

# Born on the Wrong Side of the Tracks: Exploring the Causal Effects of Segregation on Infant Health<sup>\*</sup>

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## Abstract

Prior research has found that a high level of residential racial segregation, or the degree to which racial/ethnic groups are isolated from one another, is associated with worsened infant health outcomes, particularly among non-Hispanic (NH) Black infants. However, because exposure to segregation is non-random, it is unclear whether and to what extent segregation is causally linked to infant health. To overcome this empirical limitation, we leverage exogenous variation in the placement of railroad tracks in the 19th century to predict contemporary segregation, an approach first introduced by [Ananat \(2011\)](#). In alignment with prior literature, we find that residential segregation has statistically significant associations with negative birth outcomes among Black infants. However, analyses that account for the endogeneity of segregation reveal a more complex story: using OLS methods underestimates the negative impacts of segregation on birth weight and fetal growth but overestimates its impacts on prematurity. We fail to detect comparable effects on health outcomes among NH White infants. Further, we identify several key mechanisms by which residential segregation could influence health outcomes among Black infants, including higher levels of anti-Black prejudice, greater transportation barriers, and increased food insecurity. Given that poor birth outcomes have adverse effects on adults' health and well-being, the findings suggest that in-utero exposure to residential segregation could have important implications for Black-White inequality over the life course. (JEL Classification: I14, I18, J15, R23)

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# 1 Introduction

Researchers and policymakers have directed increasing attention and resources to addressing the longstanding Black-White disparities in infant health. Non-Hispanic (NH) Black infants experience the highest rates of low birthweight, preterm birth, and infant mortality of any racial/ethnic subgroup in the United States ([Underwood et al., 2021](#); [Culhane and Goldenberg, 2011](#); [Green and Hamilton, 2019](#)). These disparities persist even after accounting for birthing parents' individual-level characteristics and health behaviors, signaling the need to better understand how structural factors drive infant health. Identifying the most salient structural factors and assessing the magnitude of their impact is essential to reducing racial/ethnic disparities in early-life health and thus addressing the long-term consequences of these disparities on adult economic status and well-being.

In the present study, we focus on one such structural factor: Black-White racial residential segregation (i.e., segregation). Segregation refers to the degree of spatial separation between racial/ethnic groups. NH White and NH Black Americans comprise 60 percent and 12 percent of the U.S. population, respectively (2020 U.S. Census Bureau). Yet the typical White American lives in an area that is 71 percent White and the typical Black American lives in an area that is 45 percent Black (2014-2018 American Community Survey). These patterns did not occur by happenstance: both private and governmental discriminatory processes served to segregate Black and White Americans for more than a century. While average segregation levels have declined over the past several decades, this overall trend obscures extreme racial segregation levels in certain U.S. metropolitan areas (e.g., Detroit), as well as the increasing spatial isolation between poor and affluent communities. Due to segregation, Black Americans are more likely than White and Asian Americans to live in impoverished neighborhoods with reduced access to high-quality schooling and other important resources. In sum, [Massey \(2020\)](#) described segregation as “a kind of spatial glue that holds a [racial]

stratification system together and intensifies its effects” (p. 1).

Segregation’s negative impacts on a neighborhood’s socioeconomic status (SES) and resources likely partially explain the strong association between segregation and health inequalities throughout the life course. For example, racial segregation is correlated with racial gaps in childhood asthma and early-life health outcomes such low birth weight ([Alexander and Currie, 2017](#); [Mehra et al., 2017](#)). Further, one study found that Black children who consistently lived in segregated neighborhoods were more likely to experience worse adult health and more likely to smoke or drink than those who moved in and out of highly segregated neighborhoods ([Schwartz et al., 2022](#)). In contrast, studies have generally found no effects, or sometimes even positive effects, of segregation on health outcomes among White populations, including White infants ([Kramer and Hogue, 2009](#)).

Despite the large body of evidence linking residential segregation and infant and child health, very few studies have assessed whether these links are causal. Such assessments are difficult because unobserved area-level characteristics simultaneously affect both segregation and health outcomes for Black infants. For example, a high exposure to toxins from factories and limited access to supermarkets selling nutrient-dense foods could affect both segregation and infant health ([Bailey et al., 2017](#)). Failing to account for these omitted variables produces biased estimates from OLS or even fixed effects models.

To address these potential biases, we use an instrumental variables (IV) identification strategy ([Ananat, 2011](#)), leveraging plausibly exogenous historical railroad divisions to estimate the causal impacts of residential segregation on the health of NH Black and NH White infants. Specifically, we leverage the fact that, in the early 19th century, train companies laid thousands of miles of railroad tracks in metropolitan areas to transport goods and passengers between cities. The arrangement of these tracks created ready-made neighborhood subdivisions, which local policymakers used to establish and enforce racially segregated neighborhoods in response to large influxes of Black migrants from the U.S. South ([Ananat,](#)

2011). These patterns have persisted to the present day, and thus railroad lines often define the boundaries between Black and White communities (see Figure 1). In other words, although train companies did not choose track configurations to facilitate racial segregation, they were a key technology that enabled segregation (Ananat, 2011). Importantly, we argue that the historical placement of railroad tracks is unrelated to contemporary birth outcomes and can serve as an exogenous instrument for estimating the causal effects of segregation on health.

The main IV results show that plausibly exogenous exposure to residential segregation has significant negative impacts on the birth outcomes of NH Black infants. Specifically, a 1 SD increase in racial segregation (equivalent to a 13.6% change) leads to a 28 gram decrease in birth weight, a 0.08 percentage point increase in the likelihood of low birth weight, a 0.02 percentage point increase in the likelihood of very low birth weight, a 0.07 percentage point increase in being categorized as small for gestational age, a 0.08 week decrease in gestational length, a 0.05 percentage point increase in the likelihood of preterm birth, and a 0.57 gram per week decrease in fetal growth among Black infants. The OLS results were generally smaller in magnitude or equal to the IV results, with the notable exception of prematurity-related outcomes. This pattern suggests that analyses that fail to account for the endogeneity of segregation likely underestimate its consequences for low birth weight and fetal growth, but overestimate its consequences for preterm birth. Importantly, we find few to no effects on White infants, providing some support for our proposed strategy to adequately account for unobservable factors correlated with segregation. Finally, we explore structural pathways through which segregation could potentially affect infant health. The analyses suggest that segregation is linked to increased area food insecurity (particularly among Black residents) and higher levels of implicit and explicit anti-Black prejudice, findings consistent with those of prior studies linking each of these mechanisms to poor birth outcomes (Simonovich et al., 2020; Grilo et al., 2022; Orchard and Price, 2017). Taken together, the findings contribute

to a growing literature documenting the causal impacts of racial segregation on the health and economic outcomes of Black Americans.

## 2 Background

### 2.1 Evolution of racial segregation outside the U.S. South

Residential segregation in the northern and western United States has a long and complex history. The large influx of Black migrants arriving from the U.S. South during the first half of the 20th century (i.e., the Great Migration) played a central role in this process ([Massey and Denton, 1988](#)). After the Civil War and the dissolution of legalized chattel slavery, Black Americans living in the former Confederacy made important strides in political participation, literacy, and economic advancement ([Foner, 2002](#); [Logan and Parman, 2017](#)). However, the premature withdrawal of federal oversight allowed former Confederate states to impose a series of laws rolling back progressive reforms such as state-funded public school systems for all racial groups and anti-discrimination laws. In addition, state and local governments actively worked to disenfranchise Black Americans and implement state-sanctioned segregation. Coupled with an exploitative sharecropping system that kept Black Southerners in permanent servitude, increasing levels of anti-Black racism (e.g., threats, land theft, public lynching), and the post-World War I increase in demand for labor in the North, these developments prompted many Black families to leave the U.S. South in search of better economic opportunities and freedom from the constant specter of violence ([Wilkerson, 2010](#)). Between 1910 and 1960/70, millions of Black Southerners migrated to the North and West, settling in urban centers such as Chicago, New York, and Detroit.

The historical evidence suggests that relatively few of these Black Southern migrants were able to achieve the economic security and prosperity they hoped for. White residents did not welcome the large influx of new migrants; both governmental and private actors

worked to segregate neighborhoods. Discriminatory practices such as redlining (the Federal Housing Administration’s refusal to insure houses in or in close proximity to Black neighborhoods) (Aaronson et al., 2021), racial housing covenants that barred homeowners from selling to Black Americans, and interracial violence (i.e., lynching) (Massey and Denton, 1988; Cook et al., 2018) funneled Black residents into highly segregated, overcrowded inner city neighborhoods with substandard housing and limited access to education and job opportunities.

However, the problem of segregation is not relegated to the past. As Massey (2020) noted (p.1), “segregation...remains an important nexus in America’s system of socioeconomic stratification.” Although openly discriminatory practices such as redlining and racial housing covenants are now illegal and average segregation levels have declined since the 1980s (Massey and Denton, 1988), extreme racial segregation persists in certain U.S. metropolitan areas and the spatial isolation between poor and affluent communities is increasing. Further, even the most affluent Black Americans are more likely than the least affluent Hispanic or Asian Americans to be segregated from White Americans. Even today, banks are more likely to deny mortgages to Black prospective home buyers (Wheeler and Olson, 2015), and appraisers routinely undervalue owner-occupied homes in Black communities (Perry et al., 2018). As such, the average Black American lives in a census tract where over 33% of the residents have incomes below the federal poverty line, whereas the average White American lives in a tract where only 21% of the residents are poor.

## 2.2 Segregation and infant health

A large literature suggests that segregation is associated with early life morbidity and mortality, particularly among Black infants. First, pregnant people who live in more segregated areas are less likely to successfully carry a pregnancy to term. For example, using a sample of Georgia births, Brown et al. (2012) found that segregation was associated with a higher risk

of stillbirth among Black birthing people, while the opposite was true for their White counterparts. More recent work from [Williams et al. \(2018\)](#) using national-level data found that low and declining segregation levels were associated with decreased stillbirth risks; further, Black pregnant people experienced disproportionate benefits from declines in segregation. In a 2017 systematic review, Mehra and colleagues reported that most of the focal studies found that Black infants born to parents living in more segregated neighborhoods were more likely to experience low birth weight, preterm birth, and infant mortality than those born to parents living in less segregated neighborhoods. In contrast, prior studies have found few to no associations between segregation and birth outcomes among NH White birthing people.

One important limitation of most extant studies on segregation and (infant) health is that they do not show that the estimated relationships are causal. Importantly, unmeasured area characteristics such as exposure to environmental toxins, lack of access to healthy food, and high levels of violence and crime could both increase segregation levels and worsen infant health outcomes. This empirical challenge often prevents researchers from fully understanding whether and to what extent segregation impacts early life health.

We are aware of only one prior study that attempted to estimate the causal impacts of segregation on infant health. [Austin et al. \(2016\)](#) estimated the links between MSA-level segregation and racial disparities in birth weight using the railroad division index as an instrument for segregation. Using two-stage least squares (2SLS) models, the authors found that every 1 percentage point increase in segregation lowered birth weight by 2.8 grams. In contrast, the same increase had little impact on White infants' birth weight. Importantly, the authors found that failing to account for the endogeneity of segregation understated the impact of segregation on health and well-being. However, the study focused on only one birth outcome (birth weight for the full infant sample, restricted to infants born at or after 37 weeks gestation). This limitation may prevent the identification of important pathways through which segregation impacts infant health, such as through preterm birth. Finally,

the study sample was restricted to a single year of data (2000), and thus does not allow an assessment of whether and to what extent the relationships between segregation and birth outcomes vary over time and across historical contexts ([Logan and Parman, 2017](#)).

### **2.3 Contribution of the present study**

This study builds on prior work examining the causal relationships between segregation and infant health ([Austin et al., 2016](#)) by examining several plausible structural pathways linking segregation and health. First, we measure infant health using an array of important birth outcomes, including low and very low birth weight, preterm and very preterm birth, gestational age, small for gestational age, and fetal growth. We examine preterm birth because experts have identified this outcome as the most important correlate of infant mortality. We also focus on intrauterine growth restriction (i.e., small for gestational age) because researchers consider it a potential pathway linking segregation and low birth weight. We use Vital Statistics birth records from 121 non-Southern MSAs for a 10-year period (2010-2019), which allows us to better understand trends in the links between segregation and birth outcomes over time.

We also integrate several additional sources of data to explore potential mechanisms through which segregation might influence birth outcomes. Recent work suggests that segregation reduces intergenerational mobility for Black children, and potential mechanisms underlying this link are reductions in government expenditures, declines in support for anti-poverty policies, and increases in anti-Black racism ([Chyn et al., 2022](#)). We focus primarily on access to resources and measures of the social environment that prior work has linked to adverse birth outcomes. First, we capture access to resources and infrastructure via MSA-level measures of food insecurity, housing security, and barriers to transportation. Diminished access to these resources could adversely affect food intake, stress levels, and ability to access healthcare, which in turn could affect infant health outcomes. Second, we assess

the links between segregation and MSA-level explicit and implicit prejudice, which prior work has linked to preterm birth among Black infants ([Orchard and Price, 2017](#)).

### 3 Data

The analyses use data from the American Community Survey (segregation and area characteristics), the 2010-2019 U.S. Vital Statistics Natality Files (infant health outcomes), Harvard’s Project Implicit website (anti-Black prejudice measures), the Food Environment Atlas (food insecurity), and the Comprehensive Housing Affordability Strategy data (housing insecurity).

**Segregation data.** We use nationally representative population samples from the American Community Survey (ACS) Integrated Public Use Microdata Series data ([Ruggles et al., 2022](#)) and data from [Cutler et al. \(1999\)](#) to capture residential segregation (via the dissimilarity index). The ACS is a nationally representative survey administered to three million households annually by the U.S. Census Bureau. The ACS data provide population estimates by race and Hispanic origin in each census tract, which we used to calculate a measure of segregation: the dissimilarity index. This index is a statistical measure used to assess the level of segregation within a given geographic area. It is based on the principle that segregation is defined as the unequal distribution of a particular population group across a geographic area. While this measure can be calculated for many social groups, we focus here on NH Black and NH White populations because they are the focus of the present study. (Throughout the remainder of the article, we use “Black” to refer to NH Black populations and “White” to refer to NH White populations.) The dissimilarity index was calculated as follows:

$$\text{Dissimilarity index} = \frac{1}{2} \sum_{i=1}^N \left| \frac{\text{Black}_i}{\text{Black}} - \frac{\text{White}_i}{\text{White}} \right| \quad (1)$$

where  $i$  is an index for a census tract within a city,<sup>1</sup>  $Black_i$  is the total number of Black residents in tract  $i$ ,  $White_i$  is the total number of White residents in tract  $i$ ,  $Black$  is the total number of Black residents in the city, and  $White$  is the total number of White residents in the city.

The index of dissimilarity measures the fraction of one group that would have to move to another neighborhood in order to equalize the population distribution in the metropolitan statistical area. In other words, this index measures how evenly Black residents are spread across census tracts within a city. The index of dissimilarity ranges from 0 to 1, with higher values indicating a greater degree of segregation ([Massey and Denton, 1988](#)). For example, a value of 0.5 indicates that 50% of the members of a specific population group would need to move to a different area in order for the two groups to be equally distributed. In general, values above 0.6 are considered to represent a high level of segregation, while values below 0.3 are considered to represent a low level of segregation ([Massey and Denton, 1988](#)).

**Infant health data.** The main data source for measuring infant health outcomes is a version of the 2010-2019 Vital Statistics Natality Files (VSNF). The VSNF comprises a yearly, individual-level record of all U.S. births and contains information on parental characteristics, including birthing person's age, race, education, and marital status. The data also contain information on the child's health at birth, such as gestational weeks and birth weight. We used this information to construct other infant health measures based on generally accepted cutoffs in the literature: preterm birth (gestational weeks  $< 37$ ), very preterm birth (gestational weeks  $< 34$ ), low birth weight (birth weight  $< 2,500$  grams), very low birth weight (birth weight  $< 1,500$  grams), and fetal growth (birth weight divided by gestational weeks; this measure was used in [Noghanibehambari 2022](#)). We also created a dummy outcome measure of small for gestational age that equals 1 if birth weight is below the 10th percentile of the birth weight distribution for the same gestational age ([Talge et al., 2014](#)).

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<sup>1</sup>We use the term “city” and metropolitan statistical area (MSA) interchangeably. Our unit of measurement in the empirical analysis is metropolitan statistical areas.

**Implicit and explicit prejudice data.** We used data collected from Harvard’s Project Implicit website, which has been gathering information on implicit and explicit prejudice toward various social groups, including Black Americans, since 1998. Specifically, we utilized data collected between 2010 and 2019 from individuals who voluntarily accessed the website and completed the anti-Black implicit association test. Although the Project Implicit website relies on a convenience sample of voluntary participants, it is currently the most extensive and inclusive source of data on implicit and explicit prejudice in the United States. The use of this dataset allowed us to examine the associations between racial segregation and the prevalence of implicit and explicit racial biases.

**Food insecurity data.** To measure food insecurity, we used data from the United States Department of Agriculture (USDA) Economic Research Service (ERS) Food Environment Atlas 2020. The Food Environment Atlas is a publicly available dataset that provides information on various measures of food access and availability across the United States. Specifically, we used data on food insecurity rates, which are based on the percentage of households that were categorized as having low or very low food security. These data were used to examine the relationship between the prevalence and distribution of food insecurity and segregation at the city level.

**Housing insecurity data.** To measure housing insecurity, we used the U.S. Department of Housing and Urban Development’s Comprehensive Housing Affordability Strategy (CHAS) data, 2015-2019. Specifically, we used CHAS data to identify the percentage of households that had at least one of four housing problems: high housing costs, overcrowding, lack of kitchen facilities, or lack of plumbing facilities. CHAS includes a range of data related to housing, including data on housing insecurity, such as the percentage of households that are severely or moderately cost-burdened. The use of this dataset allowed us to investigate the relationship between segregation and housing insecurity at the city level.

We derived the main estimation sample (i.e., the integrated segregation and birth data

samples) using the following criteria: First, we included only singleton births of either Black or White birthing people because health at birth is consistently worse for multiple births than for singleton births for reasons other than the health environment during the intrauterine period ([Almond and Mazumder, 2011](#)). Next, we restricted the sample to births occurring in the 121 U.S. cities outside the South for which [Ananat \(2011\)](#) constructed the railroad division index (RDI), because having the RDI data is essential to the instrumental variables estimation strategy.<sup>2</sup>. Finally, we only included cases with comprehensive information on all control variables (see Table [A.9](#) for details on sample derivation). The findings are robust to alternative specifications that balance the number of observations in the sample with the range of controls considered.

Table [A.1](#) presents summary statistics for the sample. In alignment with prior empirical evidence, adverse birth outcomes occurred significantly more frequently among Black infants than among their White counterparts. For example, the average rate of low birth weight among Blacks is 10.7%, while the same rate among Whites is significantly lower at 5.0%. A similar pattern is observed for the rate of premature births, with 13.6% of Black infants born prematurely compared to 8.0% of White infants.

## 4 Empirical Strategy

**Ordinary Least Squares (OLS).** We began the empirical analysis by examining the cross-sectional relationship between segregation and birth outcomes among Black and White birthing persons, as is standard in much of the literature on segregation and infant health.

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<sup>2</sup>[Ananat \(2011\)](#) defined the railroad division index (RDI) as:

$$RDI = 1 - \sum_i \left( \frac{area_{neighborhood_i}}{areatotal} \right)^2 \quad (2)$$

The RDI measures the extent to which the city's land is divided into subunits by railroads, with a higher value indicating a city is more divided.

Specifically, we estimated equations of the following form:

$$Y_{it} = \alpha + \beta Segregation_c + X'_{it}\gamma + \epsilon_{it} \quad (3)$$

where  $Y_{it}$  is the birth outcomes of infant  $i$  at time  $t$ .  $Segregation_c$  is the segregation level in city  $c$ .  $X_{it}$  is a vector of control variables for maternal and infant characteristics, including indicators for birthing parent's age (< 20, 20-24, 25-34, 35-44), education (high school dropout, high school graduate, some college), and marital status, and an indicator for infant sex. The parameter of interest in this model is  $\beta$ , which represents the conditional correlation between segregation and the health of infant  $i$  at year  $t$ .

**Instrumental Variables (IV).** OLS estimates of Equation 3 are prone to bias because (i) exposure to segregation is not randomly assigned and (ii) there are omitted variables. To address these potential sources of bias, we employed an instrumental variables estimation strategy. We ran equations (second stage) similar to those above, but in the first stage we accounted for the non-random nature of segregation using railroad division as an instrument for segregation. Because railroad tracks act as dividers, impeding the flow of pedestrian and vehicle traffic and thus creating geographic areas that are relatively isolated from one another, we expect areas with more railroad-created subunits to have more segregation. The use of railroad division as an instrument follows the approach developed by [Ananat \(2011\)](#). The specification for the first stage is:

$$Segregation_c = \delta RDI_c + \mu \quad (4)$$

where  $RDI$  is the railroad division index as defined in Equation 2. The specification for the second stage is:

$$Y_{it} = \delta_s + \theta_t + \beta \widehat{Segregation}_c + X'_{it}\gamma + \epsilon_{it} \quad (5)$$

where  $\delta_s$  represents state fixed effects and  $\theta_t$  represents year of birth fixed effects that control for time-invariant unobserved heterogeneity that might affect infant health.  $\widehat{Segregation}_c$  is the predicted changes in city  $c$ 's residential segregation obtained through the first-stage estimates. Following Chyn et al. (2022), we adjusted standard errors using methods suitable for addressing the issue of weak instruments (Anderson and Rubin, 1949; Lee et al., 2022) and found consistent inference results.

The IV framework requires the exclusion restrictions to hold in order to interpret the estimates as the causal effect of segregation. The exclusion restriction of RDI for segregation requires railroad placement to affect infant health outcomes through changes in segregation and not directly in any way. It is useful to consider the causes of U.S. railroad placement to assess whether any of these factors directly affect contemporary infant health. In the early days of railroads, railroad company executives and investors often decided where to lay the tracks. They considered factors such as the availability of land, the potential for business along the proposed route, and the potential to connect with other railroads. They also took into account the terrain and any natural obstacles that might make construction more difficult or expensive (Atack and Passell, 1994). Ultimately, the goal was to build a profitable railroad that would connect important population centers and economic hubs. Thus, the factors that determined the placement of railroads were not necessarily related to the characteristics of a city that affect infant health. Below, we summarize regression results that support the assumption that railroad placement affects infant health through racial segregation.

We replicated a falsification check used by Ananat (2011) to test for correlations between RDI and city characteristics in 1910-1920, just after the period of major railroad construction; results are shown in Appendix Table A.2. We found no association between RDI and 1910-1920 city characteristics, which lends support to the reliability of the exclusion restriction that railroad division affects birth outcomes through changes in segregation and not in other

ways.

The IV framework also requires a relevant first stage. Table 4 reports the first-stage estimates of Equation (4). We began by analyzing the first-stage results without controlling for track length per square kilometer; results are shown in Column (1). The coefficient for this specification is positive and significant at the 1% level, meaning that higher values of RDI are associated with higher residential segregation in 1990. The first-stage estimate is similar in the specification controlling for track length, shown in Column (2). In both cases, the F-statistics are all greater than 10 ([Stock and Yogo, 2005](#)).

## 5 Results

**Concern about endogenous sample selection.** Endogenous sample selection is a significant concern. Specifically, if segregation has an impact on fertility among Black birthing people, it may lead to biased estimates. To address this issue, we conducted tests to assess the impact of segregation on fertility rates (births per 1,000 birthing people aged 15-44) and birth rates (births per 1,000 people in the general population) of Black birthing people, and the results are presented in Table 2. We also used the probability of male birth as a proxy for miscarriages, as male fetuses are more vulnerable to the negative effects of maternal stress in utero, and a reduction in male births may indicate an increase in miscarriages ([Sanders and Stoecker, 2015](#)). Our analysis revealed no significant impact of segregation on fertility rates for Black birthing people (Columns 1 to 4). Additionally, we observed very small impacts of segregation on the likelihood of male births for Black populations (Columns 5 and 6). These findings indicate that endogenous sample selection does not bias our results and that the impact of segregation on the birth outcomes of Black infants is not overstated.

**OLS results.** We began the econometric analysis by conducting an OLS regression estimating Equation 3 separately for Blacks and Whites; results are presented in Table 3.

As shown in Panel A, among Black infants, a 1 SD increase in residential segregation is associated with roughly a 20 g decrease in birth weight (Column 1), a 0.07 percentage point increase in low birth weight (Column 2), a 0.02 percentage point increase in very low birth weight (Column 3), and a 0.04 percentage point increase in being categorized as small for gestational age (Column 4). In addition, this increase in segregation is associated with a 0.09 week decrease in gestational length (Column 5), a 0.01 percentage point increase in the likelihood of preterm birth (Column 6), a 0.05 percentage point increase in the likelihood of very preterm birth, and a 0.35 gram per week decrease in fetal growth (Column 8) for Black infants. Panel B of Table 3 shows the results for White infants. Relative to the results for Black infants, estimates are smaller (Columns 1, 2, 3, 5, 6, and 7) or indicate relationships in the opposite direction (Columns 4 and 8).

Though robust, the OLS results might still be biased. They could be overestimated because living in highly segregated areas may constrain social and economic opportunities for Black birthing people, reducing access to social and health services that support pre-conception and prenatal care ([Acevedo-Garcia et al., 2003](#); [Williams and Collins, 2016](#)). In contrast, the results could be biased downward if living near ethnic enclaves is associated with positive health factors such as social support and cohesion ([Bell et al., 2006](#)). To correct for these and other potential biases, we employ an instrumental variables strategy.

**IV results.** Table 5 reports second-stage estimates. Panel A presents estimates for Black infants. As shown in Columns 1-4, a 1 SD increase in residential segregation leads to a 28 gram decrease in birth weight, a 0.08 percentage point increase in the likelihood of low birth weight, a 0.02 percentage point increase in the likelihood of very low birth weight, a 0.07 percentage point increase in being categorized as small for gestational age, a 0.08 week decrease in gestational length, a 0.05 percentage point increase in the likelihood of preterm birth, and a 0.57 gram per week decrease in fetal growth among Black infants. Among White infants (Panel B), the coefficients are either not statistically significant (Columns 2, 4, and

8), in the unexpected direction (Columns 2, 3, 4, and 7), or smaller in magnitude (Columns 1, 5, and 6).

We ran multiple robustness tests for the IV estimates. First, the results are robust when no control variables are included, which is significant given that [Blandhol et al. \(2022\)](#) demonstrated that the interpretation of linear instrumental variable estimates as local average treatment effects may not be justified when covariates are included in the regression model (Table A.3). Second, following [Ananat \(2011\)](#), we controlled for city characteristics in 1910 and 1920, as these historical city characteristics might affect cities today. The results, shown in Tables A.4 and A.5, indicate that the estimates remain robust even after controlling for these historical city characteristics, which may have affected cities in ways that persist today. Third, the results are robust when we use the isolation index instead of the dissimilarity index to measure segregation; results are shown in Table A.6.<sup>3</sup> Specifically, the effects were smaller in magnitude but still present when using the isolation index compared to the dissimilarity index. This robustness check confirms that the results are not reliant on a single measure and provides a more robust and accurate representation of the effects of segregation patterns in a given city.

**IV estimates and OLS estimates.** A comparison of the OLS results in Table 3 and the IV results in Table 5 indicates that the OLS analysis underestimates the impact of segregation on birth weight, incidence of small for gestational age, and fetal growth among Black infants, while it overestimates the impact on preterm birth and very preterm birth. The discrepancy between model results could be due to the fact that segregation can cause chronic stress, which is a major contributing factor in the development of low birth weight ([Dunkel Schetter, 2011](#)). In particular, current research suggests that pregnancy anxiety, chronic stress, and depression play a significant role in the occurrence of preterm birth and

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<sup>3</sup>The isolation index is a widely used measure of segregation that gauges the probability of minority residents being surrounded by others within their group. A higher isolation index value suggests more pronounced levels of segregation ([Massey and Denton, 1988](#)).

low birth weight. Specifically, researchers have identified anxiety during pregnancy as a major risk factor in the development of preterm birth (Dunkel Schetter and Glynn, 2011), and view chronic stress and depression as contributing factors in the etiology of low birth weight (Rich-Edwards and Grizzard, 2005; Field et al., 2006; Dunkel Schetter and Lobel, 2012).

## 6 Mechanisms

A limited number of studies have established that segregation is associated with lower public spending because areas with a high level of segregation generate fewer revenues (Chyn et al., 2022; Cox et al., 2022). In addition, a larger body of literature has documented the association between racial resentment and lukewarm support for welfare programs and redistributive policies (Metzl, 2019; Westbrook, 2020). Because government spending and redistributive polices can directly or indirectly impact infants' health outcomes in various ways, including by providing better nutrition or a healthier environment, these policies could act as potential mechanisms driving the relationships between segregation and infant health. Using government finances data from the U.S. Census Bureau, we replicated the findings of Chyn et al. (2022) on the relationship between segregation and government spending, and extended their study by including additional data and conducting further analyses. Specifically, in addition to the data used by Chyn et al. (2022), we used data from 1985-1986 and 1993-1995 to increase power and test the robustness of the Chyn et al. (2022)'s results. We analyzed both government spending and revenue categories to gain a more complete understanding of the impact of segregation on government finances. The analysis confirmed the conclusion of Chyn et al. (2022) that segregation has a substantial negative impact on government spending (Table A.7). Additionally, we found that segregation leads to lower government revenue. This implies that segregation not only reduces the funds available for

government expenditure, but also has an impact on the overall size of the government's budget. It should be noted that this reduction in revenue cannot solely be attributed to the impoverishment of segregated communities, as it may also be a result of intentional disinvestment in these areas.

We also explored potential mechanisms in several additional ways. First, anti-Black prejudice can shape the experiences and opportunities of Black birthing people and can have significant impacts on access to education, employment, healthcare, and other resources, which could in turn adversely influence infant health. For example, if a health care provider holds conscious or unconscious biases against Black birthing people, they may be less likely to provide the same level of care to Black birthing people as they do to others, which can generate disparities in both access to health care and the quality of care received and thus may have negative impacts on infant health. Table 6 presents results concerning the relationship between segregation and racial prejudice. Specifically, the results in Columns (1) and (2) show that when segregation increases by 1 standard deviation, there is a corresponding 1.1 percentage point increase in anti-Black implicit prejudice and a 3.3 percentage point increase in anti-Black explicit prejudice among non-Black test takers. The results in Columns (3) and (4) of Table 6, which show no association between higher levels of segregation and prejudice measures among Black test takers, serve as a placebo test.

Second, food insecurity, or a lack of access to sufficient, safe, and nutritious food, may also be a critical mechanism by which segregation worsens Black infants' birth outcomes. Poor nutrition during pregnancy can lead to low birth weight ([Bergner and Susser, 1970](#)), which is associated with an increased risk of complications during childbirth, such as preterm delivery, and an increased risk of long-term health problems for the infant, such as developmental delays and chronic conditions ([Destra, 2019](#)). Food insecurity can also lead to maternal malnutrition, which can weaken the immune system and increase the risk of infections, complications, and adverse outcomes for both the pregnant person and the infant ([Black](#)

et al., 2008). Additionally, food insecurity can contribute to stress and mental health issues, which can have negative impacts on pregnancy and childbirth (Pourmotabbed et al., 2020).

Segregation can lead to food insecurity by limiting the resources and opportunities available to individuals and communities, including access to nutritious and healthy food options. For example, segregated neighborhoods may have fewer supermarkets and grocery stores, and thus limited access to fresh and healthy food options (Bower et al., 2014). The results in Table 7 show that higher levels of segregation are associated with lower access to stores for Black individuals (Column 1), but not for White individuals (Column 2). These results also illustrate the link between higher levels of segregation and higher levels of food insecurity (Column 3) and very low food security (Column 4). In addition, neighborhoods with higher levels of segregation tend to have fewer grocery stores (Column 5), providing further evidence of the ways in which segregation can restrict access to essential resources and opportunities, leading to food insecurity and other negative outcomes.

Third, transportation barriers such as long commutes, unreliable transportation options, and obstacles to using public transportation can lead to stress and limit pregnant people's ability to obtain healthcare services and otherwise engage in activities that promote their mental and physical well-being (Broussard, 2010). This limitation, in turn, can affect maternal stress levels and parenting practices, resulting in impacts on infant health. Using American Community Survey data, we tested whether transportation barriers are higher in areas with higher levels of segregation; results are presented in Table 8. We found that higher segregation levels correspond to longer commutes for both Black individuals (Column 1) and White individuals (Column 3), with a greater increase among Blacks. Higher segregation levels also result in a significantly lower percentage of households without vehicles among Whites (Column 4); the coefficient for Blacks is even larger (Column 2) but is not statistically significant.

Finally, we used the Comprehensive Housing Affordability Strategy (CHAS) data to

examine the relationship between segregation and housing insecurity (results in Table A.8). We did not observe a significant association between segregation and housing insecurity for Black owners or renters. In contrast, White owners and renters gain an advantage from segregation because higher segregation levels are linked to fewer housing issues for Whites.

## 7 Conclusion

In the United States, NH Black infants experience dramatically worse birth outcomes than infants in other racial/ethnic groups. Racial segregation, which has served as a tool of discrimination and oppression against Black Americans, resulting in unequal access to resources, opportunities, and services, and thus perpetuating and exacerbating existing inequalities, is one possible driver of these differences in birth outcomes. Indeed, there is robust evidence that racial segregation is associated with worsened health outcomes for NH Black infants, which suggests that eliminating racial segregation could play a crucial role in reducing health disparities. However, the presence of a causal link between segregation and infant health, as well as the magnitude of this link, remains largely uncertain, partly due to non-random exposure to segregation.

In this paper, we leverage administrative birth data and plausibly exogenous variations driven by railroad division to provide evidence on the causal effect of racial residential segregation on the health of NH Black infants. Instrumental variable results reveal that higher levels of racial segregation lead to multiple adverse health outcomes for Black infants, including decreased birth weight, shorter gestational length, and higher likelihood of low birth weight and preterm birth. We found no comparable impacts among White infants.

This research highlights the need for policymakers and community leaders to address segregation as a root cause of health disparities and to implement measures that promote more equitable and integrated communities. Given that poor birth outcomes can have harmful

impacts on adults' health and well-being, alleviating these disparities can also address their long-term consequences for adults' economic status and well-being. The current results also provide suggestive evidence that greater anti-Black prejudice, higher transportation barriers, increased food insecurity, and lower government spending and weaker redistributive policies are significant mechanisms contributing to the link between residential segregation and poor health outcomes among Black infants. By understanding these mechanisms, policymakers and community leaders can develop targeted interventions to address the specific challenges faced by communities affected by segregation and can work toward a more equitable and just society.

## References

- Aaronson, D., Hartley, D., and Mazumder, B. (2021). The Effects of the 1930s HOLC "Redlining" Maps. *American Economic Journal: Economic Policy*, 13(4):355–92.
- Acevedo-Garcia, D., Lochner, K. A., Osypuk, T. L., and Subramanian, S. V. (2003). Future directions in residential segregation and health research: a multilevel approach. *American journal of public health*, 93(2):215–221.
- Alexander, D. and Currie, J. (2017). Is it who you are or where you live? Residential segregation and racial gaps in childhood asthma. *Journal of health economics*, 55:186–200.
- Almond, D. and Mazumder, B. (2011). Health Capital and the Prenatal Environment: The Effect of Ramadan Observance during Pregnancy. *American Economic Journal: Applied Economics*, 3(4):56–85.
- Ananat, E. O. (2011). The Wrong Side(s) of the Tracks: The Causal Effects of Racial Segregation on Urban Poverty and Inequality. *American Economic Journal: Applied Economics*, 3(2):34–66.

- Anderson, T. W. and Rubin, H. (1949). Estimation of the parameters of a single equation in a complete system of stochastic equations. *The Annals of mathematical statistics*, 20(1):46–63.
- Atack, J. and Passell, P. (1994). A New Economic View of American History: From Colonial Times to 1940.
- Austin, N., Harper, S., and Strumpf, E. (2016). Does Segregation Lead to Lower Birth Weight? *Epidemiology*, 27(5):682–689.
- Bailey, Z. D., Krieger, N., Agénor, M., Graves, J., Linos, N., and Bassett, M. T. (2017). Structural racism and health inequities in the USA: evidence and interventions. *The Lancet*, 389(10077):1453–1463.
- Bell, J. F., Zimmerman, F. J., Almgren, G. R., Mayer, J. D., and Huebner, C. E. (2006). Birth outcomes among urban African-American women: a multilevel analysis of the role of racial residential segregation. *Social science & medicine*, 63(12):3030–3045.
- Bergner, L. and Susser, M. W. (1970). Low birth weight and prenatal nutrition: an interpretative review. *Pediatrics*, 46(6):946–966.
- Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., De Onis, M., Ezzati, M., Mathers, C., and Rivera, J. (2008). Maternal and child undernutrition: global and regional exposures and health consequences. *The lancet*, 371(9608):243–260.
- Blandhol, C., Bonney, J., Mogstad, M., and Torgovitsky, A. (2022). When is TSLS Actually LATE? Working Paper 29709, National Bureau of Economic Research.
- Bower, K. M., Thorpe Jr, R. J., Rohde, C., and Gaskin, D. J. (2014). The intersection of neighborhood racial segregation, poverty, and urbanicity and its impact on food store availability in the United States. *Preventive medicine*, 58:33–39.
- Broussard, C. A. (2010). Research regarding low-income single mothers' mental and physical health: A decade in review. *Journal of Poverty*, 14(4):443–451.
- Brown, R. A., Hogue, C., and Kramer, M. (2012). Social and economic determinants

- of stillbirths in Georgia. *International Journal on Disability and Human Development*, 11(4):369–375.
- Chyn, E., Haggag, K., and Stuart, B. A. (2022). The Effects of Racial Segregation on Intergenerational Mobility: Evidence from Historical Railroad Placement. Working Paper 30563, National Bureau of Economic Research.
- Cook, L. D., Logan, T. D., and Parman, J. M. (2018). Racial Segregation and Southern Lynching. *Social Science History*, 42(4):635–675.
- Cox, R., Cunningham, J., Ortega, A., and Whaley, K. D. (2022). Black Lives: The High Cost of Segregation. Working Paper 050922, Washington Center for Equitable Growth.
- Culhane, J. F. and Goldenberg, R. L. (2011). Racial disparities in preterm birth. 35(4):234–239.
- Cutler, D. M., Glaeser, E. L., and Vigdor, J. L. (1999). The rise and decline of the American ghetto. *Journal of political economy*, 107(3):455–506.
- Desta, M. (2019). Low birth weight and adverse perinatal outcomes. In *Childbirth*, pages 1–15. IntechOpen.
- Dunkel Schetter, C. (2011). Psychological science on pregnancy: stress processes, biopsychosocial models, and emerging research issues. *Annual review of psychology*, 62:531–558.
- Dunkel Schetter, C. and Glynn, L. M. (2011). Stress in pregnancy: Empirical evidence and theoretical issues to guide interdisciplinary research.
- Dunkel Schetter, C. and Lobel, M. (2012). Pregnancy and birth outcomes: A multilevel analysis of prenatal maternal stress and birth weight.
- Field, T., Diego, M., and Hernandez-Reif, M. (2006). Prenatal depression effects on the fetus and newborn: a review. *Infant Behavior and Development*, 29(3):445–455.
- Foner, E. (2002). *Reconstruction: America's unfinished revolution, 1863-1877*. Harper Collins.
- Green, T. and Hamilton, T. G. (2019). Maternal educational attainment and infant mortality

- in the united states. *Demographic Research*, 41:713–752.
- Grilo, S. A., Earnshaw, V. A., Lewis, J. B., Stasko, E. C., Magriples, U., Tobin, J. N., and Ickovics, J. R. (2022). Food matters: Food insecurity among pregnant adolescents and infant birth outcomes. *The journal of applied research on children : informing policy for children at risk*, 6.
- Kramer, M. R. and Hogue, C. R. (2009). Is segregation bad for your health? *Epidemiologic reviews*, 31(1):178–194.
- Lee, D. S., McCrary, J., Moreira, M. J., and Porter, J. (2022). Valid t-ratio Inference for IV. *American Economic Review*, 112(10):3260–90.
- Logan, T. D. and Parman, J. M. (2017). The National Rise in Residential Segregation. *The Journal of Economic History*, 77(1):127–170.
- Massey, D. S. (2020). Still the Linchpin: Segregation and Stratification in the USA. *Race and Social Problems*, 12(1):1–12.
- Massey, D. S. and Denton, N. A. (1988). The dimensions of residential segregation. *Social forces*, 67(2):281–315.
- Mehra, R., Boyd, L. M., and Ickovics, J. R. (2017). Racial residential segregation and adverse birth outcomes: a systematic review and meta-analysis. *Social science & medicine*, 191:237–250.
- Metzl, J. M. (2019). Dying of whiteness: How the politics of racial resentment is killing America’s heartland.
- Noghanibehambari, H. (2022). Intergenerational health effects of medicaid. *Economics & Human Biology*, 45:101114.
- Orchard, J. and Price, J. (2017). County-level racial prejudice and the black-white gap in infant health outcomes. *Social science & medicine*, 181:191–198.
- Perry, A., Rothwell, J., and Harshbarger, D. (2018). The devaluation of assets in black neighborhoods. *Library Catalog: www. brookings. edu*.

- Pourmotabbed, A., Moradi, S., Babaei, A., Ghavami, A., Mohammadi, H., Jalili, C., Symonds, M. E., and Miraghajani, M. (2020). Food insecurity and mental health: a systematic review and meta-analysis. *Public health nutrition*, 23(10):1778–1790.
- Rich-Edwards, J. W. and Grizzard, T. A. (2005). Psychosocial stress and neuroendocrine mechanisms in preterm delivery. *American journal of obstetrics and gynecology*, 192(5):S30–S35.
- Ruggles, S., Flood, S., Goeken, R., Schouweiler, M., and Sobek, M. (2022). IPUMS USA: Version 12.0 [dataset].
- Sanders, N. J. and Stoecker, C. (2015). Where Have All the Young Men Gone? Using Gender Ratios to Measure Fetal Death Rates. *Journal of Health Economics*, 41:30–45.
- Schwartz, G. L., Wang, G., Kershaw, K. N., McGowan, C., Kim, M. H., and Hamad, R. (2022). The long shadow of residential racial segregation: Associations between childhood residential segregation trajectories and young adult health among Black US Americans. *Health & place*, 77:102904.
- Simonovich, S. D., Pineros-Leano, M., Ali, A., Awosika, O., Herman, A., Withington, M. H. C., Loiacono, B., Cory, M., Estrada, M., Soto, D., and Buscemi, J. (2020). A systematic review examining the relationship between food insecurity and early childhood physiological health outcomes. *Translational Behavioral Medicine*, 10(5):1086–1097.
- Stock, J. and Yogo, M. (2005). *Testing for Weak Instruments in Linear IV Regression*, pages 80–108. Cambridge University Press, New York.
- Talge, N. M., Mudd, L. M., Sikorskii, A., and Basso, O. (2014). United States birth weight reference corrected for implausible gestational age estimates. *Pediatrics*, 133(5):844–853.
- Underwood, L., Adams, A., Booker, C., and members of the Black Maternal Health Caucus (2021). Black Maternal Health Momnibus Act of 2021.
- Weinberg, I., Iceland, J., and Steinmetz, E. (2002). Measurement of segregation by the us bureau of the census.”. *Racial and ethnic residential segregation in the United States*:

1980–2000.

- Westbrook, A. (2020). Dying of Whiteness: How the Politics of Racial Resentment is Killing America's Heartland. *Family Medicine*, 52(3):227–228.
- Wheeler, C. H. and Olson, L. M. (2015). Racial differences in mortgage denials over the housing cycle: Evidence from US metropolitan areas. *Journal of Housing Economics*, 30:33–49.
- Wilkerson, I. (2010). *The Warmth of Other Suns: The Epic Story of America's Great Migration*. Random House.
- Williams, A. D., Wallace, M., Nobles, C., and Mendola, P. (2018). Racial residential segregation and racial disparities in stillbirth in the United States. *Health & place*, 51:208–216.
- Williams, D. R. and Collins, C. (2016). Racial residential segregation: a fundamental cause of racial disparities in health. *Public health reports*.

## 8 Figures

Figure 1: Lines of Segregation

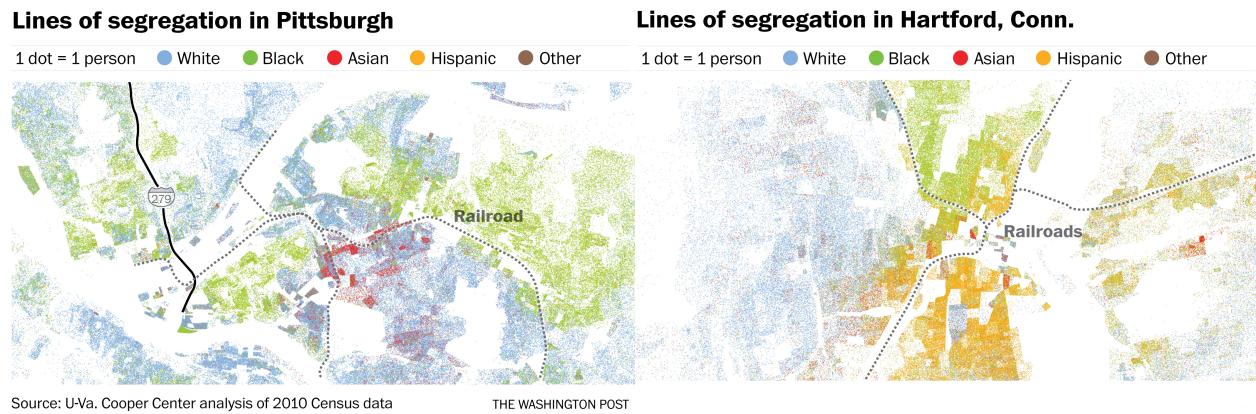
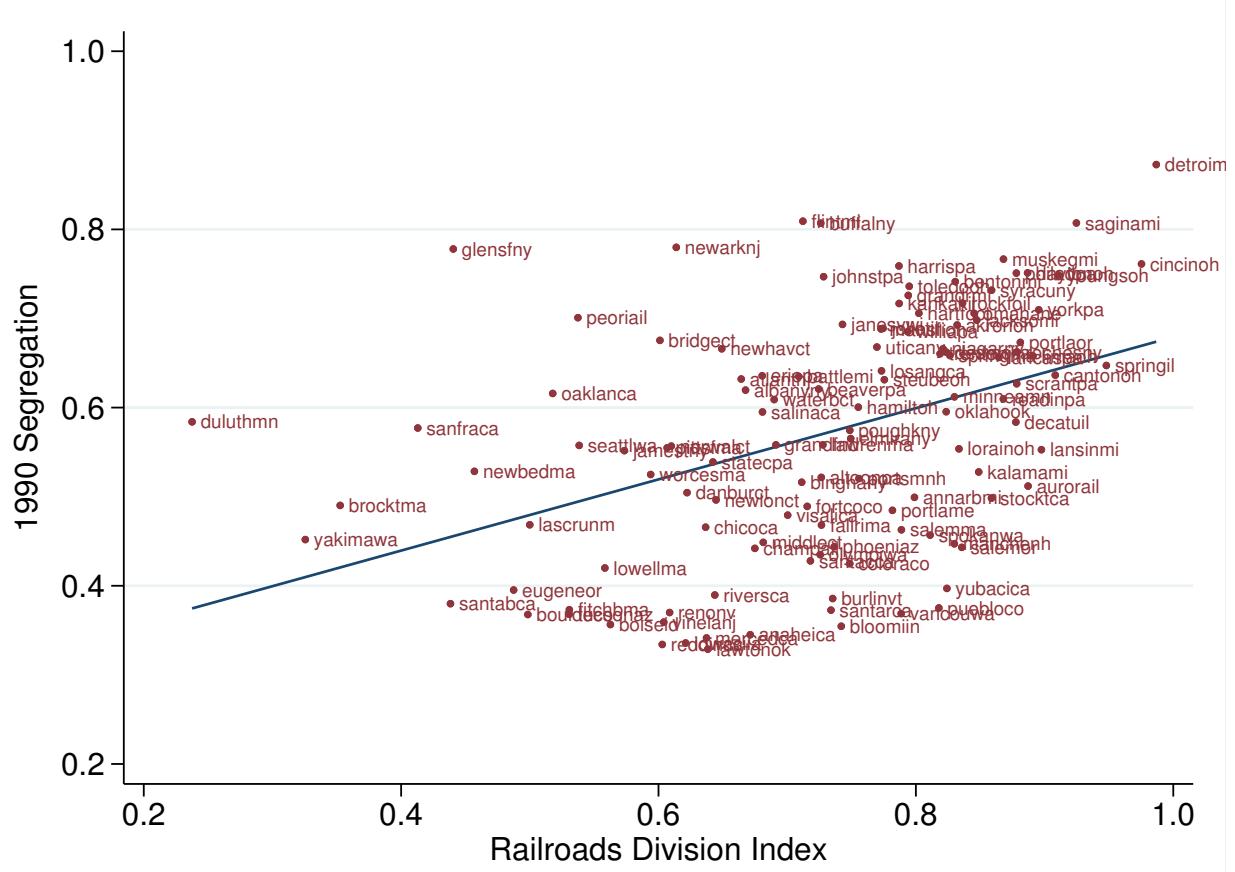


Figure 2: Segregation and Railroads Division Index



Notes: This figure depicts the relationship between 1990 segregation and the railroad division index.

## 9 Tables

Table 1: Components of Segregation

Dimension of Segregation	Definition	Measurement
Evenness	Unequal distribution of Black and White populations across areal units (e.g., neighborhoods) of an urban area	Dissimilarity index Theil's entropy index
Exposure	Degree to which Black and White populations have the potential contact	Isolation index Interaction index
Clustering	Degree to which minority (e.g., Black Americans) areas adjoin one another in space	White's index of spatial proximity
Centralization	Degree to which a group (Black or White) is located in close proximity of far away from the center urban area	Centralization index
Concentration	Relative amount of physical space taken up by a minority group (e.g., Black Americans) in an urban environment	Concentration index

Source: [Weinberg et al. \(2002\)](#), Measurement of Segregation by the US Bureau of the Census, *Racial and Ethnic Residential Segregation in the United States: 1980-2000*

Table 2: Racial Segregation and Fertility of Black Birthing People

	<i>Births per 1,000 women aged 15-44</i>	<i>Births per 1,000 population</i>	<i>Probability of a male birth</i>			
	(1)	(2)	(3)	(4)	(5)	(6)
1990 Dissmilarity index	0.2967 (0.3185)	-0.9131 (0.8101)	-0.0132 (0.0605)	-0.1760 (0.1503)	-0.0000* (0.0000)	-0.0000*** (0.0000)
Effect of 1 SD increase	0.040	-0.124	-0.002	-0.024	-0.000	-0.000
Mean dep. var.	4.73	4.73	0.97	0.97	0.51	0.51
Observations	25,920	25,920	25,920	25,920	1,020,350	1,020,350
Year of birth FE	No	Yes	No	Yes	No	Yes
State of birth FE	No	Yes	No	Yes	No	Yes

Notes: Data are from Vital Statistics Natality and Surveillance, Epidemiology, and End Results (SEER) 2010-2019. Fertility rate is defined as births per 1,000 birthing people aged 15-44, birth rate is defined as births per 1,000 population, and male birth is a dummy for male birth. Controls include four dummies for birthing person's age, three dummies for birthing person's education, and a dummy for birthing person's marital status. Heteroskedasticity robust standard errors are reported in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table 3: OLS Estimates

<i>Outcomes</i>	<i>Birth Weight</i>	<i>Low Birth Weight</i>	<i>Very Low Birth Weight</i>	<i>Small for Gestational Age</i>	<i>Gestational Weeks</i>	<i>Preterm Birth</i>	<i>Very preterm Birth</i>	<i>Fetal Growth</i>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Panel A: Blacks</b>								
1990 Dissmilarity index	-143.8228*** (4.4149)	0.0540*** (0.0022)	0.0164*** (0.0011)	0.0281*** (0.0027)	-0.6530*** (0.0202)	0.0793*** (0.0025)	0.0372*** (0.0015)	-2.5420*** (0.1038)
Effect of 1 SD increase	-19.591	0.007	0.002	0.004	-0.089	0.011	0.005	-0.346
Mean dep. var.	3,145.79	0.11	0.02	0.17	38.43	0.14	0.05	81.50
Observations	1,020,350	1,020,350	1,020,350	1,020,350	1,019,553	1,020,350	1,020,350	1,019,553
<b>Panel B: Whites</b>								
1990 Dissmilarity index	-3.2835** (1.6742)	0.0107*** (0.0007)	0.0042*** (0.0003)	-0.0050*** (0.0009)	-0.2214*** (0.0067)	0.0250*** (0.0008)	0.0115*** (0.0004)	0.3759*** (0.0397)
Effect of 1 SD increase	-0.447	0.001	0.001	-0.001	-0.030	0.003	0.002	0.051
Mean dep. var.	3,387.33	0.05	0.01	0.09	38.97	0.08	0.02	86.75
Observations	5,066,070	5,066,070	5,066,070	5,066,070	5,063,035	5,066,070	5,066,070	5,063,035
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows OLS estimation results from Equation (3). Data are from Vital Statistics Natality 2010-2019. Controls include four dummies for birthing person's age, three dummies for birthing person's education, a dummy for birthing person's marital status, and a dummy for male birth. Heteroskedasticity robust standard errors are reported in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table 4: Instrumental Variables Estimates: First-Stage

<i>Outcome</i>	<i>1990 Segregation</i>	
	(1)	(2)
RDI	0.40*** (0.08)	0.36*** (0.09)
Observations	121	121
R-squared	0.17	0.20
Control for railroad track length	No	Yes
F-test	21.57	13.46

Notes: The table shows estimation results from Equation (4). Data are from Vital Statistics Natality 2010-2019. Columns (1) and (3) show results without controlling for track length per square kilometer. Columns (2) and (4) show results controlling for track length. Heteroskedasticity robust standard errors are reported in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table 5: Instrumental Variables Estimates: Second-Stage

Outcomes	<i>Birth Weight</i>	<i>Low Birth Weight</i>	<i>Very Low Birth Weight</i>	<i>Small for Gestational Age</i>	<i>Gestational Weeks</i>	<i>Preterm Birth</i>	<i>Very preterm Birth</i>	<i>Fetal Growth</i>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Panel A: Blacks</b>								
1990 Dissmilarity index	-204.7514*** (28.8789) [28.5860] {29.3298}	0.0594*** (0.0145) [0.0144] {0.0150}	0.0159** (0.0067) [0.0066] {0.0071}	0.0495*** (0.0180) [0.0178] {0.0182}	-0.6023*** (0.1309) [0.1296] {0.1350}	0.0392** (0.0162) [0.0160] {0.0166}	0.0168* (0.0098) [0.0097] {0.0102}	-4.2074*** (0.6790) [0.6721] {0.6890}
Effect of 1 SD increase	-27.891	0.008	0.002	0.007	-0.082	0.005	0.002	-0.573
Mean dep. var.	3,145.79	0.11	0.02	0.17	38.43	0.14	0.05	81.50
Observations	1,020,350	1,020,350	1,020,350	1,020,350	1,019,553	1,020,350	1,020,350	1,019,553
<b>Panel B: Whites</b>								
1990 Dissmilarity index	-62.1018*** (15.1465) [14.9931] {15.1383}	-0.0070 (0.0060) [0.0060] {0.0061}	-0.0076*** (0.0024) [0.0024] {0.0025}	-0.0049 (0.0081) [0.0080] {0.0081}	-0.5185*** (0.0602) [0.0595] {0.0605}	0.0196*** (0.0075) [0.0074] {0.0076}	-0.0065* (0.0039) [0.0039] {0.0040}	-0.2791 (0.3575) [0.3539] {0.3582}
Effect of 1 SD increase	-8.459	-0.001	-0.001	-0.001	-0.071	0.003	-0.001	-0.038
Mean dep. var.	3,387.33	0.05	0.01	0.09	38.97	0.08	0.02	86.75
Observations	5,066,070	5,066,070	5,066,070	5,066,070	5,063,035	5,066,070	5,066,070	5,063,035
Year of birth FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State of birth FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Data are from Vital Statistics Natality 2010-2019. Controls include four dummies for birthing person's age, three dummies for birthing person's education, a dummy for birthing person's marital status, and a dummy for male birth. Heteroskedasticity robust standard errors are reported in parentheses. Following Chyn et al. (2022), we also reported Anderson and Rubin (1949)'s standard errors in square brackets and Lee et al. (2022) tF's standard errors in curly brackets. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table 6: Racial Segregation and Anti-Black Prejudice

	Non-Black test takers		Black test takers	
	<i>Implicit prejudice</i> (1)	<i>Explicit prejudice</i> (2)	<i>Implicit prejudice</i> (3)	<i>Explicit prejudice</i> (4)
1990 Dissimilarity Index	0.080** (0.033)	0.240*** (0.071)	0.016 (0.098)	0.006 (0.278)
Effect of 1 SD increase	0.011	0.033	0.002	0.001
Mean of dep. var.	0.36	0.45	-0.03	-0.90
Observations	294,891	283,885	29,410	28,162
Year fixed effects	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Notes: Data are from Harvard Implicit Association Test 2010-2019. Controls include test takers' age, gender, and education attainment. Heteroskedasticity robust standard errors are reported in parentheses.  
 \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table 7: Racial Segregation and Food Insecurity

<i>Outcomes</i>	<i>Black, percent low access to store</i> (1)	<i>White, percent low access to store</i> (2)	<i>2015-17 Household food insecurity (%, three-year average)</i> (3)	<i>2015-17 Household very low food security (%, three-year average)</i> (4)	<i>2016 Grocery stores</i> (5)
1990 Dissimilarity Index	3.884*** (1.421)	-3.583 (10.247)	5.281** (2.449)	3.865*** (1.178)	-0.276*** (0.088)
Effect of 1 SD increase	0.529	-0.488	0.719	0.526	-0.038
Mean of dep. var.	1.19	18.59	12.92	5.11	0.18
Observations	249	249	251	251	251
<i>Outcomes</i>	<i>2016 Supercenters &amp; club stores</i> (6)	<i>2011 Convenience stores</i> (7)	<i>2016 Specialized food stores</i> (8)	<i>2016 WIC-authorized stores</i> (9)	<i>2017 SNAP-authorized stores</i> (10)
1990 Dissimilarity Index	0.170 (0.148)	0.026* (0.014)	-0.113** (0.048)	0.089 (0.060)	0.359* (0.188)
Effect of 1 SD increase	0.023	0.003	-0.015	0.012	0.049
Mean of dep. var.	0.38	0.02	0.07	0.14	0.70
Observations	251	251	251	251	251

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Notes: Data are from USDA ERS Food Environment Atlas 2020. USDA defines “food insecurity” as a household-level economic and social condition of limited or uncertain access to adequate food. USDA defines “very low food security as at times during the year food intake of household members is reduced and their normal eating patterns are disrupted because the household lacks money and other resources for food. Heteroskedasticity robust standard errors are reported in parentheses. The number of stores are per 1,000 population. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table 8: Racial Segregation and Transportation Barriers

	<i>Blacks</i>		<i>Whites</i>	
	<i>Average travel time to work (minutes)</i> (1)	<i>Percent of households without a vehicle</i> (2)	<i>Average travel time to work (minutes)</i> (3)	<i>Percent of households without a vehicle</i> (4)
1990 Dissimilarity Index	19.586*** (5.741)	-0.214 (0.134)	16.146*** (2.344)	-0.064*** (0.017)
Effect of 1 SD increase	2.668	-0.029	2.199	-0.009
Mean of dep. var.	22.90	0.22	23.43	0.06
Observations	281	282	282	282

Notes: Data are from American Community Survey 2011-2019. Heteroskedasticity robust standard errors are reported in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

## A Appendix: Supplementary Figures and Tables

Table A.1: Summary Statistics

	(1) Blacks	(2) Whites
Birth weight (grams)	3145.794 (611.31)	3387.325 (548.39)
Low birth weight (< 2,500 grams)	0.107 (0.31)	0.050 (0.22)
Very low birthweight (< 1,500 grams)	0.022 (0.15)	0.008 (0.09)
Small for gestational age	0.170 (0.38)	0.094 (0.29)
Gestational weeks	38.429 (2.79)	38.975 (2.17)
Preterm (Gestation < 37 weeks)	0.136 (0.34)	0.080 (0.27)
Very premature (Gestation < 34 weeks)	0.046 (0.21)	0.021 (0.14)
Fetal growth (birth weight/gestational weeks)	81.497 (14.36)	86.753 (12.99)
Male birth	0.509 (0.50)	0.513 (0.50)
Prenatal care visits	10.508 (4.50)	11.867 (3.87)
Any prenatal care visit	0.977 (0.15)	0.992 (0.09)
First trimester visit	0.667 (0.47)	0.816 (0.39)
Observations	1,020,350	5,066,070

Notes: Data are from Vital Statistics Natality 2010-2019.

Table A.2: Testing RDI as An Instrument

	First stage		1910			1915	
	1990 dissimilarity	Physical area index	Population	Ethnic dissimilarity index	Ethnic isolation index	Percent Black	Street car per capita
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
RDI	0.36*** (0.09)	-3,993 (11,986.5)	665.75 (1,363.0)	-.08 (0.185)	0.03 (0.07)	-0.001 (0.01)	-132.11 (183.21)
Track length	18.51* (10.73)	-574,401 (553,669)	75,553 (134,815)	15.34 (53.25)	-12.44 (17.29)	9.24*** (0.65)	3,361 (20,507)
Observations	121	58	121	49	49	121	13

	1920						1990
	Percent Black	Percent literate	Labor force participation	Percent employment in trade	Percent employment in manufacturing	Percent employment in railroads	Income segregation
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
RDI	0.01 (0.01)	0.05* (0.03)	0.03 (0.02)	-0.08 (0.09)	0.19 (0.14)	-0.07 (0.07)	0.03 (0.03)
Track length	9.12*** (0.62)	0.18 (0.88)	-3.43** (1.50)	-0.15 (2.91)	18.40* (10.91)	1.59 (2.43)	-2.50 (1.63)
Observations	121	121	121	121	121	121	69

Notes: This table replicates Table 1 from [Ananat \(2011\)](#). Heteroskedasticity robust standard errors are reported in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table A.3: Robustness to Not Including Covariates

<i>Outcomes</i>	<i>Birth Weight</i>	<i>Low Birth Weight</i>	<i>Very Low Birth Weight</i>	<i>Small for Gestational Age</i>	<i>Gestational Weeks</i>	<i>Preterm Birth</i>	<i>Very preterm Birth</i>	<i>Fetal Growth</i>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Panel A: Blacks</b>								
1990 Dissmilarity index	-171.6657*** (19.9023)	0.0495*** (0.0101)	0.0148*** (0.0047)	0.0450*** (0.0123)	-0.5059*** (0.0911)	0.0349*** (0.0112)	0.0144** (0.0068)	-3.5369*** (0.4683)
Effect of 1 SD increase	-23.384	0.007	0.002	0.006	-0.069	0.005	0.002	-0.482
Mean dep. var.	3,145.79	0.11	0.02	0.17	38.43	0.14	0.05	81.50
Observations	1,020,350	1,020,350	1,020,350	1,020,350	1,019,553	1,020,350	1,020,350	1,019,553
<b>Panel B: Whites</b>								
1990 Dissmilarity index	-51.9399*** (8.8868)	-0.0100*** (0.0035)	-0.0054*** (0.0014)	0.0041 (0.0047)	-0.2768*** (0.0350)	0.0059 (0.0043)	-0.0066*** (0.0023)	-0.5636*** (0.2101)
Effect of 1 SD increase	-7.075	-0.001	-0.001	0.001	-0.038	0.001	-0.001	-0.077
Mean dep. var.	3,387.33	0.05	0.01	0.09	38.97	0.08	0.02	86.75
Observations	5,066,070	5,066,070	5,066,070	5,066,070	5,063,035	5,066,070	5,066,070	5,063,035
Year of birth FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State of birth FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Data are from Vital Statistics Natality 2010-2019. Heteroskedasticity robust standard errors are reported in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table A.4: Robustness to Controlling for City Characteristics in 1910-1920, Black Infants

<i>Outcomes</i>	<i>Birth Weight</i>	<i>Low Birth Weight</i>	<i>Very Low Birth Weight</i>	<i>Small for Gestational Age</i>	<i>Gestational Weeks</i>	<i>Preterm Birth</i>	<i>Very preterm Birth</i>	<i>Fetal Growth</i>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Panel A: Baseline results</b>								
1990 Dissimilarity index	-204.7514*** (28.8789)	0.0594*** (0.0145)	0.0159** (0.0067)	0.0495*** (0.0180)	-0.6023*** (0.1309)	0.0392** (0.0162)	0.0168* (0.0098)	-4.2074*** (0.6790)
Effect of 1 SD increase	-27.891	0.008	0.002	0.007	-0.082	0.005	0.002	-0.573
Mean dep. var.	3,145.79	0.11	0.02	0.17	38.43	0.14	0.05	81.50
Observations	1,020,350	1,020,350	1,020,350	1,020,350	1,019,553	1,020,350	1,020,350	1,019,553
<b>Panel B: Add 1910 city characteristics control</b>								
1990 Dissimilarity index	-189.4718*** (27.5629)	0.0533*** (0.0138)	0.0141** (0.0064)	0.0482*** (0.0172)	-0.5520*** (0.1248)	0.0352** (0.0154)	0.0144 (0.0093)	-3.8838*** (0.6480)
Effect of 1 SD increase	-25.810	0.007	0.002	0.007	-0.075	0.005	0.002	-0.529
Mean dep. var.	3,145.79	0.11	0.02	0.17	38.43	0.14	0.05	81.50
Observations	1,020,350	1,020,350	1,020,350	1,020,350	1,019,553	1,020,350	1,020,350	1,019,553
<b>Panel C: Add 1920 city characteristics control</b>								
1990 Dissimilarity index	-228.4676*** (40.9660)	0.0777*** (0.0206)	0.0053 (0.0095)	0.0528** (0.0256)	-0.7560*** (0.1855)	0.0723*** (0.0229)	0.0164 (0.0139)	-4.3919*** (0.9635)
Effect of 1 SD increase	-31.121	0.011	0.001	0.007	-0.103	0.010	0.002	-0.598
Mean dep. var.	3,145.79	0.11	0.02	0.17	38.43	0.14	0.05	81.50
Observations	1,020,350	1,020,350	1,020,350	1,020,350	1,019,553	1,020,350	1,020,350	1,019,553
Year of birth FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State of birth FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Data are from Vital Statistics Natality 2010-2019 and Ananat (2011). The sample is limited to infants of White mothers. 1910 city characteristics include population and the Black population share. 1920 city characteristics include Black population share, literacy rate, labor force participation rate, share of employment in trade, share of employment in manufacturing, and share of employment in railroads. Heteroskedasticity robust standard errors are reported in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table A.5: Robustness to Controlling for City Characteristics in 1910-1920, **White Infants**

<i>Outcomes</i>	<i>Birth Weight</i>	<i>Low Birth Weight</i>	<i>Very Low Birth Weight</i>	<i>Small for Gestational Age</i>	<i>Gestational Weeks</i>	<i>Preterm Birth</i>	<i>Very preterm Birth</i>	<i>Fetal Growth</i>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Panel A: Baseline results</b>								
1990 Dissmilarity index	-62.1018*** (15.1465)	-0.0070 (0.0060)	-0.0076*** (0.0024)	-0.0049 (0.0081)	-0.5185*** (0.0602)	0.0196*** (0.0075)	-0.0065* (0.0039)	-0.2791 (0.3575)
Effect of 1 SD increase	-8.459	-0.001	-0.001	-0.001	-0.071	0.003	-0.001	-0.038
Mean dep. var.	3,387.33	0.05	0.01	0.09	38.97	0.08	0.02	86.75
Observations	5,066,070	5,066,070	5,066,070	5,066,070	5,063,035	5,066,070	5,066,070	5,063,035
<b>Panel B: Add 1910 city characteristics control</b>								
1990 Dissmilarity index	-58.6693*** (14.2331)	-0.0092 (0.0057)	-0.0081*** (0.0023)	-0.0019 (0.0076)	-0.4347*** (0.0565)	0.0161** (0.0070)	-0.0081** (0.0037)	-0.3527 (0.3359)
Effect of 1 SD increase	-7.992	-0.001	-0.001	-0.000	-0.059	0.002	-0.001	-0.048
Mean dep. var.	3,387.33	0.05	0.01	0.09	38.97	0.08	0.02	86.75
Observations	5,066,070	5,066,070	5,066,070	5,066,070	5,063,035	5,066,070	5,066,070	5,063,035
<b>Panel C: Add 1920 city characteristics control</b>								
1990 Dissmilarity index	-26.4539* (15.0638)	-0.0030 (0.0061)	-0.0073*** (0.0024)	-0.0130 (0.0081)	-0.3801*** (0.0598)	0.0276*** (0.0074)	-0.0050 (0.0040)	0.3294 (0.3552)
Effect of 1 SD increase	-3.604	-0.000	-0.001	-0.002	-0.052	0.004	-0.001	0.045
Mean dep. var.	3,387.33	0.05	0.01	0.09	38.97	0.08	0.02	86.75
Observations	5,066,070	5,066,070	5,066,070	5,066,070	5,063,035	5,066,070	5,066,070	5,063,035
Year of birth FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State of birth FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Data are from Vital Statistics Natality 2010-2019 and Ananat (2011). The sample is limited to infants of White mothers. 1910 city characteristics include population and the Black population share. 1920 city characteristics include Black population share, literacy rate, labor force participation rate, share of employment in trade, share of employment in manufacturing, and share of employment in railroads. Heteroskedasticity robust standard errors are reported in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table A.6: Robustness to Using the Index of Isolation to Measure Segregation

<i>Outcomes</i>	<i>Birth Weight</i>	<i>Low Birth Weight</i>	<i>Very Low Birth Weight</i>	<i>Small for Gestational Age</i>	<i>Gestational Weeks</i>	<i>Preterm Birth</i>	<i>Very preterm Birth</i>	<i>Fetal Growth</i>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Panel A: Blacks</b>								
1990 Isolation index	-143.8261*** (20.2926)	0.0417*** (0.0102)	0.0112** (0.0047)	0.0347*** (0.0127)	-0.4231*** (0.0920)	0.0275** (0.0114)	0.0118* (0.0069)	-2.9557*** (0.4771)
Effect of 1 SD increase	-19.592	0.006	0.002	0.005	-0.058	0.004	0.002	-0.403
Mean dep. var.	3,145.79	0.11	0.02	0.17	38.43	0.14	0.05	81.50
Observations	1,020,350	1,020,350	1,020,350	1,020,350	1,019,553	1,020,350	1,020,350	1,019,553
<b>Panel B: Whites</b>								
1990 Isolation index	-40.9548*** (9.9877)	-0.0046 (0.0040)	-0.0050*** (0.0016)	-0.0032 (0.0053)	-0.3420*** (0.0397)	0.0129*** (0.0049)	-0.0043* (0.0026)	-0.1841 (0.2358)
Effect of 1 SD increase	-5.579	-0.001	-0.001	-0.000	-0.047	0.002	-0.001	-0.025
Mean dep. var.	3,387.33	0.05	0.01	0.09	38.97	0.08	0.02	86.75
Observations	5,066,070	5,066,070	5,066,070	5,066,070	5,063,035	5,066,070	5,066,070	5,063,035
Year of birth FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State of birth FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Data are from Vital Statistics Natality 2010-2019. Controls include four dummies for birthing person's age, three dummies for birthing person's education, a dummy for birthing person's marital status, and a dummy for male birth. Heteroskedasticity robust standard errors are reported in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table A.7: Residential Segregation and Government Spending

	Government revenues				
	Total (1)	Total taxes (2)	Property taxes (3)	Sales taxes (4)	Other revenues (5)
1990 Dissimilarity Index	-1.962*** (0.408)	-0.668*** (0.132)	-0.799*** (0.125)	-0.441*** (0.052)	-0.003 (0.015)
Effect of 1 SD increase	-0.267	-0.091	-0.109	-0.060	-0.000
Mean of dep. var.	1.299	0.432	0.288	0.076	0.031
Observations	1,301	1,301	1,301	1,301	1,301

	Government expenditures				
	Total (6)	Education (7)	Public safety (8)	Welfare and health (9)	Other expenditures (10)
1990 Dissimilarity Index	-2.132*** (0.389)	-1.366*** (0.320)	-0.110** (0.050)	-0.696*** (0.217)	-0.651*** (0.205)
Effect of 1 SD increase	-0.290	-0.186	-0.015	-0.095	-0.089
Mean of dep. var.	1.310	0.381	0.221	0.132	0.775
Observations	1,301	1,301	1,301	1,301	1,301

Notes: The data used in the analysis comes from the 2015 US Census Bureau and covers the government's revenues and expenditures from 1985 to 1995 on a per capita basis. Heteroskedasticity robust standard errors are reported in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table A.8: Racial Segregation and Housing Insecurity

Outcomes	<i>Percent of housing insecurity</i>			
	<i>Black owners</i> (1)	<i>Black renters</i> (2)	<i>White owners</i> (3)	<i>White renters</i> (4)
1990 Dissimilarity Index	-0.304* (0.174)	0.046 (0.191)	-0.280*** (0.053)	-0.227*** (0.056)
Effect of 1 SD increase	-0.041	0.006	-0.038	-0.031
Mean of dep. var.	0.31	0.54	0.20	0.43
Observations	248	249	251	251

Notes: Dependent variables are percentage of households with at least 1 of 4 housing problems: overcrowding, high housing costs, lack of kitchen facilities, or lack of plumbing facilities. Data are from the U.S. Department of Housing and Urban Development's Comprehensive Housing Affordability Strategy (CHAS) data 2015-2019. Heteroskedasticity robust standard errors are reported in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

Table A.9: Outlining Sample Derivation

Births that occurred in the U.S. between 2010 and 2019	N = 38,226,962
Multiple births, infants whose birthing parents are neither Black nor White	n = 13,194,806
Births that occurred outside of 121 U.S. cities where RDI data is available	n = 17,951,471
Missing information on birthing person's education	n = 727,600
Missing information on birthing person's marital status	n = 266,665
Final sample	n = 6,086,420