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Intergenerational Neighborhood Attainment and the Legacy of Racial Residential Segregation: A Causal Mediation Analysis

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Abstract Advances in mediation analysis are used to examine the legacy effects of racial residential segregation in the United States on neighborhood attainments across two familial generations. The legacy effects of segregation are anticipated to operate through two primary pathways: a neighborhood effects pathway and an urban continuity pathway. The neighborhood effects pathway explains why parent's exposure to racial residential segregation during their family-rearing years can influence the residential outcomes of their children later in life. The urban continuity pathway captures the temporal consistency of the built and topographical environment in providing similar residential opportunities across generations. Findings from the Panel Study of Income Dynamics and U.S. Census data indicate that the legacy effect of racial residential segregation among black families operates primarily through the neighborhood effects that influence children growing up. For white families, there is less support for the legacy effects of segregation. The findings are supported by a comprehensive mediation analysis that provides a formal sensitivity analysis, deploys an instrumental variable, and assesses effect heterogeneity. Knowledge of the legacy of segregation moves neighborhood attainment research beyond point-in-time studies of racial residential segregation to provide a deeper understanding into the ways stratified residential environments are reproduced.

Keywords Residential stratification · Urban poverty · Neighborhood effects · Housing · Social mobility

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Introduction

The rise of racial residential segregation to peak levels among twentieth century cities in the United States is well documented (Galster and Carr 1991; Hirsch 1983; Jackson 1985; Lieberson 1980; Massey 2008; Massey and Denton 1993; Philpott 1978; Sugrue 1996). Despite government efforts and moderate declines in the levels of black-white racial residential segregation since the 1960s (Logan and Stults 2011), racial disparities by neighborhood socioeconomic status (SES) and racial composition persist generation after generation, producing a resilient form of urban poverty (Sharkey 2008; Vartanian et al. 2007). This study advances our understanding of this intergenerational process by examining how the legacy of racial residential segregation—a prior generation's exposure to black-white residential segregation at the metropolitan-area level—affects the next generations' neighborhood attainment (Alba and Logan 1991). Neighborhood attainment is assessed in terms of SES and racial composition at the census-tract level. Of central interest is how racial residential segregation influences the intergenerational reproduction of local neighborhood advantages and disadvantages.

The centrality of racial residential segregation for intergenerational reproduction is based on two propositions that guide this study. First, to some extent, the levels of racial segregation experienced by prior generations should matter for the neighborhood status attainments of today's generation, and these long-run effects should persist beyond what can be explained by the point-in-time effects of racial residential segregation alone. Second, researchers should be able to examine the key pathways through which the long-run effects of segregation are transmitted from generation to generation.

Two key pathways are hypothesized to transmit the legacy effect of segregation in this study: the neighborhood effects pathway and the urban continuity pathway. The *neighborhood effects pathway* speaks to the influence of neighborhood environments on childhood development. This study independently considers neighborhood SES and neighborhood racial composition as key transmitters of the neighborhood effects pathway because relative spatial advantages and disadvantages are tightly intertwined, yet analytically distinct, with issues of race and class in the United States. The *urban continuity pathway* speaks to the role of built infrastructure and topographical features in affecting intergenerational patterns of neighborhood attainment. Methodological advancements in mediation analysis are used on data from the Panel Study of Income Dynamics (PSID) and the U.S. Census to assess the relative explanatory power of these pathways for white and black families that have origins in the United States dating back at least to the height of racial residential segregation in the late 1960s.

The Legacy Effects of Racal Residential Segregation

A community's spatial organization is not simply a reflection of the stratification hierarchy but is also an active producer of it. Racial residential segregation, in particular, is an important focus because many consider it to be a structural cause of concentrated urban poverty and racial socioeconomic inequality (e.g., Massey 1990; Massey et al. 1991). A primary reason why residential segregation, and racial segregation in particular, matters stems from the effects that neighborhoods have on childhood socialization and development—in colloquial terms, *neighborhood effects* (Jencks and Mayer 1990). Neighborhood effects operate in two fundamental ways. One way is through the development of human capital. The second is through the transmission of local knowledge and customs that influence place attachment and neighborhood stereotyping. These reasons, discussed in detail later, help explain the strong relationship between neighborhood environment while growing up and neighborhood status attainments in adulthood. Approximately 50 % to 60 % of one's relative neighborhood advantages/disadvantages are typically transmitted from one generation to the next (Sharkey 2008; Vartanian et al. 2007).

Several dimensions of racial residential segregation (e.g., Massey and Denton 1988) are capable of producing the kinds of residential environments that affect human capital development, place attachment, and neighborhood stereotyping. First, large-scale institutional disparities between racial groups often associated with municipal-level segregation—such as access to quality of school systems, effective environmental protections against pollution, and munificent law enforcement—will affect human capital development via educational opportunities, physical health, and exposure to crime and violence. Advantaged residential locations allow families to more easily transfer instrumental attributes from one generation to the next. Access to good schools and to other children from affluent families does not guarantee high levels of human capital in the next generation, but advantaged locations improve the chances beyond parental resources alone (Borjas 1995; Sharkey and Elwert 2011).

Conversely, families living in neighborhoods that subject children to inferior educational institutions, few occupationally successful role models, and an informal street economy with lucrative short-run opportunities through criminal enterprises suffer locational disadvantages that make it more difficult, but not impossible, to acquire the types of skills and attributes needed to gain access to more affluent residential spaces later in life (Sampson et al. 1997; Venkatesh 2006). These are the kinds of neighborhood-level socioeconomic mechanisms often associated with high levels of racial residential segregation (Massey 1990). For these reasons, it is important to examine the role of neighborhood SES independently from neighborhood racial composition.[1]

Second, the lack of neighborhood exposure to out-group members, or the spatial isolation of within group members, will limit the formation of social ties across groups and lead to differential group socialization that later in life crystallizes people's attachment to different kinds of neighborhoods. Individuals often become personally attached to the places where they grew up (Bonaiuto et al. 1999; Fried 1982; Hidalgo and Hernandez 2001). This process starts early in life when parents, no matter what the objective neighborhood conditions, try to provide a homeplace and a sense of security for their children (Briggs et al. 2010). A key source of place attachment comes from interactions between people that over time embed places with special meaning and significance (Kasarda and Janowitz 1974; Lefebvre 1992). Wanting (or in some cases, needing) to be close to family and friends facilitates those local attachments (Hedman 2013; McDonald and Richards 2008).

People also avoid residential spaces that are heavily concentrated with out-group members. During childhood, individuals learn to associate different racial groups with

[1] Researchers have known for some time that black-white residential segregation cannot be fully explained by racial disparities of human capital development alone (e.g., Taeuber and Taeuber 1965).

different geographic areas of the city (Sharkey 2012). These mental maps of the city are created by feelings of fear and hostility in ways that fuel negative neighborhood stereotyping—that is, negative beliefs about life in neighborhoods of a different race (Ellen 2000; Krysan and Farley 2002; Quillian and Pager 2001). Place attachment and neighborhood stereotyping begin to take shape early in life; later in life, these factors influence residential decisions when home-seekers find themselves drawn toward familiar neighborhood environments. For these reasons, examining the role of neighborhood racial composition independently from neighborhood SES is important.

High levels of racial residential segregation can affect human capital development, place attachment, and negative neighborhood stereotyping through discriminatory housing market practices experienced by a generation of black parents represented in this study (e.g., Massey and Denton 1993; Sugrue 1996). Historically, when black parents in this study sought ideal locations for raising children, they were confronted with a rigid residential opportunity structure shaped by racial residential segregation. The negative effects of racial segregation on the housing outcomes of black parents helped to determine the residential environment where their children grew up, developed skills, formed social ties, and acquired local knowledge. These developmental factors then influenced the children's neighborhood attainments as an adult. For example, Galster and Keeney (1988), using data from the 1977 HUD housing audit study, find a feedback loop between the levels of racial residential segregation and local housing discrimination that operates, in part, through the socioeconomic dislocations inflicted on blacks in highly segregated metropolitan areas. According to the neighborhood effects thesis, the experiences of prior generations with housing discrimination and racial residential segregation can continue to manifest detrimental effects through a spatially linked life course that ties the parent's neighborhood attainment to the children's outcomes later in life (cf. Elder 1999; Elder et al. 2003). Thus, neighborhood effects are a primary pathway by which the legacy of racial residential segregation is expected to have long-term implications for neighborhood attainment outcomes.

Additionally, the legacy of racial residential segregation may also shape today's neighborhood status attainments through the point-in-time constraints placed on home-seekers that are distinct from the neighborhood effects pathway. The underlying spatial structures that support these point-in-time constraints are cemented, often literally, into the urban fabric of American cities through the built environment (e.g., housing projects, highways, and railways) and topographical features that are indelible or are slow to change (e.g., bodies of water, elevation changes, and designated natural areas). This is evidenced by the strong correlation between past and current levels of racial residential segregation at the metropolitan-area level as well as by the relationship between historical settlement patterns and current levels of racial residential segregation. A case in point is Ananat's (2011) study using nineteenth century railroad configurations to examine the exogenous effects of racial residential segregation on current levels of urban poverty. The density of urban railways in the 1800s remains highly correlated with the level of racial residential segregation today more than 100 years later. These urban continuity effects ensure that each new generation is subjected to a similar residential blueprint.

The theoretical implication of urban continuity pathway is that racial residential segregation is potentially capable of imposing spatial constraints anew on each succeeding generation of home-seekers apart from any childhood influences.

Contemporary levels of segregation matter during the housing search process for two reasons. First, contemporaneous exposure to racial residential segregation influences where individuals seek and/or acquire information about vacancies. This can occur as prospective movers receive selective information about housing opportunities through realtors who "steer" home-seekers to particular neighborhoods by race (Yinger 1991)—a persistent form of housing discrimination (Galster and Godfrey 2005)—or through the home-seeker's local activity spaces that are predetermined by existing spatial patterns of racial residential segregation (Johnston 1972). The housing search process generally begins with limited information about the range of residential options because racial segregation filters who gets information about particular vacancies (Krysan and Bader 2007). As a result, individuals make housing decisions based on a selective set of alternatives that are directly related to current levels of racial residential segregation.

Second, contemporary levels of racial residential segregation will structure the supply and demand of housing by determining the relative price and availability of various neighborhood amenities, especially racial and ethnic neighborhood compositions (Wong 2008). Thus, when searching for housing commensurate with one's financial resources, the home-seeker will be confronted by the gestalt of other peoples' preferences and prejudices that are embodied in contemporary levels of racial residential segregation. This structuring affects the availability of affordable housing in different kinds of neighborhoods, which has direct implications for their residential decision-making.

Several studies have found compelling evidence of the contemporaneous effect of racial residential segregation on residential mobility patterns and neighborhood attainment outcomes. For example, in highly segregated metropolitan areas, white and black households are less likely to be residentially mobile (Pais et al. 2012; South and Deane 1993). When black households move into highly segregated areas, they are more likely to move to poor neighborhoods than nonpoor neighborhoods (South and Crowder 1997; South et al. 2011b). Black households also have more difficulty converting socioeconomic resources into better-quality neighborhoods in highly segregated areas (Pais et al. 2012), and whites tend to pay a premium to live in whiter and higher-income neighborhoods in highly segregated areas (Cutler et al. 1999; also see Yinger 2016). Finally, black families in highly segregated metropolitan areas also tend to live in more disadvantaged neighborhoods, on average, than whites or blacks in less-segregated areas (Krivo et al. 2009). Yet, these point-in-time studies are agnostic about the difference between the immediate influences that segregation imposes on home-seekers versus the legacy of segregation that operates through the neighborhood effects pathway. The unanswered question is whether the legacy of racial residential segregation operates primarily through exposing children to neighborhood environments of racial isolation and class disadvantage or whether the urban continuity effects of racial residential segregation are sufficient, in and of itself, to affect the neighborhood attainments of each succeeding generation.

Research Hypotheses

Figure 1 summarizes the research hypotheses posited by this legacy effect thesis. The neighborhood status attainments for this study are neighborhood income levels and neighborhood racial composition. The four key components in Fig. 1 are the

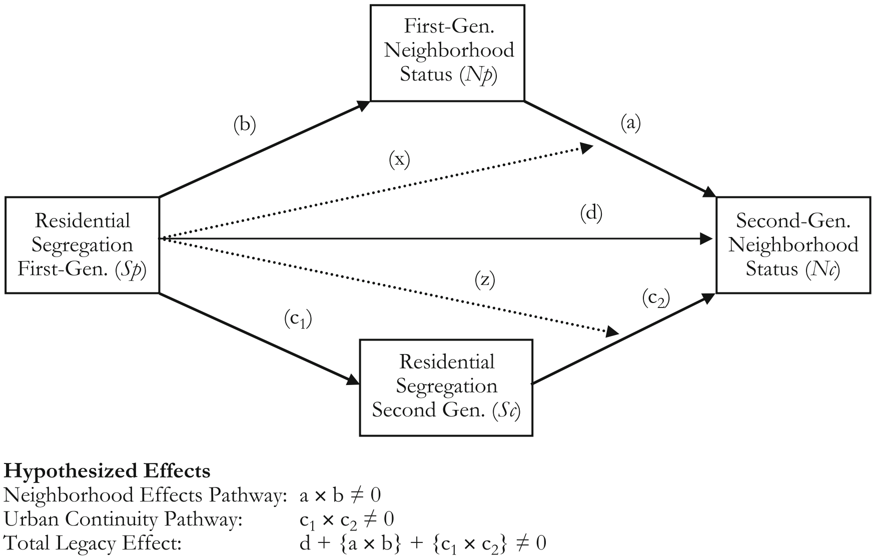


Fig. 1 A conceptual model of the legacy effects of racial residential segregation on intergenerational neighborhood attainment

neighborhood status attainments of the child (i.e., the second generation) as adults (e.g., older than 26 years), *Nc*; the parent's neighborhood status attainment (first generation), which is the neighborhood environment of the child growing up, *Np*; the first generation's exposure as adults to racial residential segregation at the metropolitan-area level, *Sp*; and the second generation's exposure as an adult to racial residential segregation at the metropolitan-area level, *Sc*. The focal effects of interest are as follows: (a) the intergenerational effect between first and second generation's neighborhood status attainment; (b) the effect of racial residential segregation on the first generation's neighborhood attainment; (c_1) the effect of the first generation's residential segregation on the second generation's residential segregation; (c_2) the effect of the second generation's residential segregation on the second generation's neighborhood attainment; $c_1 \times c_2$, the urban continuity pathway; and last, the neighborhood effect pathway, a × b.

The x and z in Fig. 1 signify potential interaction effects. In this context, there are several reasons why it is important to consider the potential interaction effects between the antecedent and the hypothesized mediators. First, the effect of a child's neighborhood environment on future neighborhood attainment might vary by the level of the parent's exposure to residential segregation. This interaction may occur if opportunities for intergenerational social and spatial mobility are more rigid or fluid in highly segregated places compared with less-segregated places. Second, if prior levels of residential segregation are high, and contemporaneous levels are also high, then the combined effects of racial residential segregation on the second generation's neighborhood attainment could be amplified and multiplicative, not simply additive. Significant interactions in the context of meditation analysis will signify heterogeneous legacy effects.

Given the reported racial differences in previous work between whites and blacks in the effects of segregation on residential mobility and neighborhood attainment, we should also expect to see differences in how the legacy effects of segregation operate for white and black families. The general expectation is that racial residential segregation is more detrimental to the neighborhood outcomes among black families than white families. This racial difference can manifest itself in two ways. If segregation advantages white families at the expense of black families, then the legacy effects will be of similar magnitude but of opposite sign for white and black families. However, it is also possible that the legacy effects of segregation are universally negative (e.g., greater number of poor white and black neighborhoods that are racially isolated), and black families simply bear a disproportionate share of these negative externalities—that is, larger negative effects for black families relative to white families.

Data and Methods

The intergenerational data for this study come from the 1968– 2011 PSID. The PSID incorporates intergenerational dynamics by adding new households to the panel as children in the original sample split off to form their own households. With the PSID-Geocode Match File, researchers can merge geographic information (e.g., census tract and metropolitan-level census data) to individual PSID records. The effective sample for this study allows for drawing inferences about intergenerational spatial mobility for white and black U.S. families in metropolitan areas that have a lineage dating back to at least the 1960s, and have consequently produced children who have gone on to establish their own households throughout the latter half of the twentieth and early years of the twenty-first century.

Sample Selection and Neighborhood Status

The sample selection and core variable construction follows Hertz (2005) and Sharkey (2008). First, I create two PSID files: (1) a parent file (first generation), including all PSID respondents that are ever parents (adoptive parents included); and (2) a child file (second generation), including all PSID respondents that were ever children of a PSID parent. I then match pairs of parents and children using family IDs provided by the PSID. Matched family pairs are included in the sample if they meet the following criteria: (1) the parent is observed as the head of household at age 26 or older in at least one year when the child was under 18 years old; (2) the child is later observed as an adult head of household or a spouse/partner of a head of household at age 26 or older. Sparse data on other racial and ethnic groups limit the effective sample to only black and white families. This procedure produces 5,037 parent-child pairs (N = 2,180 black families, and N = 2,857 white families).

I use two key measures to assess neighborhood status attainment. The first is the average level of family income in the census tract.[2] The second is the percentage non-Hispanic black in the census tract. Data for the census-tract measures come from the Neighborhood Change Data Base (NCDB), which provides decennial U.S. Census data from 1970 to 2010 normalized to the census tract boundaries in 2010 (GeoLytics 2013). I use linear interpolation and extrapolation to estimate tract measures for noncensus

[2] Median family income is not available for 1970, but the difference between the mean and median income at the census tract level is inconsequential given that the skew is minimal and income is logged.

years. I also convert average neighborhood income into real 2000 dollars using the consumer price Index (CPI). The census tract data are then merged with the parent's file and the child's file in long format (i.e., person-year). The final step is to adjust neighborhood income and racial composition to remove sibling variation and to make generational comparisons constant at age 40 (see Hertz 2005; Sharkey 2008).

Family Control Variables

The following family control variables have been found to be statistically significant in previous intergenerational neighborhood research: gender, educational attainment, homeownership, family income, and parental aspiration. Gender of both first- and second-generation respondents is coded as 1 for men and 0 for women. The educational attainment of both the first and second generation is coded categorically as less than a high school degree, high school degree, some college, college degree or more (less than high school degree is the reference group). Homeownership is measured as the proportion of years that the first generation is observed owning their home. The first generation's family income is constructed using the same approach as neighborhood income. And finally, parental aspiration is a measurement scale in the PSID that captures how ambitious the parent is with regard to improving their economic well-being.

Racial Residential Segregation and Predetermined Metropolitan Area Characteristics

The raw metropolitan-level data come from the U.S. Census of Population and Housing Summary Files (U.S. Department of Commerce). I use crosswalks to convert historic metropolitan statistical area (MSA) codes to current Office of Management and Budget (OMB) core-based statistical area (CBSA) codes. The construction of these metropolitan-area variables follows the same averaging procedure as the neighborhood outcomes variables. Metropolitan-area variables are interpolated and extrapolated for noncensus years; I then merge these values via the PSID retrocoded CBSA geo-identifiers to the parent file and child file. Next, I average the metropolitan-area characteristics over the duration in which the respondents met the sample criteria noted earlier. I then link these values to the matching parent-child data file to provide distinct metropolitan-area exposures for the first generation and the second generation.

Black-white residential segregation at the metropolitan-area level is measured by the index of dissimilarity (Duncan and Duncan 1955), which is a historically common measure of spatial unevenness that reflects the relational context of the residential opportunity structure. The relational aspect is important because when people make housing decisions, they often make those decisions in relation to other available alternatives that exist in different neighborhoods. The dissimilarly index best captures this relational feature. The dissimilarity indexes are calculated for each decade from 1970 through 2010. Note the alternative dimensions of segregation that are theoretically relevant in this study also tend to be highly correlated with the index of dissimilarity (Massey and Denton 1988: Table 3). In supplemental path models, discussed in the Results section, I checked the robustness of the main findings against alternative measures of residential segregation: exposure, isolation, and a rank-order information index of income segregation.

Additional metropolitan-level characteristics are used as predetermined control variables in all models. These characteristics include the percentage of the population that is non-Hispanic black; the percentage of the population that is foreign-born; the percentage of the civilian labor force employed in finance, insurance, or real estate industries (FIRE); the percentage employed in public sector jobs (i.e., federal, state, or local government); the percentage employed in manufacturing industries; the percentage of the civilian labor force employed in the low-wage service sector (i.e., entertainment and recreation services, hotels and lodging places, private household services, and other miscellaneous personal services); the percentage of new housing units built in the last 10 years; the percentage of the population living outside central cities (to capture the relative size of the suburban population); and finally, the metropolitan area's median income and population size, both in natural log form. These metropolitan-area characteristics are commonly used to study the determinants of racial residential segregation (e.g., Farley and Frey 1994; Logan et al. 2004; Pais et al. 2012; South et al. 2011a).

Analytic Approach

The analytic approach first comes from the structural equation modeling tradition, which relies on the product of coefficients from a linear path model to determine the direct and indirect effects (Kenny 1979; Sobel 1982). I augment this standard approach, commonly used by demographers, with analyses from the potential outcomes tradition, which is synonymous with causal mediation analysis (e.g., Imai et al. 2010; Muthén and Asparouhov 2015; VanderWeele et al. 2010).

Under the following five conditions, the product of coefficients approach is consistent with causal mediation analysis: (1) no correlated errors between the first generations' exposure to racial residential segregation and the second generations' neighborhood attainment; (2) no correlated errors between the mediators (childhood neighborhood environment and contemporary segregation) and the second generations' neighborhood attainment; and (3) no correlated errors between the first generations' exposure to residential segregation and the mediators. These three conditions are the "no omitted variable" assumptions of linear path modeling.

Two additional considerations are important in the potential outcomes tradition: (4) no interaction effects between the first generations' exposure to residential segregation and the mediators;[3] and (5) no mediator confounders that are affected by the first generations' exposure to segregation. In the context of causal mediation analysis, confounders can be observed or unobserved variables that affect the mediator and the outcome and are affected by the treatment variable. This fifth condition is difficult to satisfy with observational data. In the potential outcomes framework, it is often referred to as *exposure-induced mediator-outcome confounding*, *treatment-dependent confounding*, or simply *intermediate confounding* (De Stavola et al. 2014). If these five

[3] This assumption can be extended to include the proper functional form of the specified relationships as well as the potential for mediator-mediator interactions. For this study, the linearity assumptions are met, and there is no statistical evidence of any interaction between the first generations' neighborhood attainment and the second generations' exposure to racial residential segregation. If these additional parametric assumptions are unreasonable, a researcher may wish to consult G-Computation methods (e.g., De Stavola et al. 2014).

assumptions are met, the following path equations are causally identified:

$$\textit{Direct effects}: Nc = \alpha_1 + \mathrm{a}(Np) + \mathrm{c}_2(Sc) + \mathrm{d}(Sp) + \delta(Cc) + \delta(Cp) + \delta\left(MSA_{pre}\right) + \varepsilon_1 \tag{1}$$

$$\textit{Indirect effect path \#1}: Np = \alpha_2 + \mathrm{b}(Sp) + \delta(Cp) + \delta\left(MSA_{pre}\right) + \varepsilon_2 \tag{2}$$

$$\textit{Indirect effect path \#2}: Sc = \alpha_3 + \mathrm{c}_1(Sp) + \varepsilon_3. \tag{3}$$

The key parameters in these equations match those in Fig. 1. In addition, there are intercepts, α, and regression coefficients for the child and parent control variables as well as the predetermined metropolitan-area variables, MSA_{pre} (signified here using generic δ). An implication of the five conditions for causal mediation is that the error terms (ε_1, ε_2, and ε_3) are assumed to be statistically independent from the antecedent/treatment variable and the mediator variables, conditional on the predetermined metropolitan-area characteristics. Later, I relax these assumptions with a formal sensitivity analysis and assess models with "treatment-mediator" interactions (the x and z dashed pathways in Fig. 1).

Taking the product of coefficients from these path models provides estimates of the neighborhood effects pathway Eq. (4), the urban continuity pathway Eq. (5), and the total intergenerational effect of racial residential segregation on the second generation's neighborhood attainment Eq. (6), which are all hypothesized to be nonzero:

$$\textit{Neighborhood effects pathway}: \mathrm{a} \times \mathrm{b} \neq 0 \tag{4}$$

$$\textit{Urban continuity effect}: \mathrm{c}_1 \times \mathrm{c}_2 \neq 0 \tag{5}$$

$$\textit{Total legacy effect}: \mathrm{d} + \{\mathrm{a} \times \mathrm{b}\} + \{\mathrm{c}_1 \times \mathrm{c}_2\} \neq 0. \tag{6}$$

I appropriately adjust all standard errors using complex survey design methods (Muthén and Satorra 1995), which addresses the inefficiency to the standard errors caused by the clustering of multiple PSID households within metropolitan areas. I estimate all equations simultaneously using structural equation modeling software.

Causal identification using the product of coefficients approach is valid if the five stated conditions are met. This is unlikely when analyzing observational data. To understand the implications a violation will have for the substantive conclusions, a formal sensitivity analysis is needed. Following Imai et al. (2010:315), I simulate the path model equations at incremental stages, allowing the error terms from the indirect models (ε_2, ε_3) to correlate with the error term in the direct effects model ε_1. The strength of the association between error terms will range from a correlation of $\rho = -1$ to 1 and progresses through each simulation 2,000 times in increments of .01. The increments are arbitrary, but the smaller the increments, the smoother the band for the confidence interval. *The absolute size of the ρ correlation signifies the strength of an omitted variable.* The larger the absolute value of the cross-equation correlation of errors, the more significant the violation of statistical independence: Corr (ε_1, ε_2) = ρ and Corr (ε_1, ε_3) = ρ, where ρ = range (–1, 1). Casual mediation assumptions are valid when $\rho = 0$. The results for each of the simulations can then be plotted against the observed indirect effects in Eqs. (4) and (5) to determine how large an effect an omitted variable would need to be in order to substantively alter the conclusions.[4]

Formal sensitivity checks serve as a general diagnostic, but I address four specific methodological issues through supplemental analyses. The first issue is selective migration: if the most successful group members of the second generation leave highly segregated areas for less-segregated areas, then the effects of segregation could be confounded with omitted differences between those who stay and those who leave highly segregated areas (e.g., Johnson et al. 2012). To address this issue, I restrict the PSID sample in supplemental analyses to only those families who remained in the same metropolitan area for the duration of the study period. This is a subsample of "stayers."[5]

The aforementioned formal sensitivity analysis will reveal a second important concern: the urban continuity pathway is likely to be biased by an omitted variable. To examine this issue further, an instrumental variable (IV) analysis (e.g., Ananat 2011) is used in supplemental models to provide alternative estimates of the urban continuity pathway. According to the sensitivity analyses, the potential confounding of the neighborhood effects pathway is less likely an issue.

Third, causal mediation analysis requires researchers to inspect the validity of the no "treatment-mediator" interaction assumption. An alternative direct-effects equation that allows interaction effects is used to examine this assumption:

$$Nc = \alpha + \mathrm{a}(Np) + \mathrm{c}_2(Sc) + \mathrm{d}(Sp) + \mathrm{x}(Sp \times Np) + \mathrm{z}(Sp \times Sc) + \delta(Cc) + \delta(Cp) + \delta\left(MSA_{pre}\right) + \varepsilon_1. \quad (7)$$

Equations (2) and (3) are unchanged. From this alternative model specification, researchers can recover the average causal mediated effects (ACME) for the "treated" and "control" counterfactuals. The following expressions help derive the counterfactual estimates of central interest, which in this context are referred to as the *natural* indirect effects. I start with the general expression $E[Y(T = 1) - Y(T = 0)] = E[Y(T = 1, M(T = 1)) - Y(T = 0, M(T = 0))]$, which represents the total effect of the first generations' exposure to racial residential segregation. $T = 1$ signifies the treatment condition, and $T = 0$ signifies the control condition; the mediators (M) take the values they would *naturally* take under treatment and control conditions. As is typical in studies without randomized mediators, the counterfactual condition per individual is not observed: it is only possible to identify estimates of the average mediation effect for the treatment group and control group.

These ACME estimates are defined as follows: ACME $(Np) = E[Nc(Sp = t, Np(Sp = 1)) - Nc(Sp = t, Np(Sp = 0))] = \mathrm{b}(\mathrm{a} + \mathrm{x} \times t)(t - t')$, where t and t' are the treatment contrasts selected by the researcher. With a continuous treatment variable, like

[4] Formal sensitivity analysis is an active area of research with new techniques emerging to handle multiple mediators and intermediate confounders (e.g., VanderWeele and Chiba 2014). The Imai et al. (2010) approach used here is generally applicable to common types of confounding that bias causal estimates of the indirect effects that are of primary interest in this study.

[5] A related issue is that some metropolitan areas contain few PSID families. Thus, some MSAs may be poorly represented in the analyses. To examine whether this is an issue, I further restrict the subsample of stayers to only those PSID families living in metropolitan areas with at least 10 other PSID families.

residential segregation, t and t' can take any theoretically supported value. A binary treatment scenario sets the contrasts at the treatment condition $t = 1$ and control condition $t' = 0$. For this study, $t = 1$ is the maximum level of residential segregation, and $t = 0$ is the minimum level of segregation given that the dissimilarity index can theoretically range between 0 and 1. This provides the greatest possible contrast between treatment and control conditions. Estimates of ACME (*Np*) among the treated is attained when $t = 1$: $E[Nc(Sp = 1, Np(Sp = 1)) - Nc(Sp = 1, Np(Sp = 0))] = b(a + x)$, which represents the average expected difference in a child's neighborhood attainment as an adult had the parents lived in a highly segregated metropolitan area and had the child been exposed to the type of neighborhood environment that is most likely (i.e., naturally) experienced by children from highly segregated metropolitan areas ($Sp = 1$, $Np(Sp = 1)$), compared with the neighborhood environment the child would have naturally experienced had their parents lived in an metropolitan area with low levels of segregation ($Sp = 1, Np(Sp = 0)$). Conversely, ACME (*Np*) among the controls ($t = 0$) represents the average expected difference in neighborhood attainment that can be attributed to the changes in neighborhood environment of children from less-segregated metropolitan areas: $E[Nc(Sp = 0, Np(Sp = 1)) - Nc(Sp=0, Np(Sp = 0))] = a \times b$. If there is a nonsignificant interaction effect ($x = 0$), the natural indirect effect is the same for treatment and control groups ($a \times b$).

In parallel terms, the following represents the average causal mediation effect of contemporary segregation among those originating from highly segregated metropolitan areas: ACME treated $(Sc) = E[Nc(Sp = 1, Sc(Sp = 1)) - Nc(Sp = 1, Sc(Sp = 0))] = c_1(c_2 + z)$. This is the expected difference in a child's neighborhood attainment as an adult had his parents lived in a highly segregated metropolitan area and had he then experienced a level of contemporary segregation that he would have naturally experienced by virtue of having familial origins in a highly segregated area $Nc(Sp = 1, Sc(Sp = 1))$ compared with experiencing a contemporary level of segregation he would have naturally experienced had his parents lived in an metropolitan area with low levels of segregation $Nc(Sp = 1, Sc(Sp = 0))$. Conversely, the average expected difference in neighborhood attainment that can be attributed to the contemporary changes in segregation of children from less-segregated metropolitan areas is: ACME control $(Sc) = E[Nc(Sp = 0, Sc(Sp = 1)) - Nc(Sp = 0, Sc(Sp = 0))] = c_1 \times c_2$. Again, a nonsignificant interaction effect ($z = 0$) means that the natural indirect effect is the same for treatment and control groups ($c_1 \times c_2$).[6]

Finally, the fifth assumption of no mediator confounders that are affected by the first generations' exposure to segregation is untenable in this study given that the legacy of segregation will most certainly influence numerous intermediate causes of both the mediators and outcome. These exposure-induced mediator-outcome confounders (e.g., observed family income) prevent causal identification in a manner similar to unobserved mediator-outcome confounding for which a formal sensitivity analysis may be the only recourse (Imai et al. 2014). Parameter identification (e.g., parametric estimation of the indirect effect via structural equation models) remains feasible, but the counterfactual interpretation of the indirect effects are tenable only if it is reasonable to

[6] It is possible to estimate the average direct effects (ADE) for the treated and control contrasts, but these effects are of less substantive interest here. For example, following Imai et al. (2010), ADE $= d + x(\alpha_2 + b \times t + \Sigma\delta(\mathbf{X}i))$ where $\mathbf{X}i$ are specific values of the control variables. $\Sigma\delta(\mathbf{X}i)$ drops out here because all the control variables are grand-mean centered, $\mathbf{X}i = 0$.

constrain the exposure-mediator interactions in the structural model to 0, $x(Sp \times Np) = z(Sp \times Sc) = 0$ (De Stavola et al. 2014:6; Robins and Greenland 1992). Although the implications stemming from intermediate confounders may appear daunting to those interested in quantifiably exact causal parameters of the indirect effects, researchers are still able to provide considerable insight into the causal process by comparing a range of plausible estimates through a formal sensitivity analysis and through freeing and constraining the exposure-mediator interaction effects. Substantive conclusions about the causal pathways can thus be brought about through comparing how similar or dissimilar the point estimates are under these different conditions.

Results

Table 1 provides the descriptive statistics separately for black and white PSID families.[7] This sample is representative of the black and white families in the United States in 1968 that have lived in metropolitan areas. The first generation's average neighborhood income status (logged and adjusted for age at 40 and inflation in 2000 dollars) is 10.49 (~$36,000) among black families and 10.86 (~$52,000) among white families, resulting in a statistically significant racial difference in neighborhood income status of approximately $16,000. This large racial difference in residential status is mirrored by an even larger gap in family income (~$29,500).

By the second generation, the racial difference in neighborhood income status grew to approximately $24,000 in adjusted dollars. During this same period, the racial difference in neighborhood percent black dropped only 3 percentage points from a 52 percentage point difference in the first generation to a 49 percentage point difference in the second generation. The 3 percentage point change is attributed to whites having slightly (4 % vs. 7 %) more black neighbors, on average. There was no change, on average, among black families (56 %). These large differences in neighborhood attainment between black and white families have increased (for income) and persisted (for race) over the course of two generations.

The descriptive statistics in Table 1 also provide insight into how metropolitan areas changed during the study period. There has been a decline in black-white residential segregation as measured by the dissimilarity index for whites (10 points) and blacks (8 points); an increase in the share of foreign-born population; a modest decline in public sector employment; a large decline in manufacturing employment; an increase in low-wage service work; a decline in the share of new housing built in the last 10 years; an increase in suburban population as a share of the metropolitan wide population; and increase in population size and median income. The only noteworthy racial difference among these metropolitan area characteristics is the black share of the population, which reflects the different areas of the country where the majority of blacks and whites live.

Path Analysis

Figure 2, panel a, provides the first set of results from a standard path analysis. The total legacy effect for black families is negative and statistically significant: a 1 standard

[7] Construction of the sampling weights follows Sharkey (2008:943, footnote 6).

Table 1 Means and *t* tests by race for a study of the intergenerational effect of racial residential segregation on neighborhood attainment: Panel Study of Income Dynamics, 1968–2011

	Mean Values				*t* Tests	
	Black Families		White Families		Racial Difference	
	First Gen.	Second Gen	First Gen.	Second Gen.	First Gen.	Second Gen.
Key Variables						
Neighborhood income (logged)	10.49	10.77	10.86	11.18	***	***
Neighborhood % black	.56	.56	.04	.07	***	***
Black-white residential segregation (dissimilarity index)	.71	.63	.69	.59	*	*
Family Control Variables						
Family income (logged)	10.16		10.92		***	
Male head of household	.52	.47	.89	.51	***	
Education						
Less than high school (ref.)	.32	.06	.14	.04	***	*
High school	.35	.37	.31	.26		***
Some college	.23	.38	.21	.28		***
College degree	.10	.19	.35	.43	***	***
Homeownership (proportion of years owned)	.39		.79		***	
Parental aspirations	5.13		5.29			
MSA Control Variables						
% Black population	.20	.22	.13	.14	***	***
% Foreign-born population	.06	.10	.07	.11		
% FIRE employment	.07	.07	.06	.07		
% Public sector employment	.17	.13	.16	.13		
% Manufacturing	.20	.15	.21	.14		
% Low-wage service	.05	.11	.05	.11		
% New housing (last 10 years)	.23	.17	.24	.16		
% Suburban population	.57	.61	.55	.59		
Population size (logged)	14.13	14.36	13.94	14.23		
Median income (logged)	9.87	10.84	9.70	10.85	**	
N	2,180		2,893			

Notes: n = 5,037 pairs of parents (first generation) and adult children (second generation). Significance determined using two-tailed *t* test with complex survey design corrections.

*$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed *t* test)

deviation increase in the first generation's exposure to racial residential segregation is associated with a modest 3.8 % decrease in the second generation's neighborhood income attainment [$(\exp^{-0.274 \times 0.14} - 1) \times 100$], conditional on family attributes and other metropolitan-area characteristics. The legacy effect increases marginally to –0.279 without controls for educational attainment (not shown).

In Fig. 2, panel a, we can also trace the legacy effect of racial residential segregation for black families in the first generation through the neighborhood environment of the children (b = –0.461), which influences the neighborhood attainment of the second generation (a = 0.477). The sum total of this neighborhood effects pathway explains roughly 80 % of the total legacy effect [(–0.461 × 0.477) / 0.274]. We can also trace the

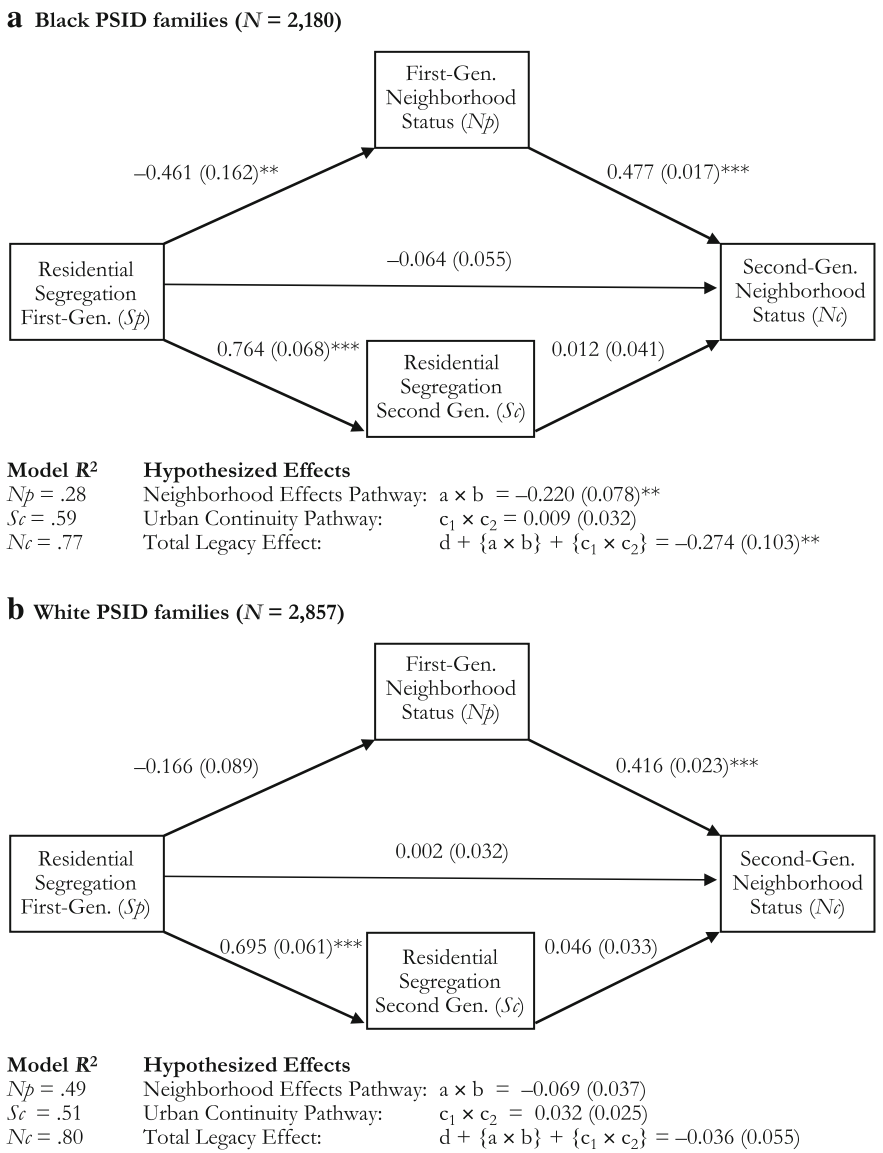


Fig. 2 Path analysis of the intergenerational effect of racial residential segregation on neighborhood income attainment for black and white PSID families, 1968–2011. Unstandardized coefficients with cluster-robust standard errors. Models control for all the individual characteristics and predetermined MSA characteristics listed in Table 1. *p < .05; **p < .01; ***p <.001 (two-tailed tests)

legacy effect of racial residential segregation in the first generation through the second generation's contemporaneous exposure to racial residential segregation (c_1 = 0.764), which in turn has little direct effect on the neighborhood attainment of the second generation (c_2 = 0.012). The sum total of the urban continuity pathway explains a negligible 3 % of the total legacy effect [(0.764 × 0.012) / 0.274].

The bottom panel of Fig. 2 (white PSID families, *N* = 2,857) provides the parallel path model for white families. Although the intergenerational elasticity (a = 0.416) and the effect of first-generation segregation exposure on second-generation exposure (c_1 = 0.695) are strong and statistically significant, the effects of residential segregation on neighborhood income attainment among white families are weak (b = –0.166, and c_2 = 0.046) and not statistically significant. There is little support for either the neighborhood effects pathway or the urban continuity pathway among white families.

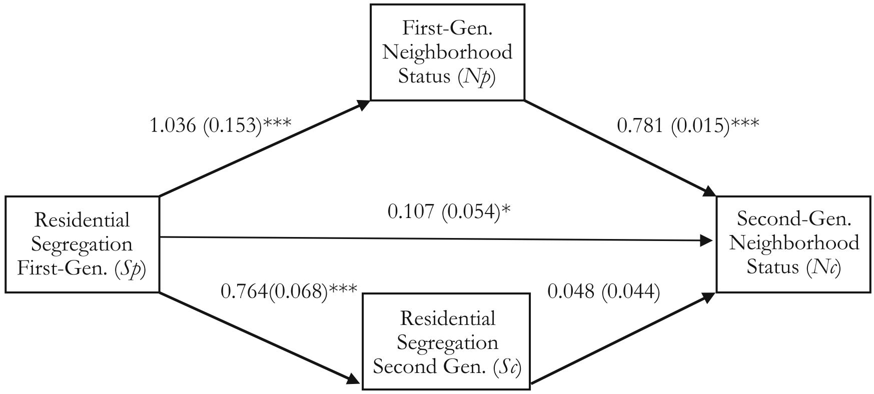
Figure 3 provides the second set of results from the path analyses that examines the intergenerational effect of racial residential segregation on the share of black neighbors for white and black families. In this analysis, the intergenerational elasticities are larger in magnitude when compared with neighborhood income. For both black and white families, the conditional intergenerational elasticity is approximately 75 % (a = 0.781 for blacks, and a = 0.741 for whites) compared with approximately 50 % for neighborhood income. These intergenerational effects are substantial. These larger elasticities indicate that there is less change in neighborhood racial composition intergenerationally than neighborhood income status.

The total legacy effect reported in Fig. 3 for black families, panel a, is positive and statistically significant: a 1 standard deviation increase in the first generation's residential segregation is associated with a 13 percentage point increase in the second generation's share of black neighbors [(0.953 × 0.14) × 100], net of other factors. This is a larger legacy effect than reported for neighborhood income, suggesting that racial residential segregation is a stronger determinant among black families of neighborhood racial composition than neighborhood SES.

Tracing the effect of racial residential segregation in the first generation through the neighborhood environment of the children (b = 1.036) accounts for roughly 85 % of the total legacy effect [0.810 / 0.953]. Conversely, the legacy effect operating through the second generation's exposure to racial residential segregation (c_1 = 0.764) continues to explain very little because the direct effect of racial residential segregation for the second generation is small and not statistically significant (c_2 = 0.048). The urban continuity pathway explains only 4 % of the total legacy effect [0.036 / 0.953]. The analysis of neighborhood racial composition for black families supports the findings from the previous analysis: the legacy of racial residential segregation operates primarily through the neighborhood environments to which children are exposed.

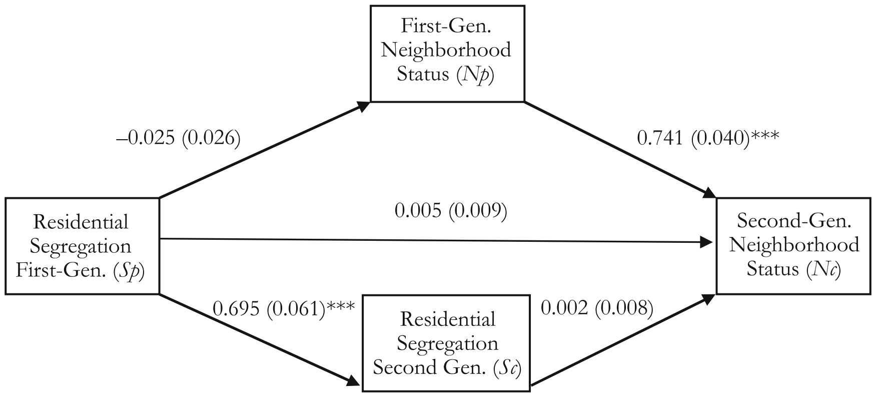
The bottom panel of Fig. 3 provides the parallel path model for white families. Again, there is little of significance to report. Although the intergenerational elasticity (a = 0.741) and the effect of first-generation segregation exposure on second-generation exposure (c_1 = 0.695) are strong and statistically significant, the conditional effects of residential segregation on neighborhood racial composition are weak (b = –0.025 and c_2 = 0.002). Thus, for white families, the neighborhood effects pathway and urban continuity pathway are of limited importance compared with black families.

a **Black PSID families (N = 2,180)**



Model R^2	**Hypothesized Effects**	
Np = .40	Neighborhood Effects Pathway:	a × b = .810 (.121)***
Sc = .59	Urban Continuity Pathway:	$c_1 \times c_2$ = .036 (.034)
Nc = .87	Total Legacy Effect:	d + {a × b} + $\{c_1 \times c_2\}$ = .953 (.133)***

b **White PSID families (N = 2,857)**



Model R^2	**Hypothesized Effects**	
Np = .53	Neighborhood Effects Pathway:	a × b = –0.019 (0.019)
Sc = .51	Urban Continuity Pathway:	$c_1 \times c_2$ = 0.001 (0.005)
Nc = .84	Total Legacy Effect:	d + {a × b} + $\{c_1 \times c_2\}$ = –0.013 (0.024)

Fig. 3 Path analysis of the intergenerational effect of racial residential segregation on neighborhood racial composition for black and white PSID families, 1968–2011. Unstandardized coefficients with cluster-robust standard errors. Models control for all the individual characteristics and predetermined MSA characteristics listed in Table 1. *p < .05; **p < .01; ***p <.001 (two-tailed tests)

Formal Sensitivity Analysis

Figure 4 illustrates the results from the sensitivity analysis. The dashed horizontal line represents the observed indirect effects Eqs. (4) and (5) from the path analyses. The y-axis represents the range of potential indirect effects. The neighborhood

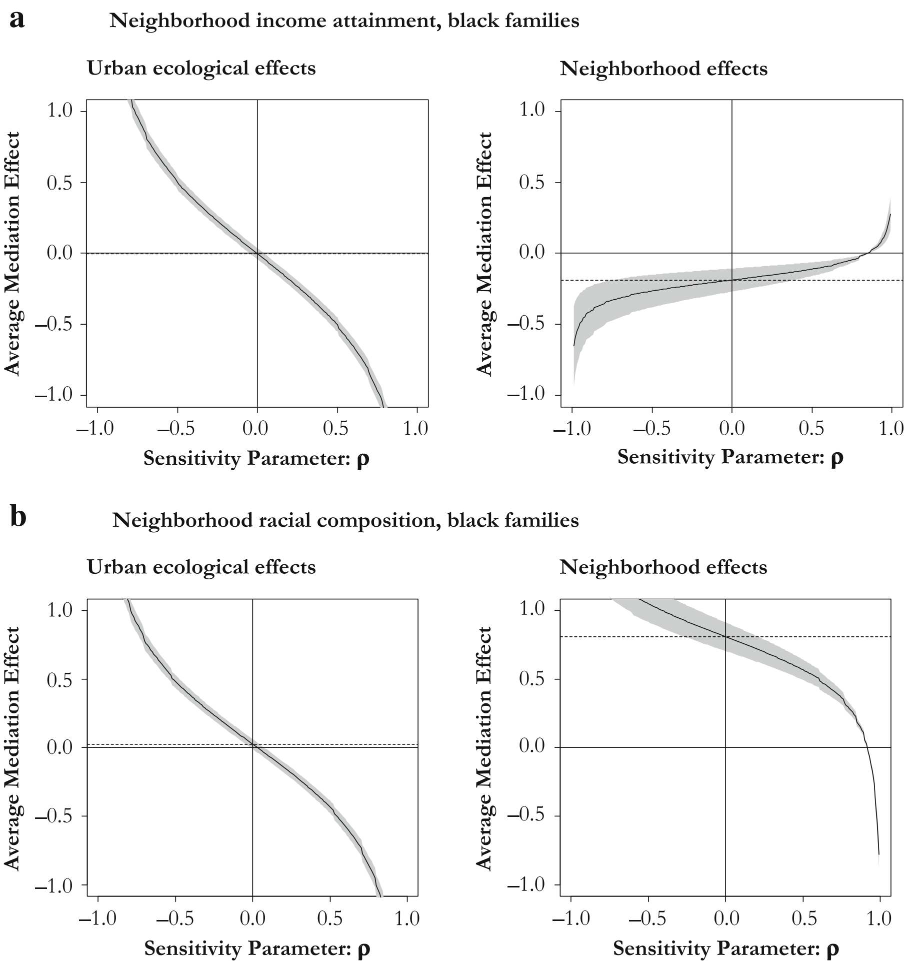


Fig. 4 Sensitivity analysis of the indirect effects of racial residential segregation on the second generation's neighborhood attainment

income results for black families produced an urban continuity effect of 0.009 and a neighborhood pathway effect of –0.220; the dashed lines correspond to these observed effects. The solid curvilinear line within the gray 95 % confidence band represents the results from the sensitivity analysis, where the sensitivity parameter ρ ranges from –1 to 1.

The results from this sensitivity analysis reveal two important findings. First, the substantive conclusions regarding the neighborhood effects pathway remain intact even if there are important omitted variables. For black families, the strength of an omitted variable would need to be very large, and perhaps even unrealistically large, to negate the neighborhood effects pathway. It is not until an error correlation is greater than .8 (e.g., ρ > .8) that the indirect effect for the neighborhood pathway approaches 0. This is true for the neighborhood income and neighborhood racial composition outcomes. Although it is unlikely that an omitted variable could produce a correlation of this

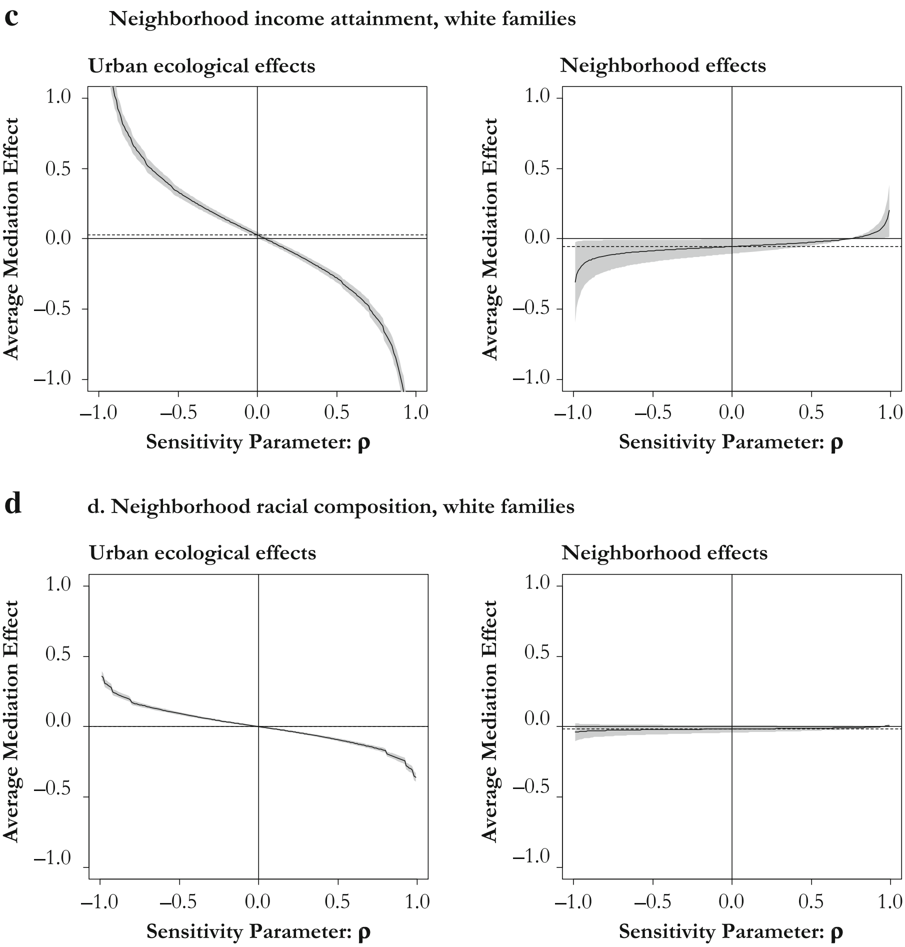


Fig. 4 (continued)

magnitude, there are likely omitted variables that may alter the magnitude of the estimated causal effect reported in this study. These potential omissions, and their consequences for causal inference, are discussed in the Conclusion section.

The urban continuity pathway, on the other hand, appears very sensitive to potential omissions. Relatively small departures of the sensitivity parameter from 0 produce statistically significant effects in either a positive or negative direction for all models. The overall pattern of the sensitively analysis holds for white and black families alike: consistent effects for the neighborhood pathway but statistically inconsistent effects for the urban continuity pathway. These findings caution us against making strong conclusions about the urban continuity pathway without further analysis. In the next section, I introduce an IV estimator to address the problem of correlated errors. In the Conclusion, I also discuss what important omitted variables could affect our causal assessments of this pathway.

Supplemental Analyses

Table 2 provides the focal point estimates using alternative samples and estimators. Three main methodological issues are addressed with these supplemental analyses. First, if whites are more likely to migrate within the United States to smaller metropolitan areas with lower levels of segregation, it could help explain the null findings for whites and the problem of correlated errors. Model 2 estimates the same path models but on a subsample of families that stayed in the same metropolitan area over the duration of the study period. For convenience, Model 1 is a reproduction of the focal point estimates from the initial path models. As expected, the point estimates in Model 2 are all larger than the initial estimates among black families, but the substantive conclusions are unchanged. Among white families, restricting the sample to stayers had no effect on the previous conclusions.

According to the sensitivity analysis, the second methodological issue is the potential for an omitted variable to confound the urban continuity pathway. Addressing this issue requires an IV that is highly correlated with racial residential segregation but is unassociated with the unexplained variance of the neighborhood outcome of interest. Ananat's (2011) study of nineteenth century railroad track patterns in the United States provides a potentially suitable instrument: the *railroad division index*, which measures via a Herfindahl index the dispersion of a city's land into subunits. If the city is undivided by railroad tracks, then the index equals 0. If the city is infinitely divided by railroad tracks, then the index equals 1. The more subdivided a city in the nineteenth century, the more boundaries are available as barriers for the development of segregated residential patterns. Ananat found this instrument to be highly correlated with current levels of racial residential segregation and plausibly exogenous to other correlates of segregation, such as a city's racial composition.

Model 4 in Table 2 provides the results from an IV estimator. First note that a different comparison model, other than the original path model, is needed to gauge the effects of the IV estimator because the railroad division index is available only for 121 metropolitan areas. The criteria used to select these cities biases inferences toward cities that were underdeveloped in the nineteenth century, which excludes cities such as Chicago, Boston, and New York City (see Ananat 2011). Model 3 provides the comparable estimates from the path model based on the same sample used in the IV approach in Model 4.

Among black families, the point estimates in Model 3 and 4 are generally larger in magnitude than those in Models 1 and 2. We owe this difference to the select sample of cities in this analysis. This is noteworthy because it suggests that racial segregation could be more impactful for people's residential outcomes among U.S. cities that did not fully develop residentially until the twentieth century. These are the cities that are most likely to have experienced rapid population growth via the Great Migration. For white families, there is now a small (especially when compared with the coefficients in the models for black families) but statistically significant neighborhood effect on neighborhood racial composition in Models 3 and 4.

Importantly, the IV estimates in Model 4 are hardly disguisable from those in Model 3, with the exception of the statistically significant urban continuity pathway on neighborhood racial composition (0.162) among black families. This effect still represents a small minority share of the total legacy effect (~11 % = 0.162 / 1.494).

Table 2 Supplemental estimates of the effect of racial residential segregation on neighborhood attainment: Panel Study of Income Dynamics, 1968–2011

	Model 1: Original	Model 2: Stayers	Model 3: IV Sample	Model 4: IV
Black PSID Families				
Outcome: Neighborhood income status				
Neighborhood effects	–0.220**	–0.232*	–0.335	–0.335
	(0.078)	(0.091)	(0.177)	(0.177)
Urban continuity effects	0.009	0.010	0.033	–0.064
	(0.032)	(0.042)	(0.055)	(0.089)
Total legacy effect	–0.274**	–0.297*	–0.764**	–0.757**
	(0.103)	(0.120)	(0.222)	(0.219)
N	2,180	1,734	575	575
Outcome: Neighborhood racial composition				
Neighborhood effects	0.810***	0.874***	1.223***	1.224***
	(0.121)	(0.134)	(0.152)	(0.153)
Urban continuity effects	0.036	0.036	0.082	0.162*
	(0.034)	(0.052)	(0.056)	(0.081)
Total legacy effect	0.953***	1.017***	1.539***	1.494***
	(0.133)	(0.151)	(0.171)	(0.152)
N	2,180	1,734	575	575
White PSID Families				
Outcome: Neighborhood income status				
Neighborhood effects	–0.069	–0.029	0.088	0.088
	(0.037)	(0.054)	(0.079)	(0.079)
Urban continuity effects	0.032	–0.004	0.022	–0.020
	(0.025)	(0.043)	(0.030)	(0.075)
Total legacy effect	–0.036	0.039	0.088	0.092
	(0.055)	(0.073)	(0.136)	(0.137)
N	2,893	1,825	1,254	1,254
Outcome: Neighborhood racial composition				
Neighborhood effects	–0.019	–0.014	0.071***	0.071***
	(0.019)	(0.033)	(0.020)	(0.020)
Urban continuity effects	0.002	0.012	0.002	–0.049
	(0.005)	(0.011)	(0.008)	(0.037)
Total legacy effect	–0.013	–0.013	0.099***	0.108***
	(0.024)	(0.038)	(0.025)	(0.027)
N	2,893	1,825	1,254	1,254

Notes: Data are unstandardized coefficients, with cluster-robust standard errors in parentheses. Models control for all the individual characteristics and predetermined MSA characteristics listed in Table 1.

*p < .05; **p < .01; ***p <.001 (two-tailed tests)

The close similarity between Models 3 and 4 means that the original results regarding urban continuity are likely to hold.[8]

Table 3 provides further supplemental analyses using five alternative measures of residential segregation: (1) black-white exposure (P × XY); (2) white-black exposure (P × YX); (3) black-black isolation (P × XX); (4) white-white isolation (P × YY); and (5) a measure of income residential segregation (H^R), a rank-order information index (Reardon and Bischoff 2011). The results in Table 3 are from the initial path model specification using these alternative measures (12 new models) to evaluate whether different measures of segregation have any effect on the substantive conclusions. Briefly, for blacks, the substantive conclusion is unchanged: the neighborhood effects pathway explains the legacy effect of residential segregation regardless of the measure used. That is, in all models (dissimilarity, exposure, isolation, and income segregation), the effect of parental exposure to residential segregation on their children's neighborhood attainment is largely mediated by the child's neighborhood environment growing up. The only exceptions are the small, but statistically significant, urban continuity effect for the isolation index (P × XX) when neighborhood racial composition is the outcome, and a noteworthy residual direct effect (d = 0.660 (0.305)) of parent's income segregation (H^R) on their children's neighborhood racial composition. The fairly large residual direct effect for income segregation likely indicates the omission of an important alternative pathway when income segregation is the key explanatory factor. Neither of these additional findings compromises the main conclusions.

For whites, the findings are more nuanced. There appears to be some support for the urban continuity pathway among whites, especially when we consider the effects of within group isolation (P × YY) and H^R income segregation on neighborhood income attainment. We also see stronger support for the both the neighborhood effects pathway and urban continuity pathway when white-black exposure (P × YX) is the measure of residential segregation.

However, a few issues make me cautious about these new findings. First, when neighborhood income is the outcome, there are noteworthy residual direct effects for both P × YX and P × YY, which complicates the decomposition of indirect pathways. Also, I included the standardized coefficient for all the total legacy effects to gauge the relative explanatory power of each measure. The magnitude of these standardized coefficients for whites is small, with the exception of exposure P × YY (0.134), in comparison with the models for blacks. Again, this supports the conclusion that the effects of residential segregation are stronger for blacks than for whites.

To provide counterfactual estimates of the mediation effects and to assess the role of intermediate confounding, the next supplemental analysis relaxes the assumption of no treatment-mediator interaction. Of the eight possible treatment-mediator interactions for each racial group per outcome (2 × 2 × 2 = 8), there are only two significant interaction effects (results not shown). For black families, there is a significant interaction effect between the first generations' segregation exposure

[8] It is important to acknowledge that this interpretation relies on the untestable exogeneity assumption of the instrument.

Table 3 Supplemental estimates using five different measures of residential segregation on neighborhood attainment: Panel Study of Income Dynamics, 1968–2011

	Model 1: Original With Dissimilarity Index	Model 2a: Exposure (black = P × XY) (white = P × YX)	Model 3a: Isolation (black = P × XX) (white = P × YY)	Model 4a: Income Segregation (H^R)
Black PSID Families				
Outcome: Neighborhood income status				
Neighborhood effects	–0.220**	0.337***	–0.195**	–0.957***
	(0.078)	(0.075)	(0.066)	(0.256)
Urban continuity effects	0.009	–0.026	–0.025	0.037
	(0.032)	(0.027)	(0.022)	(0.103)
Total legacy effect	–0.274**	0.404***	–0.277*	–1.190***
	(0.103)	(0.101)	(0.092)	(0.388)
Standardized total legacy effect	–.118	.274	–.206	–.131
N	2,180	2,180	2,180	2,180
Outcome: Neighborhood racial composition				
Neighborhood effects	0.810***	–0.898***	0.647***	1.420***
	(0.121)	(0.110)	(0.099)	(0.365)
Urban continuity effects	0.036	–0.039	0.067*	–0.036
	(0.034)	(0.027)	(0.026)	(0.127)
Total legacy effect	0.953***	–1.104***	0.767***	2.044***
	(0.133)	(0.121)	(0.112)	(0.510)
Standardized total legacy effect	.412	–.748	.569	.224
N	2,180	2,180	2,180	2,180
White PSID Families				
Outcome: Neighborhood income status				
Neighborhood effects	–0.069	–0.038	–0.091	0.669**
	(0.037)	(0.203)	(0.076)	(0.214)
Urban continuity effects	0.032	–0.004	–0.263***	0.346***
	(0.025)	(0.119)	(0.055)	(0.094)
Total legacy effect	–0.036	–0.444	0.031	0.906***
	(0.055)	(0.269)	(0.114)	(0.285)
Standardized total legacy effect	–.016	–.086	.007	.099
N	2,893	2,893	2,893	2,893
Outcome: Neighborhood racial composition				
Neighborhood effects	–0.019	0.493***	–0.157***	0.425***
	(0.019)	(0.136)	(0.037)	(0.119)
Urban continuity effects	0.002	0.118***	–0.033*	0.027
	(0.005)	(0.028)	(0.013)	(0.023)
Total legacy effect	–0.013	0.691***	–0.209***	0.485***

Table 3 (continued)

	Model 1: Original With Dissimilarity Index	Model 2a: Exposure (black = P × XY) (white = P × YX)	Model 3a: Isolation (black = P × XX) (white = P × YY)	Model 4a: Income Segregation (H^R)
	(0.024)	(0.169)	(0.046)	(0.131)
Standardized total legacy effect	–.006	.134	–.047	.053
N	2,893	2,893	2,893	2,893

Notes: Data are unstandardized coefficients, with cluster-robust standard errors in parentheses. Models control for all the individual characteristics and predetermined MSA characteristics listed in Table 1.

$^*p < .05$; $^{**}p < .01$; $^{***}p < .001$ (two-tailed tests)

(dissimilarity index) and childhood neighborhood income status. This provides us with the following counterfactual estimates (with standard errors in parentheses):

$$ACME\ treated(Np) = \mathrm{E}[Nc(Sp = 1, Np(Sp = 1)) - Nc(Sp = 1, Np(Sp = 0))]$$

$$= \mathrm{b}(\mathrm{a} + \mathrm{x}) = –0.187\ (0.067)$$

$$ACME\ control(Np) = \mathrm{E}[Nc(Sp = 0, Np(Sp = 1)) - Nc(Sp = 0, Np(Sp = 0))]$$

$$= \mathrm{a} \times \mathrm{b} = –0.307\ (0.119).$$

Despite a significant interaction (x = –0.261 (0.118)), the point estimates are similar in magnitude to the original indirect effect –0.220. It appears that the expected neighborhood effects experienced among families from highly segregated areas are slightly less pronounced than the expected neighborhood effects from those families from less-segregated metropolitan areas. This effect heterogeneity may be attributed to the adaptive resilience that develops among children who grow up in highly segregated areas (cf. Anderson 2000; Elder 1999:11).

The second significant interaction effect is between the first generations' exposure to segregation (dissimilarity index) and the second generations' exposure to segregation in predicting neighborhood racial composition for white families (z = –0.098 (0.029)):

$$ACME\ treated\ (Sc) = \mathrm{E}[Nc(Sp = 1, Sc(Sp = 1)) – Nc(Sp = 1, Sc(Sp = 0))]$$

$$= \mathrm{c}_1(\mathrm{c}_2 + \mathrm{z}) = –0.022\ (0.009)$$

$$ACME\ control\ (Sc) = \mathrm{E}[Nc(Sp = 0, Sc(Sp = 1)) – Nc(Sp = 0, Sc(Sp = 0))]$$

$$= \mathrm{c}_1 \times \mathrm{c}_2 = 0.046\ (0.014).$$

The original indirect effect was near 0 ($c_1 \times c_2 = 0.001$) and not statistically significant. These counterfactual estimates are statistically significant but remain small in magnitude. Among white families originating in highly segregated metropolitan areas, the expected –2.2 percentage point difference in the share of black neighbors is the difference between the second generation experiencing a level of contemporary segregation that is typically experienced by those from highly segregated areas compared with a contemporary level of segregation that would be typical had they originated from a metropolitan area with low levels of segregation. Conversely, among white families from less-segregated metropolitan areas, we should expect a 4.6 percentage point increase in the share of black neighbors if the children were to be exposed to contemporaneous levels of segregation commensurate with those from highly segregated areas as opposed to less-segregated areas. Combined, this set of findings means that white families from highly segregated areas do not appear to experience improved levels of neighborhood racial integration that we would expect to occur as a result of declining levels of contemporary racial residential segregation; at the same time, white families from less-segregated areas are actually likely to have more exposure to black neighbors as a result of experiencing levels of contemporary racial residential segregation that are more commensurate with highly segregated areas. In theoretical terms, this suggests to a modest degree that changing levels of segregation in places with historically high or low levels of segregation could have different implications for actual changes in neighborhood racial composition for the second generation. For the rest of the models with no treatment-mediator interaction effects, the original path models provide the appropriate estimates of the indirect effects.

Conclusion

This study develops an intergenerational perspective to study spatial reproduction that links the circumstances of the current generation to the lives of the previous generation. It moves research beyond what point-in-time studies of racial segregation are able to say about the importance of local spatial structures for individual residential outcomes. Using up-to-date mediation techniques provides a cautious way to gauge the hypothesized legacy effects through which levels of racial segregation experienced by a prior generation reproduces residential socioeconomic and racial neighborhood environments in later generations. The findings indicate that among black families, the legacy of racial residential segregation operates primarily through the neighborhood effects pathway—that is, from the expected influence childhood neighborhood environments have on the development of human capital, place attachment, and neighborhood stereotyping.

In addition to this main finding, two sets of null findings also shape conclusions about the legacy of racial residential segregation. The first set of null findings is the relative absence of a comparable legacy effect for white families. Why might the legacy of racial residential segregation matter less for whites? Perhaps neighborhood preferences of white families develop in a larger regional or national cultural field than is the case for minority groups. In this study, white families in Detroit, one of the most segregated metropolitan areas, reside in neighborhoods that are roughly 8.5 % black, on average, compared with 4 % in Salt Lake City, one of the least-segregated areas. Whites have only a 4 to 5 percentage point difference between one of the most- and least-segregated cities. No matter where whites live, there is a high propensity for them to select predominately white neighborhoods and the socioeconomic advantages that typically follow.

The second null finding of interest involves the urban continuity pathway. Prior levels of racial residential segregation are strongly related to current levels of residential segregation in ways that are expected to re-create each succeeding generations' residential outcomes. Yet, the legacy effect does not appear to be significantly passed along in this manner, at least not for black families. A cursory review of the institutional factors that led to the historical rise of racial residential segregation in the United States sheds light on this null finding (for a full review, see Massey 2008).

It is well documented that the federal government's mid-century involvement in urban renewal projects led to discriminatory choices to clear predominately black neighborhoods to make way for highway construction and federally sponsored housing projects (e.g., the American Housing Act of 1949; the Federal-Aid Highway Act of 1956; *Hills v. Gautreaux* 1976). During this period, zoning restrictions and restrictive covenants against blacks proliferated, and realtors exploited racially segmented housing markets for profit through blockbusting and racial steering. By the late 1960s, the spatial entrenchment of predominately black neighborhoods in urban America was complete. It is this early institutionalization period, from the turn of the twentieth century to the 1960s, through which the contemporaneous effect of segregation and the urban continuity pathway likely had its greatest influence on residential outcomes (e.g., as black internal migrants from the Great Migration gravitated to urban centers).

Since the mid-1960s and early 1970s, federal and state governments have taken legislative steps to address systematic racial disparities in the areas of housing. Key among these are the Fair Housing Act of 1968, several precedent court cases seeking housing equality (e.g., *Shannon v. United States Department of Housing and Urban Development*, 1970; *Southern Burlington County NAACP v. Township of Mount Laurel*, 1975), the U.S. Department of Housing and Urban Development's creation of the Office of Fair Housing and Equal Opportunity (FHEO; 1968), and the Community Reinvestment Act, 1977. In recent years, six executive orders and several amendments have been established to improve the Fair Housing Act (e.g., Housing Opportunities Made Equal (HOME) program), the physical dismantling of the country's largest public housing projects via HOPE IV, and growing support for housing voucher subsidies (Section 8). Arguably, these ameliorative steps have more effectively changed the physical residential landscape that supports the urban continuity pathway (e.g., replacing housing projects with low-rise, mixed-income developments) than addressing the neighborhood effects pathway (e.g., human capital development, place attachment, and negative neighborhood stereotyping). Unfortunately, more data are needed to fully evaluate this thesis. Without data on the parents' neighborhood conditions growing up, we are simply unable to assess whether the neighborhood effects pathway has gained salience over the urban continuity pathway in recent times.

Although the point-in-time effects of racial residential segregation may have been more pronounced in an earlier settlement era, the point-in-time mechanisms associated with the urban continuity pathway appear to be at the very least secondary in magnitude to the neighborhood effects pathway. However, several data limitations need to be discussed before reaching this conclusion. First, the results from the sensitivity analysis suggest that small departures from the assumption of statistically independent errors—for example, the presence of an omitted variable that causes both contemporaneous segregation and neighborhood attainment—may produce statistically significant positive or negative indirect effects. An IV approach adds credibility to this null finding, but IVs are not without limitations; thus, it is also important conceptually to discuss potential omissions.

An obvious suspect is systematic housing discrimination, which will affect both the neighborhood attainment of black home-seekers as well as the aggregate pattern of racial residential segregation throughout the metropolitan area. Yet, housing discrimination is also potentially endogenous to the reciprocal process that reproduces racial residential segregation (cf. Galster 1988) through the intergenerational transmission mechanisms discussed in this study. For example, housing discrimination will be endogenous if whites raised in highly segregated places are more likely to adapt discriminatory behaviors of the prior generation than whites from less racially segregated places. From an intergenerational perspective, contemporaneous occurrences of housing discrimination are more likely to be a function of past levels of racial residential segregation than to be an immediate effect of the levels of aggregate racial segregation observed through today. There are indications of more out-group animus in highly segregated places (Rocha and Espino 2009), but the question about the intergenerational transmission of racial prejudice under different kinds of spatial contexts awaits future research.

Second, omitted factors may bias the reported magnitude of the neighborhood effects pathway reported in this study. A host of unobserved family-level factors could influence both the neighborhood attainment of the parents and that of the second generation, including inherent family wealth; knowledge, aptitude, and ability not reflected in their educational attainments; and actual measures of place attachment and neighborhood stereotyping. However, even if these variables were observed, the ability to provide causally identified indirect effects is still compromised by intermediate confounding (i.e., observed or unobserved effects of segregation that also cause neighborhood attainment).

Two noteworthy results lessen concerns about intermediate confounding, but these issues are not fully eliminated. First, the exposure-mediator interactions specified in the causal mediation analysis did not significantly alter the substantive conclusions, suggesting that the problem of intermediate confounders is likely to be of minor concern (De Stavola et al. 2014; Robins and Greenland 1992). Second, according to the sensitivity analysis, these hypothetical omissions would need to be considerable to alter the magnitude of the neighborhood effects pathway. These two pieces of evidence further support the validity of the neighborhood effects pathway.

Given the likely omission of at least some relevant variables and the strong likelihood of intermediate confounding, it is important to be clear about what kind of causal inference this study can reasonably make. One kind of causal inference speaks to whether the legacy effects of racial segregation are indeed transmitted to some degree through neighborhood environments in which children grow up. The second kind of causal inference speaks to the specific magnitude of the neighborhood effects pathway (i.e., the population parameter). This study provides stronger inference for the former through theoretic knowledge and empirical sensitivity analyses while attempting to provide estimates directed at making the latter causal inference to the best of our ability given the inevitable data limitations in observation studies.

In addition to addressing these limitations, future research should explore avenues that lie beyond the scope of this study. First, it would be constructive to assess the way different dimensions of racial residential segregation (e.g., exposure, clustering, centralization) uniquely influence different aspects of the neighborhood effects pathway via the development of human capital, place attachment, and neighborhood stereotyping. The rationale for such associations is given here, but the associations remain to be fully tested. Also, future efforts to forecast the dynamic process through which racial residential segregation is intergenerationally reproduced may help discern the effectiveness of different housing policy initiatives. The implicit assumption of this study is that the residential choices at the individual level end up producing neighborhood outcomes at the meso level, which are the census tracks that scale up to create an aggregate/macro-level structure of racial residential segregation. A simulation study that includes knowledge about intergenerational processes will further our understanding of this micro-meso-macro chain of reproduction. These are the types of projects that will further our understanding of the social mechanisms that sustain racial residential stratification.

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