1987). Most left the rural south to settle in Northern inner cities.

Southern blacks migrated because they expected the North to provide an improvement in opportunities, although it remains an open question whether migrants gained *on net* along all dimensions. For example, employment opportunities were superior in the North, providing a 60-70 percent gain in real income (Collins and Wanamaker 2014)[2]. However, outcomes worsened along a number of non-labor market dimensions, namely, higher incarceration rates (Muller 2012) and lower social standing (Flippen 2013).

The Great Migration's impact on the health of migrants has been relatively unexplored despite the intense interest in the wide and persistent racial disparities in longevity over the course of the 20th century.[3] It is an open question whether the Great Migration contributed to or hindered black economic progress along the dimension of infant mortality. The urban North and rural South provided radically different health environments for children. Consequently, the impact on the health of the second-generation is potentially large. As the Great Migration is one of the most prominent events of African-American history in the 20th century, its contribution to the racial health gap, for both infant mortality and later life health, is an important aspect, and has not yet received much attention because of data availability.

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[2] However, Eichenlaub, Tolnay, and Alexander (2010) find migrants had lower *occupational status* relative to those that stayed in their Southern communities.

[3] The exception is Black *et al.* (2011), which finds that migrating North provides no improvement to longevity, and maybe even a slight reduction, conditional on survival to age 65.

In this paper, we create a novel data set linking individual infant mortality outcomes to parental socio-economic characteristics to analyze the interrelationship between economic variables, infant health, and racial and ethnic disparities. This is a new research program motivated by newly available historical individual-level death certificates.[4]

Disparities in socio-economic status explain a significant amount of the variation in infant mortality in aggregate statistics (Collins and Thomasson 2004), although there is less agreement on the underlying mechanisms of the relationships. The Great Migration represented a substantial improvement in the labor market opportunities, access to education, and medical care for those African Americans that made the journey north. Black males experienced an increase in of 60 to 70 percent of real income by migrating to Northern cities (Collins and Wanamaker 2014). This alone should have had a large impact on infant mortality based on the standard estimates of the income-gradient (Finch 2003).

Moreover, the disease environment varied across regions, as did the provision of public health infrastructure to mitigate those diseases. In the absence of modern water and sewage systems, city dwellers faced a heightened risk of water-borne diseases, a leading cause of infant deaths. Southerners, on the other hand, were exposed to parasitic infections of malaria and hookworm, which primarily afflicted children and adults. The early 20th century also experienced a wide variety of new public health measures enacted to reduce infant mortality, the timing and extent of which varied across regions.[5]

To our knowledge, the causal impact of migration on infant mortality has yet to be estimated for this time period and population. The motivation of this paper is to use newly collected microdata on births and deaths to determine the extent to which migration accounts for reductions in black infant mortality during the first half of the 20th century. In the base analysis, we compare the likelihood of death for infants whose parents migrated north to those infants whose parents remained in the South. Our methods and results touch upon four related strands of the literature.

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[4] Logan and Parman (2011) and Preston *et al.* (1996) link death certificates to census observations, but focus on adult mortality and the intergenerational transfer of health.

[5] Examples include the construction of modern water and sewage systems, malaria and hookworm eradication, promotion of sanitary privies in rural areas, and the Sheppard-Towner Act (1921) which provided federal funding for educational materials and instruction in maternal and infant nutrition, care, and hygiene.

A key theme in the literature analyzing the outcomes of migration is that isolating the causal impact is difficult, but essential. Because health can be positively correlated with innate ability, most studies find evidence of positive selection into migration, termed the "healthy migrant effect", which, unaccounted for, biases the estimates of the health return to migration (Halliday and Kimmit 2008, Jasso *et al.* 2006, Black *et al.* 2011). However, negative selection can occur when the cost of migration is low. Irish-born residents of England are less health, on average, than Irish non-migrants (Delaney *et al.* 2013). This paper's key innovation is to first, control for selection into migration using detailed parental characteristics. Secondly, we include county-of-origin fixed effects to account for location-specific unobservables.

Coming from a multitude of sending locations, immigrants faced diverse health environments, which can be used to explore causal mechanisms for observed health disparities in the receiving locations. The health literature leverages the variation in health risks, behaviors, and constraints across migrants to isolate the importance of underlying causes of health disparities seen today among ethnicities and races (Jasso *et al.* 2004). Bias from selection into migration remains a concern, making the construction of the proper counterfactual crucial. Our focus on migration internal to the U.S. during a time of large regional disparities allows us to construct an improved counterfactual by health outcomes and economic controls from the same datasets for both migrants and stayers. For international migration (Jasso *et al.* 2004), health data from the sending countries is often absent or incomplete.

A third important literature links early-life health conditions to adult health and economic outcomes. Recent work provides an understanding that *in utero* and early childhood health conditions partially explain variability in human capital accumulation, earnings, and life expectancy, among a number of other outcomes of interest.[6] For example, variation in the infectious disease environment during childhood can explain an important part of variation in adult cognitive function (Case and Paxson 2009, Chay *et al.* 2009), convergence in black-white test scores (Chay *et al.* 2009), and subsequent labor market outcomes (Bleakley 2007). While we do not directly estimate the adult gains for the second

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[6] See Almond and Currie (2010) for a recent survey of the literature on the persistent impact of early life conditions.

generation in this paper, our results have important implications for the understanding of black economic progress.

Finally, our work fits into the literature on the reduction in the black-white mortality gap and black economic progress. The rapid decline in the infant mortality rate from 104 deaths per 1,000 live births in 1910 to 7 deaths in 1998 was one of the signature developments in public health in the 20th century (Wolf 2007, Haines 2006). Over that period, the large black-white infant mortality gap gradually declined, as shown in figure 1. Diminished racial disparities in socioeconomic status accounts for most of the convergence prior to World War II (Collins and Thomasson 2004). By 1940 almost 13 percent of Blacks born in the South resided in the North, the massive movement of the black population potentially had a significant impact on the rate of convergence in the black-white infant mortality gap, and on black life-expectancy (Margo 1990, p. 109). The question is what the counterfactual black infant mortality rate would have looked like in the absence of the massive gains in wages, education, and access to medical care that occurred because of the Great Migration. Moreover, because of the importance of the fetal and infant health environments on long-term labor market outcomes, the health impacts of the Great Migration might have played an important role for black economic progress years into the future.

Prior research on infant mortality and convergence in mortality rates was limited by the availability of aggregate vital statistics. The main contribution of this paper is to estimate the causal impact of migration on infant mortality rates using a newly collected set of individual level microdata of infant mortality linked to parental characteristics. We combine a count of deaths under one-year of age from infant death certificates with a count of surviving infants on April 1st from the decennial censuses. A wealth of parental characteristics are then added by linking observations to the decennial census.

To measure infant mortality in this time period, we collect individual-level death certificates from 1919-1940 in both Southern and Northern states.[7] We restrict our attention to infant deaths in the five years prior to a census date. To this dataset we append the full universe of infants in the relevant

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[7] Currently, the sample includes Tennessee, North Carolina, South Carolina, Illinois, and Ohio.

census who were born to parents born in the South but who are living in either location. Our full dataset contains 13,507 infants, of which 1,011 are infant deaths.

The main estimate we are interested in is the treatment effect of migration. To start, we consider the OLS linear probability regression with an indicator for infant death. Controlling for year fixed effects, infants of southern-born parents living in the North are 7.8 percentage points *more* likely to die in the first year of life in the 1915-1920 period. Northern mortality rates fall rapidly relative to the south, and by 1940 the southern mortality advantage has disappeared. We find no evidence of positive selection into migration based on innate infant health capital.

II.   Trends in Infant Mortality and the North-South Gap

African Americans faced radically different health environments in the North and the South. Aggregate vital statistics drawn from the published volumes of the *Vital Statistics of the United States* show that infant mortality rates in Northern cities were as high or higher than in the South early in the 20th century. As seen in figure 2, the black infant mortality rate (IMR) in the North exceeded that of the South initially. In terms of infant mortality, being born in the rural South was preferable to being born in the urban North. The urban south, however, faced even higher rates of mortality than did the urban North. Over time, Northern mortality declined faster than in the South, so that by 1936 a black infant born in the North had a better chance of surviving the first year of life, at least according to the aggregate statistics.

However, infant mortality rates in the published *VSUS* are systematically biased downward in ways that can dramatically change inferences about the causes and consequences of infant mortality. For the first-half of the 20th century, completeness of the birth registration systems varied by state, race, urban/rural status, and education of the parent. Shapiro (1950) describes the results from the first national study to determine the proportion of births registered with state vital statistics offices. Enumerators for the 1940 Decennial Census of Population were required to fill out special infant cards in conjunction with

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their typical enumeration duties with the census.[8] These infant cards were then compared to the official

birth registration certificates in the state vital statistics offices.

The geographic variation in birth registration completeness (for whites and nonwhite combined)

can be seen in figure 3. Registrations were more complete in northern states (96.9 percent in Illinois and

95.2 percent in Ohio) compared to the southern states (86.1 percent in North Carolina, 80.4 percent in

Tennessee, and 77.5 percent in South Carolina). Black births were even more likely to go unregistered

(82.5 percent for nonwhites and 94.0 percent for whites). However, the difference across regions remains

when looking solely at black births. The northern cities had close to complete registrations, even for

nonwhites (98 percent). Births in hospitals were much more likely to be registered and blacks in northern

cities delivered in hospitals. Black mothers in the South, however, were much more likely to deliver

outside of a hospital, especially in rural farm areas and smaller cities where getting to a hospital was more

difficult. Taken together, the results of the test suggest that black births were systematically under-

registered at higher rates in the southern state relative to the northern states, biasing upward southern

mortality rates. Because we want to compare mortality trends across the regions, we take this as our prime

motivation for revising mortality estimates from 1920-1940.

A. Revising infant mortality estimates using microdata

State vital statistic offices, in partnership with online genealogy websites, have recently made

their collections of death certificate images and indexes available online to the public. At the same,

digitized versions of complete Decennial Censuses have come available. We combine these two sources

of data to revise infant mortality estimates for two northern states (Illinois and Ohio) and three southern

states (Tennessee, North Carolina, and South Carolina) for the following years: 1915-1920, 1925-1930,

and 1935-1940.[9] Data availability limits the number of states included in the study.

We estimate the cohort infant mortality rate for year t in state s using the following formula:

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[8] The 1940 enumerators were instructed to have a heightened "awareness" to record infants. Thus, we might expect
the age-specific component of the census undercount to be less than in prior years (Shapiro 1950).
[9] Census indices and death certificate collections were kindly provided by FamilySearch.org.

$$(1) \qquad IMR_{s,t} = \frac{D_{s,b=t,d<365 \; days}}{D_{s,b=t,d<365 \; days} + D_{s,b=t,d=non-infant} + Census_{s,b=t}}$$

where $D_{b=t,d<365 \; days}$ is the number of infant deaths (less than 365 days) of those born in year t in state s,

$D_{s,b=t,d=non-infant}$, similarly defined, but for non-infant deaths between 1 year and 5 years old, and

$Census_{s,b=t}$ is the number of live children enumerated in the decennial census born in year t. We have a

choice from where to draw the number of infant deaths, either the published *VSUS* or from the collection

of individual death certificates. In the current version, we use the published death counts from the

VSUS.[10] In practice, we construct six-year averages for each decade to reduce the year-to-year variability.

Migration of young children out of state can potentially bring biases to this estimate. However,

the complete census index provides us a method to address a number of these. Importantly, $Census_{s,b=t}$

includes those born in state s living any state of the U.S.. Thus, migration of children that remain alive to

the census date do not bias our estimates downward. However, we do not observe children who died after

migrating out of state as we do not have a complete death index for the entire country. We do know the

proportion of live children living outside their state of birth from the census. We estimate the number of

deaths of migrant children by applying the mortality rate of their state of birth to the expected proportion

of those that migrated. Finally, we include these deaths in the denominator only, and not in the numerator

as infant deaths. Most infant deaths occur in the first 30 days of life, or even the first day[11]. We believe

that families did not travel out of state with unhealthy very young infants. In any case, this adjustment

does not make a discernible difference to the estimated rates.

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[10] For consistency, we use the *VSUS* death counts in the presence of a number of anomalies in the death certificate data coming from what look like data digitization errors from the FamilySearch.org indexers. Twenty percent of the deaths in Ohio 1925-1930 do not report race in the index, although the race is recorded on the death certificate images. It seems that volunteer indexers chose not to code this information for a section of the data. Spot checks for a random sample of Ohio death certificates suggest that the race variable is missing at random. Additionally, Tennessee includes stillbirths for the 1915-1920 period, whereas the other states in all other periods do not include stillbirths. We are working to fix both of these issues by visually inspecting the individual death certificate images. After validating the death certificate data, we hope to use it to construct the headline infant mortality rates in equation (1) in future versions of the paper.

[11] Neonatal deaths make up 50 percent of all deaths in the entire sample. Deaths within 48 hours of birth make up 25 percent of all deaths in the entire sample.

Our preferred revised estimates for 6-year average infant mortality rates by state of birth are shown in panel A of table 1, also shown visually in figure 4. This table captures the general story we would like to tell about regional differences and convergence in infant health and its relationship with migration. First, death rates for black infants were much lower in the South, compared to the North, in the early part of the 20th century. There is a 5.6 percentage point difference on average between our sample of northern states and southern states in 1915-1920. Black infants in Illinois were 7.7 p.p., or 1.76 times, more likely to die than those in South Carolina. The urban mortality penalty remained strong in the early parts of the 20th century, which we take as explaining the North-South gap during the 1915-1920 period. Northern blacks primarily lived in urban areas (93 percent urban), whereas Southern blacks were much more rural (21 percent urban). We also see some significant variation across states within regions, with a 1.3 p.p. difference between South and North Carolina, and a 2.3 p.p. difference between Illinois and Ohio.

The last two columns of panel A in table 1 report are preferred revised estimates for the 1925-1930 and 1935-1940 periods. The North-South gap remains in the middle period, but significant convergence has reduced the gap to only 1.6 percentage points on average. The Illinois-South Carolina gap fell to only 1.4 p.p, which is 18 percent of the gap in the previous decade. By the 1935-1940 period, the southern mortality advantage has completely disappeared with the North now reporting significantly lower infant mortality rates. The absolute decline in black infant mortality in the North continued the rapid decline in the 1930s that it experienced during the 1920s (4.6 p.p. and 5.6 p.p. respectively). Whereas the South experienced the same small absolute declines in both periods (1.4 p.p. in 1920s and 1.9 p.p. in 1930s), albeit from a much lower initial level. Northern urban areas experienced a faster decline than either southern cities or southern rural areas, as we will argue in more detail in a later section.

We want to emphasize that our microdata method allows us to construct race specific mortality rates for these states in the 1915-1920 period, and 1925-1930 in South Carolina, whereas previously none existed in the *VSUS*. Our method allows us to illuminate regional differences in infant mortality for this early period. Besides this, what additional benefit do we get from revising estimates relative to the *VSUS*?

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Figure 4 plots our revised estimates relative to those found in the *VSUS*.[12] Similar to the VSUS, we capture the downward trend and convergence of infant mortality rates across regions. Black infant mortality began much higher in North in the 1910s, but declined much more rapidly than in the South. However, our revised estimates find lower mortality in the South because of systematic underreporting of black births in Southern states. The southern mortality advantage remains in the 1925-1930 period, unlike that reported in the *VSUS*. This fact pushes the eventual regional convergence to later in the 1930s, with southern mortality rates eventually surpassing those in the North by 1940.

B. Migrant-specific infant mortality rates

The combined death certificate and census index microdata allow us to construct infant mortality rates specific to migrant fathers in the two northern states in the sample, and non-migrant fathers in our three southern states in the sample, using the father's reported place of birth.[13] In fact, this is the more relevant mortality rate as we are interested in the difference in infant death between migrant and non-migrant southern-born fathers. Migrant fathers, and those from Tennessee, South Carolina, and North Carolina, may be systematically different from non-migrant fathers in terms of the factors that might determine infant mortality, such as socioeconomic status.

In general, we follow the same procedure outlined above for constructing the state-based revised rates. However, indexers chose not to digitize father's birthplace seemingly at random (i.e. the number of deaths for which we have father's birthplace recorded does not match the number of total deaths). Thus, to find the number of infant deaths to Tennessee-born fathers we scale the total number of infant deaths by the proportion of the sample with father's birthplace recorded that report a Tennessee-born father.

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[12] Table A1 in the appendix reports the full comparison in more detail.
[13] We limit the sample based on father's place of birth because in the following section we match fathers back to their childhood homes based on name, year of birth, and place of birth. Mothers cannot be matched to pre-migration childhood homes because of name changes at marriage. However, we plan to construct infant mortality rates based on mother's place of birth in future versions of this paper. In theory, one could construct mortality rates for any specific group for which both the death certificates and census index contain identifying information.

The migrant-specific infant mortality rates are our preferred estimates for the unconditional difference in likelihood of death for an infant born in the South vs. the North. Rates are reported in panel B of table 1, along with the difference to the revised state-based rates regardless of father's birthplace from panel A. We find migrant-specific rates are noticeably higher in the North and lower in the South. The state-based revised rate is 1.2 p.p. (6 percent) lower than are preferred migrant-specific rate for the 1915-1920 period in the North. Conversely, southern non-migrant rates are only 0.3 p.p (2.8 percent) less than the state-based revised rates for the same period. Similar patterns hold for the 1925-1930 and 1935-1940 periods. Importantly for our purposes, the migrant-specific rates widen the North-South gap in infant mortality relative to the state-based revised rates.

C. Migration and infant mortality

The choice of mortality rate effects the potential mortality effects of South-North migration using the unconditional mean death rate, disregarding selection bias for the moment. Table 2 reports the north-south difference in infant mortality rates for each period and each estimation method. We interpret these estimates as the naive unconditional treatment effect of migration North on infant mortality. In summary, the vital statistic estimates of the north-south mortality gap drastically underestimates the true southern mortality advantage because of the systematic underreporting of black births in the south. Our preferred estimates, which we use in the remainder of the paper, are the migrant-specific rates that isolate the sample for which we are most interested: births to fathers born in the three southern states in the sample that reside in any of the five states for which we have death certificate data.

Table 2: Unconditional effect of migration on infant mortality by estimation method (north - south in p.p.)

	1915-1920	1925-1930	1935-1940
VSUS	n.a.	-1.8	0.7
Revised state-based rates	5.8	1.6	-1.1
Migrant-specific rates	7.3	2.4	-0.2

Notes: Summary of results from table 1 and table A1.

III.   Contribution of migration to infant health gains and accounting for migrant selection

The unconditional comparison of infant mortality rates clearly show a southern health advantage that declines over time and is eventually surpassed by North by at least the late 1930s. [14] Given the high economic returns to migrating North, we move towards evaluating whether the potential positive selection of migrants bias the unconditional comparison of the previous section. The basic conceptual framework is to compare infant outcomes of blacks that migrated to the outcomes of those that stayed in the South. One innovation of our work is to include parental controls for income, education, and literacy to assess the mechanisms through which migration may have affected health. As infants are potentially more susceptible to the differences in health environment—Northern cities were less sanitary but had better health care as the 20th century continued – infant health provides an important indicator for the overall changes in health from migration, and the cost of obtaining the economic returns.

A. Census Matching Procedure

Our goal is to create a sample of live and dead children in each outcome census year, with their fathers matched to a pre-migration census. We do this with two separate matches. First, we match parents of deceased infants from the death certificates to the relevant census manuscripts. Then, we pool the fathers of these infants with the full set of fathers of live infants. Finally, we match this full set of fathers back to a previous census wave; this allows us to control for selection into migration based on childhood characteristics of the fathers. Both matches are described in more detail below. We use the outcome census years of 1920, 1930, and 1940 and are interested in children who were born in the previous five years and who either survived or did not survive the first year of life.

Each death certificate includes both parents' names and states of birth. We use this information to conduct the first match to the census. We restrict to deaths within the five years before the census year and look for both parents living in any state in the census year. For example, even though a household

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[14] Surprisingly, the migrants themselves experienced elevated mortality rates compared to non-migrants (Black *et al.* 2011).

might have had an infant who died in Illinois in 1935, we will still try to find the parents if they move to Indiana or back to the South by 1940. To maximize the number of parents who are matched to the census, we use a procedure similar to Feigenbaum (2015).[15] It proceeds as follows:

1. Calculate Jaro-Winkler string distance scores between all individuals born in the correct state; restrict to possible father matches with a Jaro-Winkler score of 0.8.

2. Calculate a Jaro-Winkler score for all spouses of the possible father matches. Drop observations who are married to a woman with a score of less than 0.8 or with an incorrect birth state.

3. If a household contains an exact match on name for both parents and this household is unique, we consider the death matched to this household.

4. If there is no exact match, but there is one unique match with both parents' scores greater than 0.8, we consider this the match.

5. If there is no candidate for the mother, we match to a father who is not living with his spouse but who is married and has the correct name and birthplace.[16]

6. In the case of multiple matches, we prioritize the observation where the parents are living in the state in which the child died.

7. If there are multiple candidates in the previous steps, we are unable to match the observation.

Our procedure results in a match rate of 39%, with this consistent across states.

Once we have matched the death certificates to the census, we have a sample of live and deceased infants for each census year. We identify the father of the infant within the census indices. We match the father of each infant backwards to a previous census wave either 10 or 20 years earlier. The goal is to find the father as a child or young adult, still living in his childhood household, so men who are older than 26 are matched over a 20 year horizon while men younger than 26 are matched over 10 years. When we have

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[15] Unfortunately, father's age is not available in the death certificates, which decreases our match rates due to double matches.

[16] We could do something similar with potential mothers who are not living with their spouse; however, the goal of the exercise is to identify households so that we can match the *father* back to a pre-migration census so we do not look for mothers living alone.

identified the individual in a previous census index, we digitize by hand the characteristics of the childhood household that are not available in the indexes: occupation of the father, home ownership, and literacy of parents.

To match individuals across censuses, we follow the procedure pioneered by Ferrie (1996) and used in Abramitzky, Boustan, and Eriksson (2012). The procedure is as follows:

(1) We begin by standardizing the first and last names of men in the later year to address orthographic differences between phonetically equivalent names using the NYSIIS algorithm (Atack and Bateman 1992). We also recode any common nicknames to standard first names (e.g. Will becomes William).

(2) We match observations backwards from the later year to the earlier year using an iterative procedure. We start by looking for a match by first name, last name, race, state of birth, and exact birth year. There are three possibilities:

    (a) if we find a *unique* match, we stop and consider the observation "matched";

    (b) if we find multiple matches for the same birth year, the observation is thrown out;

    (c) if we do not find a match at this first step, we try matching within a one-year band (older and younger) and then with a two-year band around the reported birth year; we only accept unique matches. If none of these attempts produces a match, the observation is discarded as unmatched.

Our matching procedure generates a final sample of 1,011 deceased infants and 9,517 non-deceased infants with fathers born in Tennessee, South Carolina or North Carolina but who were born in these states, Illinois, or Ohio in the five years previous to the outcome year. We can successfully match 24 percent of deceased infants and 28 percent of non-deceased infants. This results in an overall match rate of 10 percent over the two matches for the deceased infant observations.[17]

Based on the same previous work, we expect that matched individuals come from slightly higher socio-economic status. Generally, matched individuals have less common names, which is potentially correlated with better economic outcomes. For our estimates to be unbiased within our sample, we worry about this matching bias only if it is differential across states and differential across deceased and non-

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[17] Add paragraph about causes of match failure.

deceased infants. In our current sample, match rates are higher in northern states and for live births, leading us to underestimate the mortality differential between the north and south in the raw data. Therefore, we create a sub-sample which produces the correct mortality weights. We do this by sampling from the births so that the mortality rate in the sample matches the rates presented in Table 1 in each year/state cell.

B. Evidence of and Accounting for Selection

We estimate the impact of migration on infant mortality using the regression with OLS:

(2) $$D_{i,t} = \alpha + \beta_t * M_{i,t} + X_i\theta + u_i,$$

where $D_{i,t}$ is an indicator of infant mortality for individual i, M_i is an indicator of migration (=1 if residing in the North post-migration period) interacted with time-period indicators. The coefficients of interest are the β_t's, which measure the impact of migration on infant mortality in percentage points for each period separately. All regressions include census year indicators.

As seen in column 1 of table 4, the estimate excluding any controls is consistent with migrants facing higher rates of infant mortality, as we found using the revised and calculated migrant-specific rates in the previous section. Moreover, we see some significant changes in the size of this correlation over time, mirroring the subsequent decreases in the overall southern mortality advantage from figure 4.

The main concern with the naive result is that the error term contains individual and local characteristics that are correlated with both the migration decision and infant health, introducing bias into the estimate of β_t. We take a number of steps to account for the possibility of this selection bias.

Migrants differentially came from households with higher levels of income, wealth, or education as is shown in table 3.[18] As migration is costly, sons from black households with greater resources were more likely to migrate. The migrant's health, and thus the health outcomes of future offspring may be positively correlated with pre-migration economic resources. To address this issue, we control for a rich set of parental background characteristics from our matched-sample of southern-born fathers, and re-

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[18] Collins and Wannamaker (2014) and Black et al. (2011) also find that migrants are positively selected on a number of socioeconomic variables.

estimate equation (2). We include X_i, which is a set of background characteristics of the father's pre-migration household head during his childhood from a pre-migration census. Individual level controls include indicators for occupational status, homeownership, and literacy.

In the next three columns of table 4, we explore the possibility of selection on observables and unobservables using our matched-sample. In column 3, we include pre-migration controls in the regression to adjust for observable pre-migration individual and household characteristics of the father.[19] Controlling for occupational status, literacy, and homeownership does not significantly change the coefficient estimate from the naive regression, suggesting that selection on observables makes up a small part of the observed differences in infant mortality between migrants and non-migrants.

The fourth column adds county-of-origin fixed effects to account for the share of the raw difference in mortality between migrants and non-migrants by location-specific unobservables. We find the estimate is slightly larger, but the change represents only a small portion of the raw migration effect. We believe that the county-of-origin fixed effects pick up some of the rural-urban migration patterns within and across regions that are correlated with the urban mortality penalty. We do not find strong evidence of selection bias based on the results from our matched-sample.

By further slicing the data into neonatal and post-neonatal deaths we can potentially gain information on the causes and mechanisms of the negative migrant health impact. Post-neonatal deaths are typically caused by infections diseases, such as diarrhea and pneumonia, contracted after birth and may be indicative of infectious disease factors in the environment. Whereas, neonatal deaths are more commonly caused by non-communicable factors: preterm birth, asphyxia, and congenital defects. In the final column of table 4 reports results from estimating equation (2) but using an indicator for neonatal death as the dependent variable. We find that migration causes a 4.8 p.p. increase and a 2.9 p.p. increase in neonatal mortality in the 1915-1920 and 1925-1930 periods, respectively. As with overall infant mortality, we find no impact on neonatal deaths for the 1935-1940 period. The impact on neonatal deaths

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[19] Controls include a set of indicators for occupational status (Owner operator farmer, tenant farmer, farm laborer, laborer, and an all other category). We define literacy as able to both read and write. We use the head's information from the household in which the father is found as a child in a prior census.

makes up 70 percent and 111 percent of the full migration effect on total infant mortality. These results suggest that migration is working through factors that negatively affect the health of the mother during pregnancy.

D. *Assessing the potential of further omitted variable bias and selection on unobservables*

Our results suggest that selection on the observables included in the regressions above accounts for a small portion of the observed infant mortality difference between migrant and non-migrant parents. We follow Collins and Wanamaker (2014) in assessing the magnitude of any remaining omitted variable bias necessary to push the true returns to migration to zero.[20] The essence of the procedure is to compare the estimate of $\hat{\beta}_{t,no\ controls}$ without controlling for observable characteristics (column 1 of table 4) to the estimate of $\hat{\beta}_{t,controls}$ with the controls (col. 3 of table 4). Let X be the set of observable controls included in $\hat{\beta}_{t,controls}$ and Z be the set of remaining omitted variables. Through the application of the omitted variable bias formula and under the null hypothesis of $\beta_t = 0$, we can estimate the ratio of remaining omitted variables' covariance with migration status to the covariance of migration status and the observable controls:

$$\frac{\hat{\beta}_{t,controls}}{\hat{\beta}_{t,no\ controls}-\hat{\beta}_{t,controls}} = \frac{Cov(M,Z)}{Cov(M,X)}$$

Using the values from table 4, we find that the left-hand-side of the above expression is

$\frac{7.1}{7.5-7.1} = 17.8$ for 1920 and 6.7 for 1930. This implies that selection on unobservables would have to be much stronger, 17.8 times for 1920, than selection on observables and in the same direction for omitted variable bias to *fully* account for the observed difference in infant mortality rates for migrant and non-migrant parents.

While we can plausibly rule out the true migration effect being equal to zero, the same procedure allows us to explore the potential bias caused by different levels for the ratio of the covariance of

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[20] The procedure was developed by Altonji, Elder, and Taber (2005), which Miguel and Bellows (2009) apply to an OLS framework.

unobservables and observables with migration status. Our estimates may still be too high. Table 5 shows how different values for the covariance of observables and unobservables affects the size of the true values of the migration treatment effect.

Table 5: Relationship between the true value of β_t and the covariance of observables and unobservables

Ratio of covariances:	"True" value of β_{1920}	"True" value of β_{1930}
0	7.1	2.0
1	6.7	1.7
5	5.1	0.5
10	3.1	-1
17.8	0	-3.3

IV.   Mechanisms and Pathways

In this section, we explore the large number of potential pathways and mechanisms through which the migration impact might have worked. A basic conceptual framework based on a simple health production function guides our interpretation of the difference in mortality between regions, and any subsequent effect of migration. The likelihood of death is determined by infant health capital, which depends on parental inputs and the health environment. Parental inputs would include time, feeding practices, housing, medical care, and parental health endowments. During this period, limited medical knowledge implied that direct medical care likely did not play a large role. The health environment includes the type and likelihood of infection of pathogens, access to medical care, information, and public health provision. The following section discusses the regional differences in inputs to the health production function that might explain the observed differences in mortality rates, and possible mechanisms for the observed impact of migration. We start with a discussion of the impact of socioeconomic variables and conclude with environmental factors.

A. Socioeconomic and individual characteristics as potential mechanisms

Fertility

Southern-born migrant mothers may choose to delay or move forward fertility choice in response to the radically different economic and social environment they faced in the North. Moreover, migrant mothers may differ systematically from non-migrant mothers through a selection process that affects infant health outcomes through the fertility decision. We use the IPUMS 1940 full count, 1930 5 percent, and 1920 1 percent samples to determine how fertility decisions differ between migrant and non-migrant southern-born mothers. The sample is limited to southern-born black females aged 16 and above living in either the South, Northeast, or Midwest census regions.

First, we compare the period total fertility rates of southern-born migrant and non-migrant women. The period total fertility rate is calculated by adding across one-year age groups the proportion of women reporting an infant in the household. Table 5 makes this comparison for each census year. Southern-born women that remain in the South are more likely to have a child in each of the census years. Figure 5 plots the age-specific fertility rates for 1940 by migrant status. Migrant women are less likely than non-migrants to have a child at every age. Figures for 1930 and 1920 show a similar relationship. Table 7 reports results from cross-sectional regressions of fertility and marital status on regional-migrant status. Results are consistent with migrant women being 11 p.p. less likely to be childless (mean of 78.6 percent), having 1.3 less children in completed fertility (mean of 3.8), and 0.4 to 1.1 years older at the time of their first marriage. Results for the likelihood of reporting ever married are not consistent across census years. Migrants are 1.6 p.p. less likely in 1940, 0.96 p.p more likely in 1930, and the 1920 result is noisy. In sum, all the results point toward a substantial difference in fertility and marriage behavior between the movers and stayers.

Table 6: Period total fertility rate of southern-born migrant and non-migrant women

	1920	1930	1940
Non-migrant	3.7	2.3	1.9
Migrant	1.7	1.5	1.3

Notes: The sample includes southern-born black women aged 16 and over living in the South, Northeast, and Midwest census regions from the IPUMS 1940 full count, 1930 5%, and 1920 1% samples. The period total fertility

rate is calculated by adding across one-year age groups the proportion of women reporting an infant in the household.

The datasets available are not ideal. First, we do not know at what age black females migrated north, or how much return migration occurred. Second, selection into the migration stream might bias any of these estimates away from the true treatment effect. Ideally, we could address both issues with a matched sample for mothers similar to our matched sample for fathers. Unfortunately, matching married women to childhood homes in a previous census is impossible because of name changes at the time of marriage. We show the fertility results, nonetheless, as the correlations are informative for potential pathways of the migration effect on infant mortality.

B.) Environment and Urban Penalty

We turn in this section to exploring whether the large difference between the North and South is due to urban versus rural residence. Table 6 breaks potential migrants into three groups: those that move to the North, those that move to the urban South, and those that remain in rural areas of the South. We allow the treatment effect of migration to vary by type of migrant and by outcome year. We see that in 1920, migrating to the North was slightly "worse" than being in a southern city. Babies born to northern migrants faced a 9.3 percentage point higher mortality rate than southern rural infants. Those born in the urban south faced a 7.8 percentage point higher mortality rate. However, these two numbers are not statistically distinguishable. In 1930, the pattern switches, with a 4.1 higher mortality rate in the North than rural South and a 6.7 higher rate in the urban South than rural South. While this difference is not statistically significant, the pattern suggests that Northern cities became safer than Southern cities by the late 1920's. Overall, we cannot reject the hypothesis that migrating to a city was what caused migration rates to increase.

We posit that multiple factors could explain the "urban mortality penalty" in this time period. Infant diarrhea caused by a number of underlying gastro-intestinal diseases was the leading cause of death in the early death registration areas. The vital statistics available also showed urban suffering more infant

deaths than rural areas: 11.3 percent in Massachusetts cities with a population above 100,000, and 9 percent in cities below 10,000 and rural areas (Federal Security Agency 1947, p. 589). The dense urban populations of the North suffered from poor water and sewage disposal, which led to high rates of water-borne disease. Accordingly, much of the focus of urban public health officials over the course of the early 20th century was to improve water sanitation and sewage systems. Over the first few decades of the 1900s, water chlorination, sewage treatment, and other advances dramatically reduced the death rate from water-borne disease in cities (Cutler and Miller 2005).

A newborn in the rural south may have been exposed to fewer pathogens than a newborn in the Northern cities. The rural South also suffered from water-borne diseases, but mortality was never on the scale faced by the urban North. Low population densities meant that the distance between households insulated rural families to some extent from the spread of germs. However, the typical water contamination in rural areas came from improperly stored sewage leaking into the well on a single farm. Although rural areas faced a lower level of intestinal disease than urban areas, public health officials and reformers believed that efforts should be made to reduce it even further.

The solution was two-fold: build sanitary privies to prevent leaching, and move wells away from privies. The 1920s and 30s saw a concerted effort by the U.S. Public Health Service and local public health departments to install sanitary privies and educate homeowners on their importance for health (Ferrel and Mead 1936). While urban centers in the North relied on public funds, most of the effort in the South was private in nature, being funded out of the pockets of homeowners. This limited the speed with which the rural populace received modern water and sewage. As northern cities improved the water supply, the rural South lost its health advantage.

Milk provided an important vector for the spread of pathogens for infants. At the time, mother's faced three options to feed their infant: breast milk, infant formula, and cow's milk. Breastfeeding reduced the transmission of pathogens, and passed along antibodies from the mother, but was less likely to occur if the mother worked outside of the home. Cow's milk was susceptible to contamination at the site of production, during transportation, and in the home. Even if the milk reached the home uncontaminated, a

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common practice was to dilute with potentially unsanitary water or allow the infant to suck the milk from a rag. In a 1911 study, babies that were not breastfed died at rates three to four times higher than those that were (Woodbury 1925). Early public health initiatives were aimed at changing infant feeding practices and improving milk safety to reduce infant diarrhea. Surveys of infant feeding practices during the 1920-30s show that poor feeding practices crossed all economic strata, but that significant differences existed between rural and urban mothers (Wolf 2007). Rural mothers breastfed at higher rates and for longer duration, but were more likely to introduce solid food too soon and of detrimental types (Preston and Haines 1991). The cause of the differences between rural and urban infant feeding are unknown, but may stem from differential labor market opportunities outside the home and the availability and price of safe alternatives to breast milk.

The rural South did suffer from a number of diseases that were absent from the North, such as infections of malaria and hookworm. While infecting older children and adults, there was not necessarily a direct impact on infants (Bleakley 2007). Infections may indirectly affect infants through reducing the health and economic resources available to the parents.

VI.   Conclusion

The movement North of African Americans during the early 20th century was associated with large increases in infant mortality, despite the large increases in income. We do not find evidence that there was selection into migration based on health status. Importantly, even if healthier fathers were more likely to migrate north, they were unable to transfer it to their children's initial health capital stock to fully account for the negative health influences experienced in northern cities.

We find the largest effect of migration in 1920, but by 1940 the North and South had converged. Mortality rates in the North were 7.2 percentage points higher in 1920 and this gap fell to XX by 1930 and zero in 1940. Most of these differences are accounted for by neonatal mortality rate differences. We also consider rural-urban migration within the South. Even within the South, there are large differences in mortality rates between urban and rural residents. In fact, this difference is exactly as large as the

differences between North and South, meaning that the negative effects of the Great Migration on mortality were likely primarily due to residing in a city. Again, by 1940 the difference between urban and rural areas in the South was zero as cities improved their health infrastructure and sanitation.

Further work will examine the contribution of the Great Migration to the overall convergence of black-white infant mortality over the 20th century. So far, we can tell that the Great Migration contributed negatively to this convergence—in the absence of this large migration, black infant mortality rates would have fallen *faster* than they in fact did.

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Figure 1: Convergence of infant mortality rates for blacks and whites
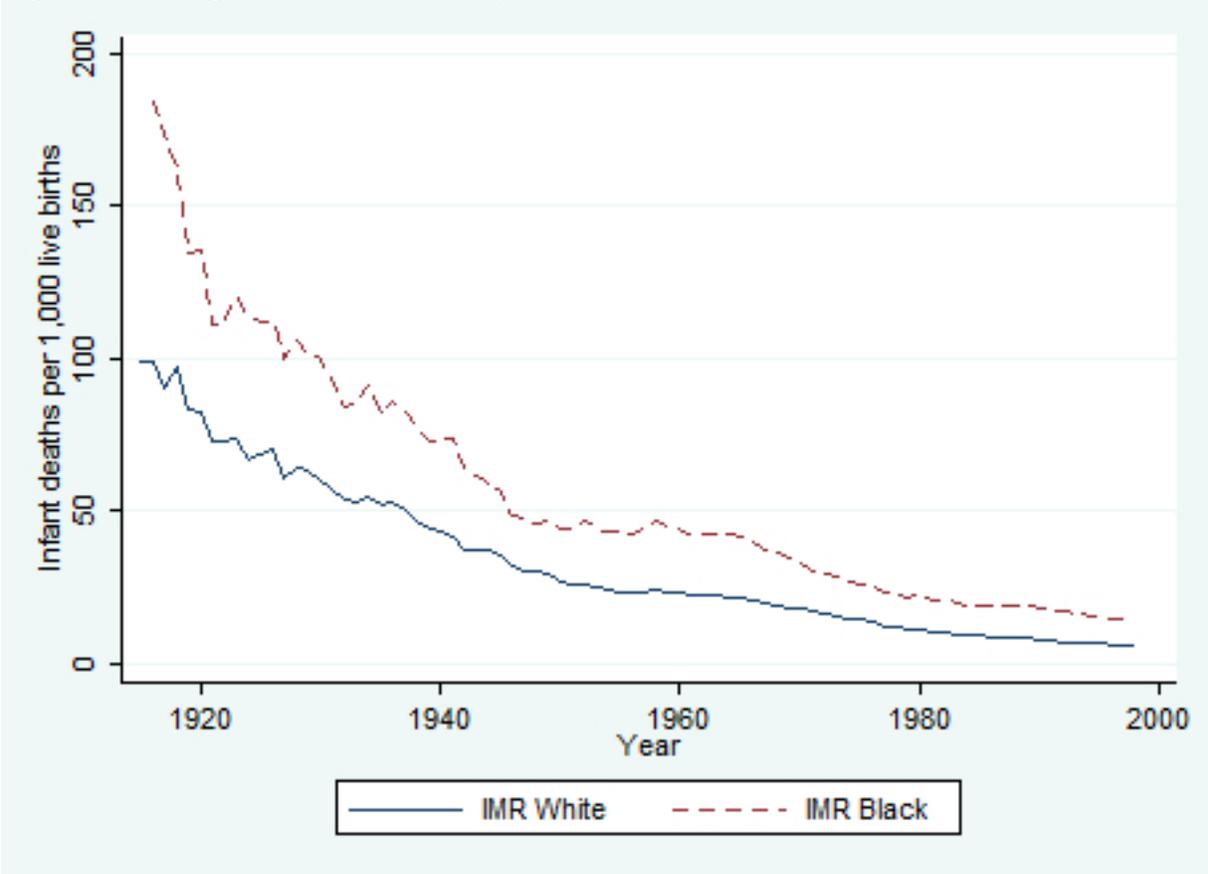
Notes: For 1915-1932, data are for the current Birth Registration Area only. Source: Haines (2006).

Figure 2a: North-South gap in published black infant mortality rates from *VSUS*
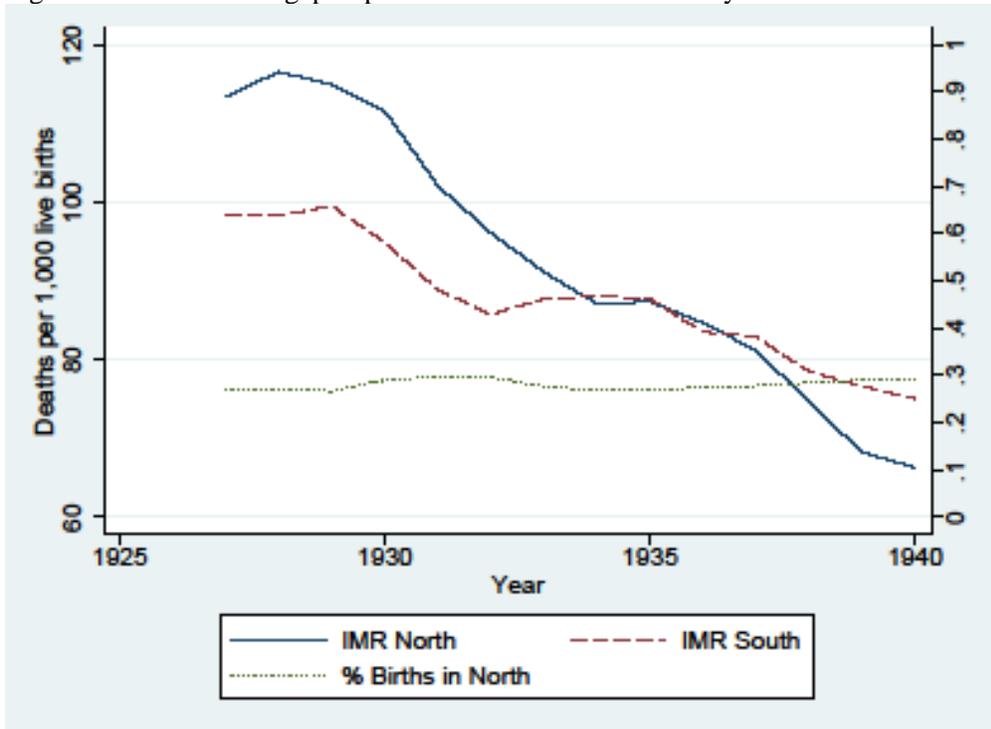
Notes: Includes all states reporting infant mortality rates in the published *VSUS*.
Source: Published volumes of aggregate statistics from the *Vital Statistics of the United States* 1927-1940.

Figure 2b: Infant mortality rates for urban status and regions
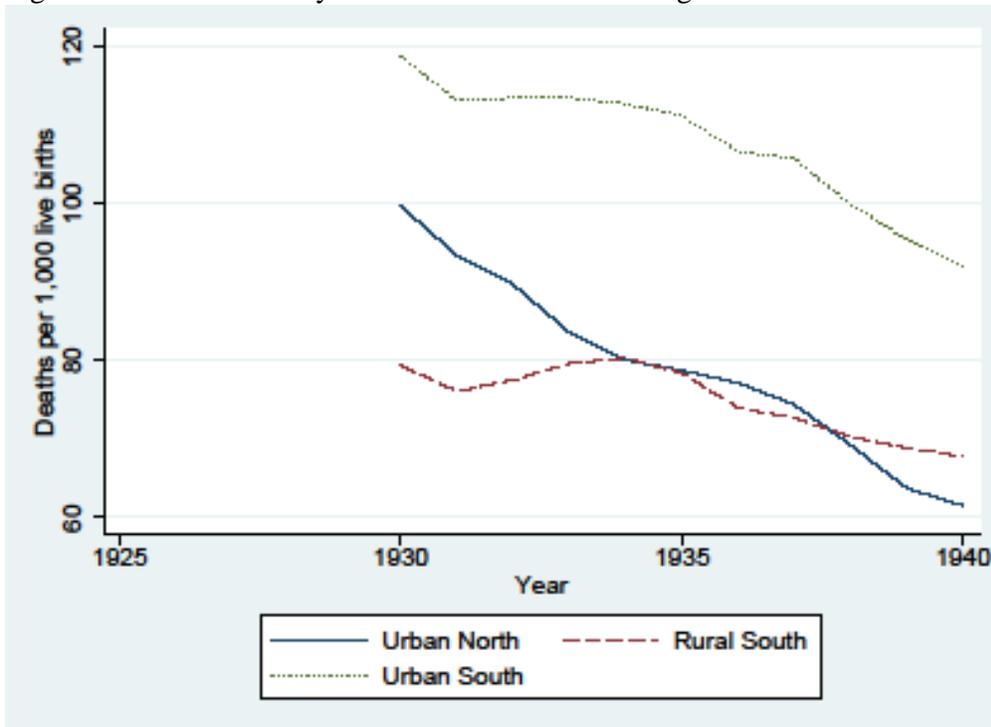
Notes: Includes all states reporting infant mortality rates in the published *VSUS*. Rural north is excluded as the black population made up a negligible portion of the population.
Source: Published volumes of aggregate statistics from the *Vital Statistics of the United States* 1927-1940.

Figure 3: Undercounting of births in the South: completeness of the birth registration area (white and nonwhite births)

Fig. 2. Percent completeness of birth registration: each State, 1 December 1939 to 31 March 1940.

Source: Shapiro (1950). The U.S. Census Bureau conducted an independent check on the completeness of the birth registration system in early 1940 by comparing special infant cards from the March 1940 Decennial Census and official birth certificates in state vital statistics offices.

Figure 4: Revised infant mortality rates compared to published rates from *VSUS*
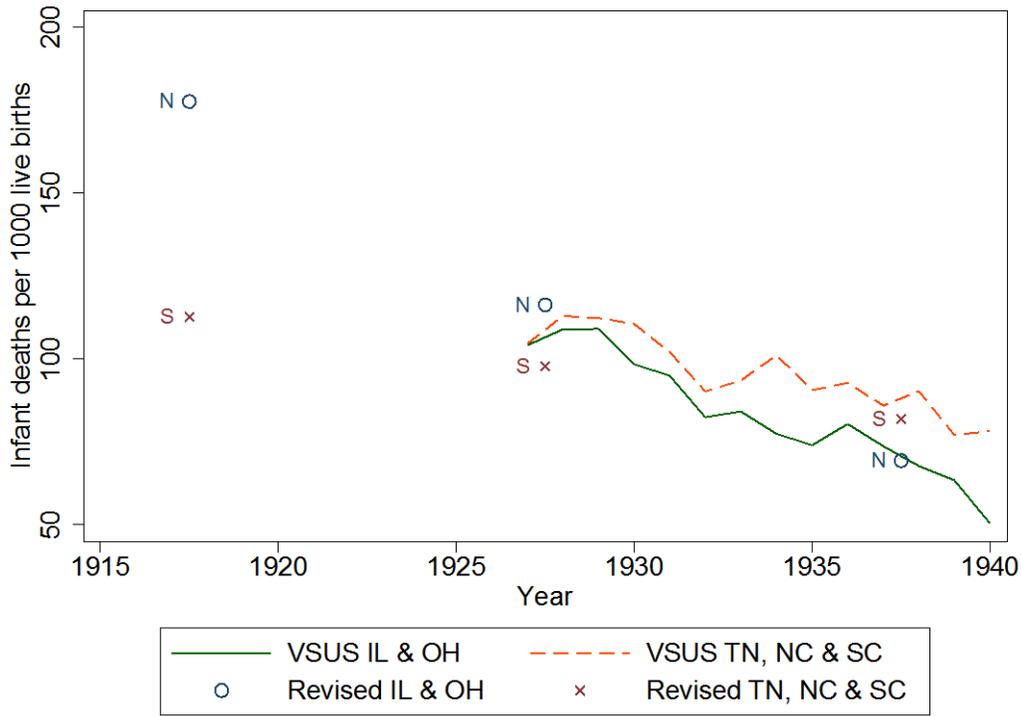
Notes: "N" denotes the northern states in our sample, whereas "S" denotes the southern states in our sample. Revised rates are 5-year averages calculated from the full census index and death certificate microdata as outlined in the data appendix and section 2. Markers are placed at the midpoint of the 6-year period to simplify the comparison to the published rates. The dashed and solid lines show the annual infant mortality rates from the published *Vital Statistics of the United States* 1927-1940.

Figure 5: Migrant and non-migrant period fertility by age of southern-born African-American women in 1940.
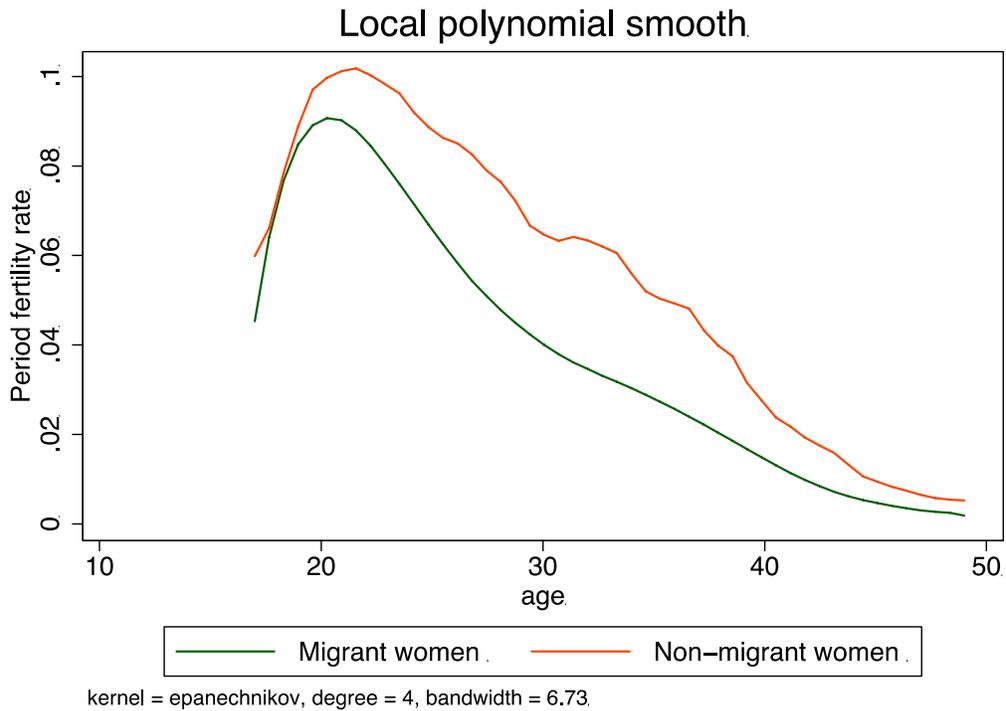
Local polynomial smooth

kernel = epanechnikov, degree = 4, bandwidth = 6.73

Notes: The sample includes southern-born black women aged 16 and over living in the South, Northeast, and Midwest census regions from the IPUMS 1940 census full count. A fourth-degree polynomial smoothing is applied over age groups for an indicator if an infant is reported as present in the household. Figures for 1930 and 1920 show a similar relationship between migrant and non-migrant women.

Figure 6: 1940 Geographical variation of infant mortality rates by High, Medium, and Low categories

Lowest Third
Middle Third
Highest Third
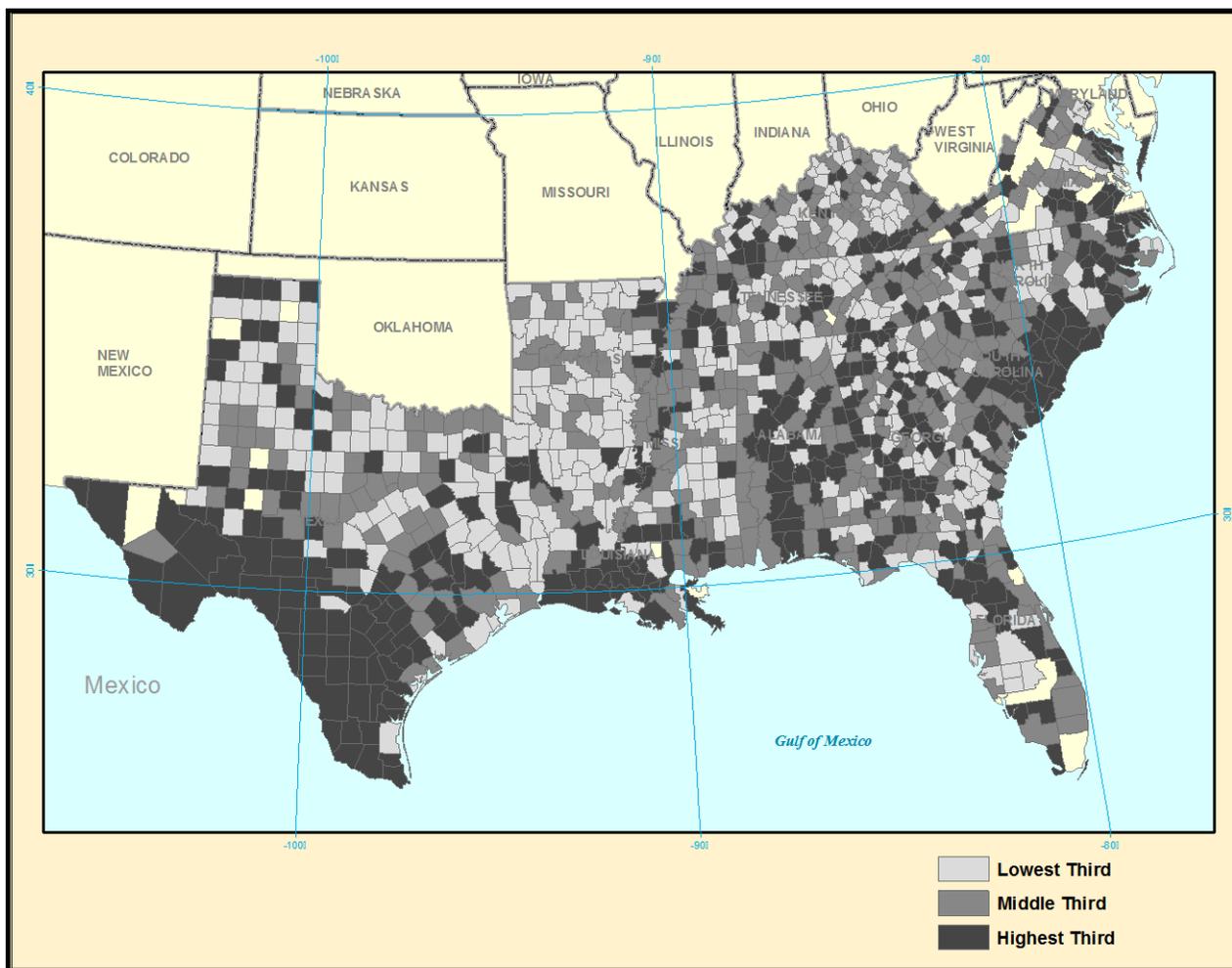
Source: *Vital Statistics of the United States, 1940* (provided by Price Fishback)

Figure 7: Difference in seasonality of deaths between North and South.

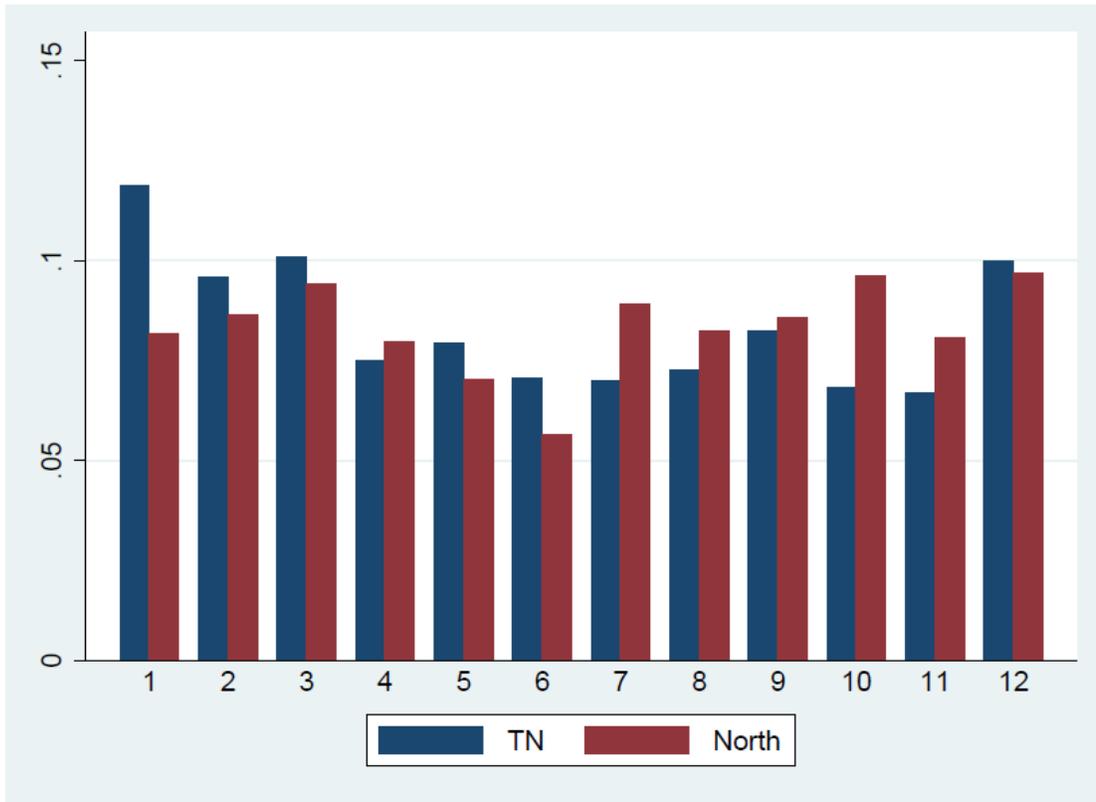Proportion of infant deaths by month, 1935 - 1940

Table 1: Revised and new state and migrant specific black infant mortality rates

Panel A: State of birth infant mortality rate (p.p.) - 6-year average

	1915-1920	1925-1930	1935-1940
Illinois	18.2	11.1	6.4
Ohio	15.9	11.6	7.4
Northern states	17.0	11.4	6.8
Tennessee	11.6	9.5	6.9
North Carolina	10.5	9.7	8.3
South Carolina	11.8	9.9	8.0
Southern states	11.2	9.8	7.9

Panel B: Migrant specific infant mortality rate (p.p.) - 6-year average

	1915-1920		1925-1930		1935-1940	
	Rate	Δ total	Rate	Δ total	Rate	Δ total
Illinois	17.6	-0.6	11.9	0.8	7.8	1.4
Ohio	18.7	2.8	11.5	0.1	7.5	0.1
Northern states	18.2	1.2	11.7	0.3	7.7	0.9
Tennessee	10.7	-0.9	8.5	-1.0	6.8	-0.1
North Carolina	10.2	-0.3	9.0	-0.7	8.2	-0.1
South Carolina	11.6	-0.3	9.8	-0.1	8.1	0.1
Southern states	10.9	-0.3	9.3	-0.5	7.9	0.0

Notes: All entries in the table are measured in terms of p.p. (alternatively deaths per 100 live births). Rates are averaged over six years of data. Panel reports revised infant mortality rates for all black births for in each state. Panel B limits births and deaths to specific child state-of-birth/father state-of-birth pairs. For children born in Illinois and Ohio, fathers can be born in Tennessee, North Carolina, or South Carolina. This is our migrant father sample. Children born in each of the southern states are required to have fathers born in the same state. This is our non-migrant sample. See section 2 in the main text or the data appendix for a description of how the revised rates are constructed. Regional averages are weighted means using the revised counts of black births as weights.
Sources: *Vital Statistics of the United States* (1915-1940), indices of the 1920-1940 Decennial Census of Population microdata and collected death certificate indices provided by FamilySearch.org.

Table 3: Summary statistics of pre-migration characteristics in matched sample

	1915-1920		1925-1930		1935-1940	
	Non-migrants	Migrants	Non-migrants	Migrants	Non-migrants	Migrants
Farmer (Owner)	0.18	0.16	0.16	0.12	0.16	0.11
	(0.39)	(0.37)	(0.37)	(0.33)	(0.36)	(0.32)
Farmer (Tenant)	0.49	0.32	0.47	0.40	0.47	0.27
	(0.50)	(0.47)	(0.50)	(0.49)	(0.50)	(0.44)
Farm laborer	0.10	0.06	0.09	0.06	0.04	0.02
	(0.30)	(0.24)	(0.28)	(0.23)	(0.19)	(0.14)
Laborer	0.12	0.20	0.11	0.13	0.16	0.15
	(0.32)	(0.40)	(0.32)	(0.34)	(0.36)	(0.36)
Homeowner	0.26	0.34	0.23	0.23	0.25	0.25
	(0.44)	(0.48)	(0.42)	(0.40)	(0.43)	(0.45)
Head literate	0.45	0.52	0.54	0.61	0.60	0.60
	(0.50)	(0.50)	(0.50)	(0.49)	(0.49)	(0.49)
Observations	2647	236	2770	1018	3259	604

Notes: The sample includes African-American births and infant deaths in Illinois, Ohio, Tennessee, North Carolina, and South Carolina to fathers born in those three southern states. Observations are weighted by the number of black births in each state and period within a region. The sample includes observations in the outcome year with fathers that could be matched to a state-of-birth childhood home in a prior census. Pre-migration occupation indicators are relative to the omitted category of "all other occupations." A tenant farmer is an observation that reports occupation as farmer and rents a farm. A head of household is literate if reporting that they can both read and write (in 1900-1920) and if reporting that they are literate in 1930.

Table 4: Evidence of selection bias for the treatment effect of migration on infant mortality

	Infant Death	Infant Death	Infant Death	Infant Death	Neonatal Death
Migrant*1920	0.085***	0.078***	0.082***	0.078***	0.053**
	(0.030)	(0.029)	(0.030)	(0.030)	(0.024)
Migrant*1930	0.021*	0.024**	0.018	0.024**	0.028***
	(0.011)	(0.012)	(0.012)	(0.012)	(0.009)
Migrant*1940	-0.002	0.000	-0.005	0.001	0.010
	(0.012)	(0.013)	(0.013)	(0.013)	(0.011)
1930 Indicator	-0.016**	-0.016*	-0.019**	-0.018**	-0.007
	(0.008)	(0.008)	(0.008)	(0.009)	(0.006)
1940 Indicator	-0.030***	-0.029***	-0.035***	-0.034***	-0.007
	(0.008)	(0.008)	(0.008)	(0.008)	(0.006)
Farmer (Owner)			-0.018	-0.012	0.004
			(0.014)	(0.014)	(0.010)
Farmer (Tenant)			-0.008	0.002	-0.009
			(0.010)	(0.010)	(0.008)
Farm Laborer			-0.012	-0.006	-0.012
			(0.014)	(0.014)	(0.010)
Laborer			0.019	0.020*	0.002
			(0.012)	(0.012)	(0.009)
Owns Home			-0.005	-0.006	-0.022**
			(0.013)	(0.013)	(0.009)
Head Literate			0.019***	0.019***	0.002
			(0.006)	(0.006)	(0.004)
Constant	0.109***	0.109***	0.108***	0.101***	0.056***
	(0.006)	(0.006)	(0.011)	(0.011)	(0.008)
N	10,507	10,507	10,507	10,507	10,507
R-squared	0.003	0.025	0.005	0.027	0.028
County FE	N	Y	N	Y	Y

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 The dependent variable is equal to 1 if the child died as an infant and 0 otherwise. The coefficients can be interpreted as a p.p. impact on infant mortality. The sample includes African-American births and infant deaths in Illinois, Ohio, Tennessee, North Carolina, and South Carolina to fathers born in those three southern states. Observations are weighted by the number of black births in each state and period within a region. The sample includes observations in the outcome year with fathers that could be matched to a state-of-birth childhood home in a prior census. Pre-migration occupation indicators are relative to the omitted category of "all other occupations." A tenant farmer is an observation that reports occupation as farmer and rents a farm. A head of household is literate if reporting that they can both read and write (in 1900-1920) and if reporting that they are literate in 1930.

Table 5: Fertility and marital outcomes of southern-born migrant and non-migrant African-American women.

	(1) Children ever born	(2) P(> 0 kids) (p.p)	(3) Age at marriage (years)	(4) P(Ever Married) (p.p)
MIG*1940	-1.27***	-11.1***	0.43***	-1.63***
	(0.02)	(0.34)	(0.032)	(0.047)
MIG*1930			1.10***	0.96***
			(0.046)	(0.22)
MIG*1920				0.39
				(0.67)
Controls				
State of birth	Y	Y	Y	Y
Age	Y	Y	Y	Y
Census year	N	N	Y	Y
Constant	3.76***	78.6***	20.92***	85.2***
	(0.03)	(0.35)	(0.05)	(0.22)
IPUMS sample	1940-100%	1940-100%	1940-100% 1930-5%	1940-100% 1930-5% 1920-1%
Observations	88,919	131,031	227,102	3,906,222
R-squared	0.094	0.052	0.070	0.260

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors are in parentheses. The sample includes southern-born black women aged 16 and over living in the South, Northeast, and Midwest census regions. All regressions include controls for state of birth and age. Census year indicators are included when sample consists of multiple census years. The variable of interest (MIG) is an indicator for a migrant mother (i.e. a southern-born female living in the Midwest or Northeast census regions at the time of the decennial census). Each column represent a regression with a separate dependent variable: 1) The number of children ever born, 2) an indicator for having at least one child, 3) age at first marriage, 4) an indicator for ever being married.

Table 6: Effect of migration to urban areas in South vs migration to the North

	(1)	(2)
Migrant*1920	0.078***	0.093***
	(0.029)	(0.030)
Migrant*1930	0.024**	0.041***
	(0.012)	(0.012)
Migrant*1940	0.000	0.004
	(0.013)	(0.013)
Urban*South*1920		0.078***
		(0.019)
Urban*South*1930		0.067***
		(0.016)
Urban*South*1940		0.010
		(0.012)
Year = 1930	-0.016**	-0.017**
	(0.008)	(0.009)
Year = 1940	-0.029**	-0.019**
	(0.008)	(0.008)
Controls?	Y	Y
County FE?	Y	Y
N	10,500	10,500
R-squared	0.0251	0.0305

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 The dependent variable is equal to 1 if the child died as an infant and 0 otherwise. The coefficients can be interpreted as a p.p. impact on infant mortality. Urban is defined as living in a city with more than 2500 people in the outcome year.The sample includes African-American births and infant deaths in Illinois, Ohio, Tennessee, North Carolina, and South Carolina to fathers born in those three southern states. Observations are weighted by the number of black births in each state and period within a region. The sample includes observations in the outcome year with fathers that could be matched to a state-of-birth childhood home in a prior census. Pre-migration controls include dummies for father's occupation, home ownership, and literacy of the father.

Appendix

DISCUSSION OF BIASES IN REVISED MORTALITY RATES

  - undercounting black births. (birth registration undercounts vs. census enumeration undercounts). Big in the South, and even in Ohio in some years. But, generally this significantly lowers the southern infant mortality rate relative to the north. This also changes the timing of eventual convergence of regional rates and north overtaking the south by pushing it to a later date. We get convergence somewhere in the late 1930s, whereas VSUS gets it in the late 1920s as seen in figure 2.

  - BIASES in the estimates and where are the differences coming from.

  - Differences could be coming from: 1.) Different period (april cutoff for census vs. calendar) 2.) Cohort rate vs. calendar rate

Biases:

1.) Census Undercount - is enumeration undercount positively correlated with birth registration undercount

2.) How would death registration undercount bias the estimates? If positively correlated with birth registration undercount, and under a high and low mortality rate.

Table A1: Comparison of revised black infant mortality rates to published *Vital Statistics of United States*

State of birth	Years	*VSUS* rate	Revised rate	Diff (Revised - VSUS)	
Illinois	1935-1940	6.34	6.39	0.04	=
Illinois	1927-1930	10.50	10.68	0.18	+
Illinois	1915-1920	n.a.	18.22	n.a	
Ohio	1935-1940	7.23	7.44	0.21	+
Ohio	1927-1930	12.15	11.04	-1.10	-
Ohio	1915-1920	n.a.	15.89	n.a	
Tennessee	1935-1940	8.21	6.88	-1.33	-
Tennessee	1927-1930	11.33	9.53	-1.80	-
Tennessee	1915-1920	n.a.	11.64	n.a.	
North Carolina	1935-1940	8.30	8.29	-0.01	=
North Carolina	1927-1930	10.49	9.75	-0.74	-
North Carolina	1915-1920	n.a.	10.52	n.a.	
South Carolina	1935-1940	9.03	7.96	-1.07	-
South Carolina	1925-1930	n.a.	9.85	n.a.	
South Carolina	1915-1920	n.a.	11.82	n.a.	

Notes: All entries in the table are measured in terms of p.p. (alternatively deaths per 100 live births). Infant mortality rates are for all black births in each state. VSUS did not report births prior to 1927 for IL, OH, NC, and TN, and prior to 1932 for SC. Because of this a comparison is not available for some years and is denoted by "n.a.". Revised and *VSUS* rates are six-year averages in 1940 and 4-year averages in 1930 to simplify the comparison. Revised rates for 1920 are six-year averages. See section 2 in the main text or the data appendix for a description of how the revised rates are constructed.

Sources: *Vital Statistics of the United States* (1915-1940), indices of the 1920-1940 Decennial Census of Population microdata and collected death certificate indices provided by FamilySearch.org.

Data Appendix

Outcome Variables:

- *1(Died as an infant)*=1 if the individual died within 365 days of birth date. From death certificate index.

  1(Died as an infant)=0 if the individual did not die within 365 days of birth date. The observation is from the census index if alive on census date. The death certificate index provides observations that died after 365 days from birth date, as a non-infant.

- *1(Neonatal death)*=1 if the individual died within 30 days of birth date. From death certificate index.

  1(Neonatal death)=0 if the individual did not die within 30 days of birth date. The observation is from the census index if alive on census date. The death certificate index provides observations that died after 30 days from birth date, as a post-neonatal death.

Variables used as Controls, Mechanisms, and for Robustness Checks

- *female*=1 for females; *female*=0 for males

Pre-migration Controls

- *Log Income Pre:* This is the log of the annual income earned by the individual/head-of-household, allocated based on a black specific industrial earnings score

- *1(Literate Pre)*=1 if the individual or head-of-household could read *and write*

  1(Literate Pre)=0 if the individual or head-of-household could not read and/or could not write.

- *1(Home Ownership Pre)=1* if the individual or head-of-household owned the home in which the family resided on the census date.

  1(Home Ownership Pre)=0 if the individual or head-of-household rented the home in   which the family resided on the census date.

- *1(Urban Pre)*=1 if the household resided in an incorporated town or city with at least 2,500 in population.

  1(Urban Pre)=0 if the household resided in a rural area or incorporated town with less   than 2,500 in population.

Post-migration controls and mechanisms

- *Log Income Father Post:* This is the log of the annual income earned by the father, allocated based on a black specific industrial earnings score adjusted for regional cost-of-living differences.

- *1(Literate Father Post)*=1 if the father could read *and* write

  1(Literate Father Post)=0 if the father could not read and/or could not write.

- *Father's age:* Age of father on child's date of birth

- *1(Literate Mother Post)*=1 if the mother could read *and write*

  1(Literate Mother Post)=0 if the mother could not read and/or could not write.
- *1(Mother Work)*=1 if the mother works outside the home

  1(Mother Work)=0 if the mother does not work outside the home
- *Mother's age:* Age of mother on child's date of birth
- *1(Cohabitate)*=1 if the mother and father are both present in the home.

  1(Cohabitate)=0 if the mother and father are not both present in the home.
- *1(Home Ownership Post)=1* if the individual owned the home in which the family resided on the census date.

  1(Home Ownership Post)=0 if the individual rented the home in which the family resided on the census date.
- *1(Urban Post)*=1 if the household resided in an incorporated town or city with at least 2,500 in population.

  1(Urban Post)=0 if the household resided in a rural area or incorporated town with less than 2,500 in population.
- *Migrant Network:* This variables counts the number of migrants living in the receiving city from the same county-of-origin as the father. Equal to zero for all non-migrants staying within the South.