

**Segregated neighborhoods, segregated schools:
Do charters break a stubborn link?**

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Abstract:

Residential and school segregation historically mirrored one another, with school segregation seen as simply reflecting residential patterns due to neighborhood-based school assignment policy. We argue that the relationship is circular, with school options also influencing residential outcomes. To explore this, we examine what happens when neighborhood and school options are decoupled via public school choice in the form of charter schools. We hypothesize that the expansion of charter schools could simultaneously lead to an increase in school segregation and a decrease in residential segregation. We test this hypothesis with data from the Census and the Common Core of Data in a national sample of over 1,500 metropolitan districts. We find that Black-White school segregation increased and residential segregation declined in response to increases in charter enrollment share from 2000 to 2010. In districts with charter schools, the average increase in charter enrollment share corresponded to a 12 percent increase in school segregation and 2 percent decline in residential segregation. We find no relationship between charter school expansion and school segregation between White and Hispanic students, perhaps because Hispanic students attend more racially diverse charters than White or Black students. White-Hispanic residential segregation did decline as charter enrollment increased. Our results demonstrate that educational policy is consequential for both school and neighborhood population processes. Decoupling these two contexts via public school choice results in their segregation patterns moving in opposite directions, rather than mirroring one another. Our findings also provide a cautionary lesson for unfettered expansion of choice without integration imperatives.

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School districts in the U.S. are charged with providing equal opportunity to their whole student population, but they must do so in a context where individual families are compelled to maximize advantages for their children. This tension between the public versus private goals of schooling is particularly difficult to resolve in a setting where district populations are spatially segregated, dynamic, and responsive to changing policies (Labaree, 1997; Levin, 2007). Efforts to equalize opportunity that involve a redistributive policy—for instance, moving resources toward disadvantaged students or reshuffling students across schools—may induce unintended changes in residential migration and segregation patterns if families move in and out of districts or school attendance zones in response to educational policies.

In the past quarter century, market-oriented school choice has emerged as a popular educational reform based on the premise that the goals of public schooling may be accomplished more efficiently through competition and parent choice, rather than redistribution of students or resources (Berends, 2015). Empowering families to openly sort into schools according to their unique preferences, so this theory goes, requires schools to compete for enrollment and, in turn, compels them to innovate instruction and improve outcomes. What makes school choice so alluring is that it does not ask advantaged families to give up anything, instead leveraging the power of market competition to produce educational improvement (Le Grand, 2007).

The alluring promise of unleashed choice in an educational marketplace may lead policymakers to overlook its potential to exacerbate segregation. Expanded school choice has already increased school segregation in some districts (e.g., Bifulco, Ladd, and Ross (2009)), but less research examines this phenomenon nationally (see Monarrez, Kisida, and Chingos (2019) for an exception). Moreover, school choice breaks the link between neighborhood residence and

school assignment by opening up alternatives to traditional, residentially-zoned public schools. This feature allows parents from any neighborhood within a school district to enroll their children, provided there are open seats (Riel, Parcel, Mickelson, & Smith, 2018). By unbundling residential and school selection, we argue that the expansion of school choice could therefore affect patterns of residential choice and segregation, in addition to school segregation.¹

In this study, we evaluate how expanding school choice affected population dynamics in neighborhoods and schools nationwide. We focus our attention on the rise of charter schools in metropolitan areas. As publicly funded but independently operating “educational laboratories,” charter schools were originally conceived as local alternatives for communities frustrated by underperforming schools (Stulberg, 2008). Amidst a wave of bipartisan support (Bush, 2002; Obama, 2008), charters grew fourfold during the 2000s as a prominent form of public school choice (Logan & Burdick-Will, 2016; Whitehurst, 2017). We evaluate how the increase in charter school enrollment between 2000 and 2010 *simultaneously* affected both school and neighborhood racial segregation within districts. This approach considers neighborhood and school segregation as contingent, reinforcing processes. We find evidence that charters increased average school segregation within school districts nationwide, supporting a cautionary view of continued charter school expansion. Simultaneously, charter expansion reduced residential segregation. These findings reveal school preferences as a social force impacting population processes beyond the domain of education. We conclude by discussing the complexity of policy choices that could promote neighborhood and school integration in the charter school era.

¹ Some argue that choice could promote social integration in schools (Garnett & Garnett, 2000; Ryan, 2010). The bulk of the research, described below, does not support this conclusion.

Background

The changing link between neighborhoods and schools

School segregation has a long tradition in the U.S., though the mechanisms that produced it have changed (Reardon & Owens, 2014). In the first half of the 20th century, many school districts enacted policies that explicitly assigned children to schools by race, a system of “de jure” segregation that violated the Equal Protection Clause and was outlawed by the U.S. Supreme Court in 1954 (Rosenberg, 1991). Following the *Brown v. Board of Education* decision, districts that had intentionally created racially separate schools were slow to affirmatively desegregate, citing the difficulty of addressing “de facto” school segregation—the downstream consequence of neighborhood segregation. The narrow focus on school assignment policy failed to address that there was nothing “de facto” about neighborhood segregation, which resulted from centuries of racialized land use, zoning, and economic policies whose effects endured well after civil rights legislation outlawed explicit housing discrimination (Krysan & Crowder, 2017; Massey & Denton, 1993). In later decisions, the Supreme Court clarified that school districts, as state actors, were responsible for racially balancing schools even if they had not originally written the housing policies producing residential segregation (*Swann v. Charlotte-Mecklenburg Board of Education*; *Keyes v. School District No. 1, Denver, Co*).

Desegregation plans—including bussing, magnet schools, and freedom of choice—subsequently swept through school districts across the country, both North and South (Rossell & Armor, 1996), peaking in the early 1980s and gradually expiring or ending by court dismissal (Reardon, Grewal, Kalogrides, & Greenberg, 2012). Many lessons can be drawn from the era of mandated school desegregation—including its dramatic effect on reducing school segregation (Reber, 2005; Rosenberg, 1991), on narrowing Black-White inequality (Johnson, 2019), and, as

an unintended consequence, its role in worsening residential segregation between school districts due to Whites' out-migration to predominantly White school districts beyond the reach of single-district desegregation plans (Clotfelter, 2004a; Logan, Zhang, & Oakley, 2017). Perhaps a simpler lesson comes from the observation that school districts had to go to great lengths—often at odds with their own constituents—to offset the mechanical link between housing and school segregation.

School desegregation plans have waned in recent decades, but many of the underlying problems they sought to address remain. Today, school and residential segregation continue to correlate and segregation in both contexts remains high, changing little in the last 25 years (Fiel & Zhang, 2017; Logan & Stults, 2011; Stroub & Richards, 2013). More than three-quarters of public school children attend their local traditional public school (TPS), assigned by residential zoning maps within each school district (National Center for Education Statistics, 2018a). These assignment policies effectively bundle residential and school choice together, so that when a family moves to a neighborhood, they simultaneously choose a school (intentionally or not).

Although still the norm across the U.S., the bundling of residence and schooling has changed in recent decades with the rise of public school choice that provides alternatives to the neighborhood school in the form of magnet schools, charter schools, open enrollment, and other choice-based student assignment policies (Whitehurst, 2017). These changes potentially alter parents' residential and school decision-making calculus by decoupling these choices. Just as housing policies that created neighborhood segregation ultimately also had consequences for school segregation, educational policies may have implications for both school and neighborhood segregation.

We hypothesize that charter school expansion may particularly influence neighborhood and school segregation patterns by weakening the neighborhood-school link. Understanding the effect of charter schools on segregation is critical because they have become an increasingly popular educational reform, championed by policymakers and promoted by think tanks as a solution to school underperformance (EdChoice, 2019; U.S. Department of Education, 2019). Since 2000, the share of students attending charters more than quadrupled, surpassing magnet school enrollment, and on pace to continue growing. Although there were only 6,885 charter schools serving 5.8 percent of students nationally in 2015-16 (National Center for Education Statistics, 2018b), this rate was higher in many large urban districts, and their growth and popularity suggest they will increasingly influence the structure of schooling in the U.S. Unlike other forms of school choice, such as magnet schools, charters rarely have strong integration imperatives (Goldring & Smrekar, 2000; Potter & Quick, 2018; Riel et al., 2018). Therefore, this educational policy change may have repercussions for both school and residential population processes.

Charter expansion and school segregation

The growth of charter schools has led to an increase in public school segmentation by race in many large districts, mostly among White and Black students (Frankenberg, Siegel-Hawley, & Wang, 2011; Garcia, 2008). Some school districts now have essentially separate White and Black charters, reminiscent of older eras of de jure school segregation. The difference now is that the pattern comes from enrollment uptake in different schools rather than racially explicit district policy (Frankenberg & Lee, 2003; Frankenberg et al., 2011; Garcia, 2008; Ladd, Clotfelter, & Holbein, 2017).

In a school enrollment system governed by market sorting rather than by district assignment rules, segregation may reflect family preferences for schools composed of predominantly same-race peers. It is difficult to definitively isolate racial preferences from factors correlated with race (“racial proxies”) (Harris, 1999; Krysan, 2002), though Billingham and Hunt (2016) show that White parents prefer fewer Black students in their children’s school regardless of school test performance and resources. And even when parents espouse academic priorities, many choose charters of similar or lower quality than their TPS (Stein, Goldring, & Cravens, 2011). Surveys and experiments evaluating school search processes reveal that White parents often start with school racial composition as a shorthand heuristic device (Saporito & Lareau, 1999; Schneider & Buckley, 2003) before weighing other educational characteristics. Perhaps these preferences explain why White children disproportionately enroll in choice schools when their local neighborhoods have high levels of low-income and minority populations, or choose non-neighborhood schools that enroll proportionally more White students than their assigned local school (Bischoff & Tach, 2018, 2020; Candipan, 2019, 2020; Saporito, 2003; Saporito & Sohoni, 2007). The uniquely racialized school selection behavior of White families has thus raised concerns that charter schools facilitate “White flight” from TPSs (Bifulco et al., 2009; Frankenberg et al., 2011; Renzulli & Evans, 2005).

In addition to Whites’ avoidance of non-White schools, other social forces may contribute to the racial segmentation of charters. In the 1990s, charter schools opened in racially segregated Black and Hispanic neighborhoods of large cities. Many families were attracted to the alternative charters provided to historically under-resourced TPSs with large class sizes where parents had little power (May, 2006; Reid & Johnson, 2001; Renzulli, 2006). Further, in many predominantly Black cities, racially homogenous schools advance an Afrocentric mission that may be attractive

to Black parents and students (Fabricant & Fine, 2012; Teasley, Crutchfield, Williams Jennings, Clayton, & Okilwa, 2016). Finally, due to convenience and local knowledge, many charters enroll students from their local neighborhoods (often in high-minority areas), even though they do not have official attendance zones (Pattillo, Delale-O'Connor, & Butts, 2014).

Most of our understanding of charter schools and school segregation is limited to a subset of large, usually urban school districts, or draws upon segregation measures that do not account for demographic composition (Frankenberg et al., 2011). One exception is a recent report showing that charter growth increases the segregation of Black and Hispanic students from White and Asian students between schools within school districts (Monarrez et al., 2019), results we build on here.

Charter expansion and residential segregation

Our study provides the first national estimates of how charter expansion affects both school and residential segregation. Does weakening the policy link between neighborhoods and schools decouple neighborhood and school segregation patterns? How might charter expansion affect residential segregation? On one hand, residential segregation could be unresponsive to charter expansion if families do not bundle schools into their residential decisions as much as commonly thought. In 2012, only 19 percent of families reported moving explicitly for the local public school (National Center for Education Statistics, 2016), and families may not be very knowledgeable about local school assignment rules (Lareau, Evans, & Yee, 2016). Moreover, long-standing patterns of residential segregation due to house price premiums, exclusionary practices, and preferences may be too persistent to be responsive to changing school enrollment rules (Bayer, Ferreira, & McMillan, 2007; Krysan & Crowder, 2017).

However, Tiebout theories of residential sorting suggest that families seek to maximize public goods (e.g., schools) afforded by their neighborhood, within their economic constraints (Tiebout, 1956). Many parents, particularly White and middle-class parents, “shop” for schools by renting or buying homes in neighborhoods (and, at a larger scale, school districts) assigned to attractive schools that best match their preferences for academic achievement, social environment, enrichment activities, reputation, or other characteristics (Goldstein & Hastings, 2019; Lareau & Goyette, 2014), thus using neighborhood choice as a form of school choice. This type of residential sorting under a strict residence-based school assignment system leads to racially and socioeconomically stratified neighborhoods (Bischoff, 2008; Owens, 2016, 2017). Some past research demonstrates that liberalizing school assignment does affect the residential location decisions of parents. Nechyba (2003) shows that the availability of a private school market reduces residential income segregation, while Brunner, Cho, and Reback (2012) show that inter-district enrollment programs affect housing values near school district boundaries. Conversely, when a neighborhood-school link is strengthened—as in North Carolina after mandatory desegregation plans expired—residential segregation increases because residential location is once again very consequential for school enrollment (Liebowitz, 2018; Liebowitz & Page, 2014).

Beyond the private maximization of public goods, other theories of residential segregation also suggest that loosening the link between neighborhood residence and school attendance might reduce residential segregation. First, spatial assimilation theories suggest that racial segregation arises due to differences in the housing and neighborhoods that different racial groups can afford (Massey, 1985; Wagmiller Jr, Gage-Bouchard, & Karraker, 2017). When school choice options proliferate, the capitalization of school quality into housing values is reduced (Schwartz, Voicu, & Horn, 2014), which could reduce racial residential segregation driven by economic differences.

Second, place stratification theories center race in positing that residential segregation occurs due to Whites maintaining their housing advantage via institutionalized racial discrimination in housing search processes, lending, local zoning, and resistance to sharing neighborhoods with minority, particularly Black, residents (Logan & Alba, 1993; Logan & Molotch, 1987; Pais, South, & Crowder, 2012). Neighborhood schools may be one motivation for advantaged groups like White parents to hoard their own opportunities and resist residential integration. Removing the school as one neighborhood opportunity to be hoarded could reduce residential segregation.

Third, underlying and intersecting with these processes, groups' preferences create and uphold racial residential segregation (Clark, 1991). Whites' stated and revealed preferences for White neighbors are well-documented, with evidence that Whites view Black neighbors as the most undesirable, after Asian and Hispanic neighbors (Charles, 2000; Emerson, Yancey, & Chai, 2001; Farley, Fielding, & Krysan, 1997; Howell & Korver-Glenn, 2018). Black, Hispanic, and Asian householders, in contrast, prefer more racially diverse areas (Charles, 2000; Krysan & Farley, 2002). White parents with young children are particularly sensitive to local racial composition, exiting or avoiding neighborhoods as the proportion of Black or Hispanic neighbors and local schoolchildren increases (Goyette, Farrie, & Freely, 2012; Goyette, Iceland, & Weininger, 2014; Hall & Hibel, 2017; South, Crowder, & Pais, 2011). These behaviors aggregate into higher levels of racial residential segregation among families with children (Iceland, Goyette, Nelson, & Chan, 2010; Jargowsky, 2014; Owens, 2017). If racial preferences are driven in part by concerns about schools, the expansion of non-neighborhood alternatives could reduce residential segregation.

This Study

In contrast to the perception that neighborhood and school segregation simply reflect one another, our study evaluates the possibility that neighborhood and school segregation trends move in opposite directions as the growth of charter schools weakens their link. Prior research, focused on several dozen large districts, demonstrates that when choice options exist in neighborhoods comprising fewer White children, parents opt out of TPSs, which are consequentially less White than their local neighborhoods (Bischoff & Tach, 2018, 2020; Candipan, 2019; Saporito, 2003; Saporito & Sohoni, 2006; Sohoni & Saporito, 2009). We build on this research, leveraging variation in charter school growth to evaluate the simultaneous and contingent system of school and residential segregation in metropolitan areas and school districts throughout the U.S. In the aggregate, we hypothesize that charter school expansion will lead to a rise in school segregation and a decline in residential segregation as neighborhood and school choices are unbundled.

Residential and school segregation can occur either within or between school districts. Sorting between districts is a key driver of total segregation (Fiel, 2013; Owens, 2016; Stroub & Richards, 2013), and charter expansion could induce population mobility by providing attractive alternatives to TPSs that draw parents into urban districts (or keep them from moving away). In many states, however, district boundaries correspond to other community characteristics, so charter expansion in one district might not provide a sufficient signal to move the needle on large-scale sorting processes across an entire metropolitan area. This bears out in the descriptive results we report below. Accordingly, we focus our analysis primarily on segregation within school districts, theorizing that charter expansion likely affects local decisions by offering alternatives to TPSs that nudge family school and residential sorting behaviors within the districts where they already live or were already prone to select.

Data and Methods

Analytical approach

Our analyses evaluate change in both residential and school segregation as overlapping and mutually reinforcing systems. We begin by examining residential and school segregation within metropolitan statistical areas (MSAs) in 2000 and 2010, and we decompose total MSA segregation into its between and within school district components. As our decomposition reveals, the largest changes in school and residential segregation during the 2000s occurred within school districts (both between public school sectors and within the charter sector) rather than between school districts.

We measure segregation using the Variance Ratio Index, also known as the Separation Index, the Squared Coefficient of Variation, and η^2 (Coleman, Kelly, & Moore, 1975; Duncan & Duncan, 1955; Fossett, 2017; James & Taeuber, 1985; Reardon & Firebaugh, 2002; Zoloth, 1976). When estimated for pairwise groups (e.g., White-Black, White-Hispanic), the Variance Ratio Index can be decomposed into different administrative or geographic levels (e.g., within and between school districts or school sectors). The Variance Ratio Index describes the difference in neighborhood (or school) racial composition (e.g., percent White) between the average White and average non-White resident (or student). A value of 0 expresses an even distribution, where neither Whites nor non-Whites over-concentrate in a subset of schools or neighborhoods. A value of 100 indicates extreme racial polarization, where Whites and non-Whites populate completely separate neighborhoods or schools.

In an appendix, we elaborate on the useful properties of the Variance Ratio Index and provide a detailed description of our decomposition method. We also present within-district

analysis results using alternate segregation indices, noting that our substantive conclusions are insensitive to index choice.

School enrollment data

We separately measure pairwise segregation between White and Black and White and Hispanic 4th-grade students.² We focus on 4th-grade students because elementary school enrollment is more commonly tied to residential address, and we wish to capture segregation patterns among schools serving a single grade cohort (Stroub & Richards, 2013). Results are substantively similar for 8th- and 10th-graders (Appendix Table 6). We do not present results for segregation between White and Asian groups. Prior work on racial hierarchies in the U.S. shows that Asians are perceived to provide some advantages to neighborhood and school contexts, suggesting that charter expansion may not have the same relationship with White-Asian residential or school segregation as with White-Black and White-Hispanic segregation (Abascal & Baldassarri, 2015; Charles, 2003). Moreover, the comparatively small and geographically concentrated Asian population limits our statistical analyses. Exploratory results are available upon request.

Public school enrollment counts by race come from the 1989-1990, 1999-2000, and 2009-2010 NCES Common Core of Data (CCD) Public School Universe. The CCD includes an identifier code, school name, address, charter/magnet status, and school district for every public school in the country, by year.³ Charter and magnet school status was first tracked in 1998-1999,

² In the CCD, Hispanic is measured as a separate racial category and therefore all measures of White and Black student counts are restricted to non-Hispanic. For brevity, we dropped the non-Hispanic modifier.

³ The CCD has incomplete racial data for 14 states in 1989-1990 and one state in 1999-2000. We report findings using the nearest proximal year with available racial enrollment counts, but our conclusions do not change when dropping all such records from the analytical sample. CCD does not provide race-by-grade counts in 1989-1990, so we infer counts of 4th-graders-by-race by multiplying 4th grade total enrollment counts with total racial group proportions.

but in some cases, charter schools are listed as an entity separate from their geographic school district. Using school district boundary shapefiles provided by NCES and geospatial tools, we reallocate these charter schools to the school districts where they are geographically located. The NCES Private School Survey supplies additional racial enrollment counts for nearly all private schools in the U.S., which we geographically match to MSAs in the 1999-2000 and 2009-10 academic years.

Residential population data

We measure residential segregation using census tract boundaries from the 1990, 2000, and 2010 decennial Census TIGER files, produced by the National Historical Geographic Information System (NHGIS) (Manson, Schroeder, Van Riper, & Ruggles, 2017).⁴ Our goal is to evaluate neighborhoods as discrete, non-overlapping spatial units within school district boundaries, but there are complicated overlay issues. In 2000, for instance, nearly 30 percent of census tracts were bisected by one or more school districts. Accordingly, we subdivide bisected census tracts into smaller neighborhoods where each sub-partition of the original tract is matched to its true school district jurisdiction. We aggregate block-level Census data to generate population counts for each partitioned tract. For simplicity, we refer to all census tracts as “neighborhoods,” whether partitioned or whole.

Population counts are derived from the 1990, 2000, and 2010 decennial Census. The Census reports race and Hispanic ethnicity as conceptually distinct. We combine these variables to define three distinct subpopulations—non-Hispanic White, non-Hispanic Black, and Hispanic—comparable to school enrollment racial categories in NCES data.

⁴ A relevant alternative neighborhood definition is school assignment boundaries, which do not line up precisely with Census tracts. However, boundaries for catchment zones are only available longitudinally for several dozen districts.

Sample

We focus on MSAs defined as 2003 Core Based Statistical Areas or divisions. We exclude metropolitan areas with fewer than 50 4th-graders of each pairwise racial group in 2000 or 2010 and all micropolitan areas (sample N=309 MSAs). In our district analysis, we restrict the sample to metropolitan elementary and unified school districts with at least two schools and neighborhoods. There were 3,385 such districts in 2000, representing 74.2 percent of all 4th-graders enrolled in public schools nationwide and 89.8 percent of those living in MSAs.⁵ We further restrict to a White-Black analytical sample that includes 1,601 school districts with at least five 4th graders of each racial group and meets sample criteria across all years in the analysis. In 2000, the White-Black sample included 86.5 percent and 93.2 percent of all White and Black metropolitan 4th-graders, respectively. A White-Hispanic sample (n=1,354) is defined using the same criteria.⁶ Appendix Table 1 reports district sample coverage in further detail.

Charter school enrollment growth

We use an indicator from the CCD to identify 584 charter schools nationally in 1999-2000 and 2,139 charters schools in 2009-2010.⁷ Table 1 reports charter growth in metropolitan school

⁵ The district analysis excludes Detroit Public Schools (MI) and Orleans Parish Schools (LA) because each district experienced atypical population changes during the 2000s and also implemented large-scale charter expansion. We also drop four districts with unreliable charter enrollment counts (Campbell Union, CA; Fort Leavenworth, KS; Salt Lake City, UT; and Williamsburg-James City, VA). Results hold when including these school districts. Results are also robust to dropping outliers in charter school enrollment change and in segregation change from 2000 to 2010 (available upon request).

⁶ Analyses of alternative pairwise samples requiring one, two, or five percent representation of each racial group yield similar conclusions.

⁷ Our school count is limited to those enrolling at least ten 4th graders and coded “regular.” New Jersey charter school indicators are not available in the CCD in 1999-2000 so we substitute the 2000-2001 data. Additionally, we found 13 schools nationally not coded as charter school but that had the words “Charter”, “Success”, or similar words in their school name; we categorize them as charter schools, but results do not change when excluding this step. We perform similar steps to correct misallocated magnet school records.

districts. To generate these statistics, we measure the percentage of 4th-grade students attending a charter school among all 4th-grade public school students (which includes students enrolled in charter, magnet, and TPSs), separately, by year. In the White-Black sample, 0.63 percent of 4th-grade public school students attended charter schools in 2000, on average, across districts. This increased to 2.59 percent in 2010, quadrupling over the decade and growing more than other sectors, but the growth of charters was concentrated in only about one in four school districts. The right panel of Table 1 presents means for school districts with any charter school presence in 2000 or 2010 (n=453 in the White-Black sample). The average percentage of 4th-graders in each school district attending charters increased from 2.22 percentage points in 2000 to 9.15 percentage points in 2010. We find similar patterns of charter school growth in the White-Hispanic pairwise sample.

[Table 1 about here]

Table 1 also reports district enrollment rates in other sectors—traditional, magnet, and private schools. Magnet and charter schools are often compared and contrasted as public choice options, though magnet schools are more likely to have enrollment criteria designed to improve district racial balance and thus less likely to attract those with preferences for segregation (Goldring & Swain, 2020; Riel et al., 2018; Saporito & Sohoni, 2006). Moreover, as Table 1 shows, magnet school presence was established prior to the 2000s in many districts and grew more gradually than charter schools.⁸ Only 135 school districts across all three samples began offering magnet school options during this period, compared to 328 school districts that began offering charter school options, indicating that magnet school presence was concentrated in a smaller

⁸ CCD indicators for magnet schools can be complex and imperfect, with some magnets operating as programs located inside TPSs. Our inspection of 2010 CCD data indicates that fewer than one percent of magnet schools are co-located in buildings with TPSs, so this does not appear to be a problem in our sample that would substantially bias results.

number of metropolitan school districts. Accordingly, we do not emphasize magnet enrollment as a key explanatory variable in the analysis, though we account for it statistically.

Analysis

We first provide a descriptive analysis of segregation within MSAs. We decompose total segregation into segregation between and within districts and school sectors, following Clotfelter (2004b) and Fiel (2013). (See appendix for methodological details.) Then, we turn to our primary analyses, evaluating the effect of charter school expansion on segregation *within* school districts. Within-district school and residential segregation outcomes are reported in Table 2. Notably, across all years, average White-Black segregation was higher than White-Hispanic segregation for both school and residential segregation within districts. White-Black public school segregation may be lower than residential segregation because White children living in districts with a large Black presence are more likely to enroll in private school and are thus selectively omitted from public school segregation (Saporito, 2009).

[Table 2 about here]

Our hypotheses focus on change in segregation between 2000 and 2010. Table 2 reveals that White-Black school segregation increased in school districts in our sample over this period by an average of 2.15 index points even though school district residential segregation declined by an average of 0.82 index points. District White-Hispanic school segregation also increased, as did residential segregation.

We evaluate the effect of charter school enrollment change within districts using a structural equation model in which we simultaneously estimate one regression equation predicting change in school segregation and another predicting change in residential segregation. Estimating

these regressions simultaneously allows us to adjust for correlated residuals, thereby accounting for the link between school and residential segregation that we hypothesize charter schools weaken.⁹ The key explanatory variable is change in charter school enrollment during the 2000s. We include control variables for level of segregation in 2000 and change in segregation during the 1990s. The general regression equation, where “seg” refers to a specific within-district segregation outcome, is:

$$seg_{2010-2000} = \delta cht_{2010-2000} + \gamma seg_{2000-1990} + \lambda seg_{2000} + \beta X_{2000} + \varepsilon$$

The regression equation predicts that change in segregation between 2000 and 2010 is a function of pre-existing trends and levels of segregation, change in charter school enrollment, and a vector of covariates, X .¹⁰ We estimate models separately for each pairwise segregation measure (White-Black and White-Hispanic) and compute robust standard errors clustered by MSA. Notably, our outcome measure for school segregation within districts describes the distribution of students across all types of public schools, including TPSs, charter schools, and magnet schools. In this way, we can evaluate how change in the relative share of charter school students impacts segregation across the full system of publicly enrolled students. Private school students are not included in this portion of the analysis, but we do address this population with statistical controls.

The estimation model includes a set of covariate controls to reduce the possibility that the effect of charter school expansion is confounded by other observable school district characteristics expected to influence segregation, drawing from Logan et al. (2017). Appendix Table 2 reports

⁹ We use the “gsem” package in Stata 16 with the option covstructure(E.en, unstructured) specified.

¹⁰ Findings hold when we reorient our data and run time-series panel fixed effects models with controls for lagged segregation. We favor the structural equation model because it allows us to adjust for correlated residuals, consistent with our conceptualization of neighborhood and school segregation as linked.

mean characteristics of all covariates, held constant in the baseline year, 2000, to avoid controlling for changes that may have occurred directly or indirectly because of charter school expansion. To describe each school district's educational context, we measure (separately) the percent of public students enrolled in charter and magnet schools in 2000, an indicator for whether the school district was ever forced to desegregate its schools, an indicator for whether a desegregation order had been dismissed since 1990, and a categorical variable measuring school district size.¹¹ To describe the residential demographic context of each school district, we include the percent of resident children enrolled in private school, population size (log), land area (log), racial composition, and the percent of MSA residents living within the district (district "share") by race, all measured in 2000. We also observe whether the district had a downtown area and whether the school district is located in a southern or border state. Finally, we include two variables approximating the spatial assimilation theory of segregation: the difference in poverty rates between Whites and non-Whites and the median income ratio of Whites to non-Whites.

The key parameter of interest is δ , capturing the average treatment effect of charter school enrollment change on segregation within school districts. Although this estimation incorporates prior trends and levels within the school district, we may be concerned that changes in segregation and charter school enrollment are correlated with other unobserved changes in school district characteristics, such as public demand for school choice. Relatedly, we must consider the possibility of reverse causation in which charter school enrollment grows in response to change in segregation. We conduct several robustness checks to explore these issues, described below.

¹¹ Desegregation orders by school district are provided by the Brown American Communities Project (Logan, Oakley, & Stowell, 2008). Desegregation dismissals come from Stanford's Brown Fades database (Reardon et al., 2012).

Results

Segregation in MSAs

The 2000s saw a rapid increase in charter school enrollment. Our hypotheses anticipate that this new flexible option, delinking residence from assigned school, influenced both school and residential population patterns. We begin in Table 3 with a decomposition that considers segregation in MSAs, focusing on changes within and between different administrative and geographic levels. Results reveal that most segregation change in the 2000s occurred within districts, motivating our in-depth district-level analysis that follows.

[Table 3 about here]

Table 3, Row 1 shows that total White-Black and White-Hispanic segregation between schools in MSAs increased from 2000 to 2010. Rows 2 through 5 sum to Row 1, displaying the level of segregation (2) between public and private schools; (3) among private schools; (4) between public school districts; and (5) within public school districts. While a greater share of total school segregation occurs between public school districts in both years, within-district segregation is substantial and, for White-Black segregation, increased more during this time (White-Hispanic segregation increased comparably within and between districts). Rows 6 through 9 are sub-components of within-district public school segregation that sum to Row 5. Row 6 shows that segregation between public school sectors more than doubled during this time, as did segregation within the charter sector (row 8). Both mechanisms underlie our hypothesized relationship between charter expansion and school segregation: charter expansion both provides an option to sort between sectors (exiting TPSs) and more options to sort among charter schools.

Figure 1 illustrates the racial segmentation of charter schools within school districts. These histograms show the distribution of Black, Hispanic, or White students by school racial

composition (normed to district composition) for charter (gray bars) compared to TPSs (outlined bars) in our sample in 2010. The left panel shows that most Black students attend charter schools where Black students are racially overrepresented compared to the district composition—the tallest gray bar represents Black students in charter schools where the proportion Black is 40 percentage points higher than the district composition. A similar pattern appears for White students (right panel)—a greater density of White students attends charter schools that are disproportionately White compared to TPSs. Racial segmentation is less evident for Hispanic students, consistent with past research (Frankenberg & Lee, 2003; Garcia, 2008), though there is some clustering of students in the tails.

The lower panel of Table 3 shifts the focus to neighborhood population processes, showing that, for both racial dyads, most residential segregation occurs within school districts (compare rows 11 and 12). Row 10 shows that White-Black residential segregation in MSAs declined during this time, but this was driven by declines within districts. White-Hispanic segregation increased slightly, primarily between districts. Of critical importance for our analysis, however, is whether these observed changes correspond with the expansion of charter school enrollment, which we explore next. Our analyses hereafter focus on within-district segregation.

Segregation within metropolitan school districts

Table 4 reports selected coefficients from structural equation models testing whether charter expansion affects two simultaneous outcomes: change in school segregation and change in residential segregation within school districts. (Appendix Table 3 presents complete results for the model, which include prior levels and trends in segregation and an extensive set of control variables.) For White-Black segregation, results from Model 1 support our hypothesis that charter

school expansion corresponded to simultaneously rising school segregation and declining residential segregation. Recall that the Variance Ratio Index can be interpreted as the difference in White and Black students' (or residents') exposure to Whites in their school (or neighborhood). Our findings thus imply that a one percentage point increase in charter school enrollment simultaneously widens the exposure gap for schools by 0.144 and narrows the exposure gap for neighborhoods by 0.041 index points, on a scale of 0 to 100.

[Table 4 about here]

We further explore the scale of charter school expansion effects on both school and residential segregation in Table 5. The top panel of Table 5 reports the percent change in 2000 segregation levels as a function of four policy scenarios: if charter school enrollment increased by a) 1 percentage point (units reported previously in regression models); b) 1.96 percentage points (mean change across all sample districts); c) 6.93 percentage points (mean change among districts with any charter presence); and d) 17.66 percentage points (90th percentile of charter growth among districts with any charter presence). The top left row, for instance, reads that a 1 percentage point increase in district charter enrollment predicts a 1.72 percent increase in White-Black school segregation, relative to a 2000 mean segregation level of 8.36 (Table 2). The largest expansion we considered—a 17.66 percentage point increase in charter school enrollment share—accounts for a 12 to 49 percent increase in school segregation and a 2 to 10 percent decrease in residential segregation. The 95 percent confidence intervals demonstrate considerable heterogeneity between school districts, perhaps reflecting unobserved variation in how charter schools were implemented in the 2000s. Some districts may have intentionally limited segregative sorting (similar to magnet school criteria) while others allowed segregative sorting to occur uninhibited (Potter & Quick, 2018). Under a more typical scale of charter school expansion, the estimated effects are modest:

among school districts with any charter school presence, the average enrollment change during the 2000s (6.93, top panel, row c) accounts for a 5 to 19 percent increase in school segregation and a 1 to 4 percent decrease in residential segregation. Put in terms of exposure, the difference in percent White between the average White and Black student's school grew by 1 percentage point. The difference in percent White between the average White and Black resident's neighborhood declined by 0.28 percentage points. Whether we should interpret these effects as practically significant is an issue we revisit in the Discussion section.

[Table 5 about here]

We conclude from these results that charter enrollment growth simultaneously affected White-Black residential and school segregation by breaking the traditional neighborhood-school link, but our interpretation is vulnerable to the threat of reverse causation. It is possible that change in the local population—e.g., gentrification of formerly high-minority neighborhoods—created new demand for non-neighborhood public school options. While not refuting the importance of a neighborhood-school link, this alternative explanation makes a distinction between policy-driven segregation and segregation-driven policy. To test the idea formally, we add a measure of future charter enrollment growth between 2010 and 2016 to Table 4, Model 2, capitalizing on the fact that expansion continued after 2010 (there were 1,274 more elementary charter schools in 2016 than in 2010). If the causal direction is charter expansion affecting segregation, then the contemporaneous measure of segregation should be unrelated to charter expansion that has not yet occurred. Results of the falsification test, reported in Table 4, Model 2, show that future charter enrollment growth has no discernable effect for both segregation outcomes and, importantly, does not reduce the estimated main effect. Thus, Model 2 lends support to the claim that charter enrollment growth precedes changes in school and residential segregation.

We also explore the possibility that our findings are an artifact of unmeasured school district characteristics associated with both charter growth and change in segregation—that districts with a “taste” for charters differ in unobservable ways from districts without charters. Model 3 (Table 4) presents results restricted to school districts with any charter school presence in 2000, 2010, or 2016. The estimated effects of charter school enrollment on segregation are similar in direction and magnitude. These effects also hold when adding our falsification measure for future change in charter enrollment in Model 4. We conclude from the restricted analysis that results are not driven by a latent distinction between charter-friendly and non-charter school districts. Results from Models 3 and 4 also ease the concern that a linear specification of charter enrollment share in Models 1 and 2 could be biased by zero inflation from the large proportion of non-charter school districts. We also tested this issue with nonlinear, semiparametric, and spline specifications for charter enrollment. Models yield similar conclusions that do not improve the simpler linear specification.

Our identification approach is imperfect, for there could still be unmeasured characteristics driving both charter expansion and change in segregation among districts with any charter presence. Without experimental evidence, it is difficult to address this concern definitively. Nonetheless, lingering unknown confounders would need to exact an effect net of covariate controls, segregation levels in 2000, and pre-existing trends in the 1990s. The unmeasured influence would also require a simultaneous positive effect on school segregation and negative effect on residential segregation.

We did consider several possible confounding explanations, including simultaneous changes in magnet school share, resident private school enrollment, and population racial composition between 2000 and 2010. These predictors are endogenous because they may be

responsive to charter enrollment growth, so we report results from these models as robustness checks in Figure 2. Regardless, the inclusion of these covariates has no influence on coefficient findings or effect sizes. Figure 2 also shows that our results are not sensitive to other educational changes potentially related to charter school expansion and segregation within the school district. Specifically, adding controls for level and change in per pupil spending, average student-to-teacher ratio, and number of schools has a minimal effect on the main coefficients of interest.

[Figure 2 about here]

To further test whether we are capturing effects of charter school expansion versus some other unobservable process, we examined changes in residential segregation separately among households with and without children. Theoretically, we expect that charter school expansion would have a larger effect on the residential patterns of households with children, which our findings confirm (Appendix Table 5). The difference in the coefficients between households with and without children is only marginally significant ($p < .10$), however, perhaps because childless households include empty-nesters and future parents who consider school options when choosing a neighborhood or because the residential choices of households with children spill over to affect those of childless households. We foreground results for the whole population due to data limitations in how Hispanic ethnicity is reported over time, but this analysis provides evidence consistent with our interpretation that residential patterns are truly responding to changes in charter enrollment share.

Our analysis thus far has focused on White-Black segregation. Lastly, we turn to the effect of charter school expansion on White-Hispanic segregation within districts, reported in Table 6 (full models in Appendix Table 4). We find similar evidence of a relationship between charter school enrollment growth and declining residential segregation, but no evidence of an effect on

school segregation. This conclusion is robust to the falsification exercise in Models 2 and 4, as well as the sample restriction test in Models 3 and 4. The preferred estimates from Model 1 suggest that a one percentage point increase in the share of charter school enrollment is associated with a .051 index point decrease in residential segregation ($p < .01$). In response to the mean increase in charter enrollment of 6.54 percentage points (in districts with charter presence), our model predicts a 1 to 7 percent decrease in White-Hispanic residential segregation (Table 5). Results are also robust to the additional covariates tested in Figure 2, and the relationship between charter expansion and residential segregation is stronger among households with children than without (Appendix Table 5).

[Table 6 about here]

The lack of a charter school effect on White-Hispanic school segregation matches the racial enrollment distributions by school type presented in Figure 1. Unlike White and Black students, many Hispanic students attend charter schools with a lower same-race population than in TPSs. One explanation for this observed difference could be that White aversion to Hispanic students is lower than aversion to Black students, consistent with Whites' tendencies to avoid Black neighbors over all other groups. Thus, charter schools may not lead Whites to select into segregated non-Hispanic schools. This explanation centers the behavior of White households, but Hispanic families may also respond to charter school expansion in ways that do not increase segregation. Identifying these mechanisms is beyond the scope of our aggregate analysis, and we point to the different dynamics of White-Black and White-Hispanic segregation in neighborhood and school contexts as a fruitful area for further research. Viewed altogether, our findings suggest that the strength of the neighborhood-school policy link—insofar as it shapes the housing and school choices families make—exists on a racialized spectrum.

Discussion

In this article, we examine how the contingent and dynamic processes of neighborhood and school segregation respond to charter school expansion. Charter schools weaken the link between residential and school selection and, as we show, alter patterns of both residential and school segregation: During the 2000s, metropolitan school districts throughout the U.S. saw an increase in White-Black school segregation and a decrease in White-Black residential segregation proportional to charter school growth. These findings suggest that because charter school options unbundle housing and school choice processes, White and Black families opt into marginally more integrated neighborhoods while sending their children to more racially segregated schools.

We find that in districts with any charter presence, the average charter share increase of 6.93 percentage points led to an estimated 12 percent increase in White-Black school segregation and a 2 percent decline in White-Black residential segregation. Given the general stability in segregation trends over the last 20 years, we posit that these increases are nontrivial, especially considering that charter school enrollment continues to rise. The effect on residential segregation is smaller, as we might expect given the many non-school factors that go into residential choices, but it provides evidence that educational policy shapes processes beyond the education sphere. We noted prevailing evidence of Whites' preferences for predominantly White schools, and our findings imply that these preferences may have an underappreciated effect on residential population processes. White parents may not pay as high a premium to live in White neighborhoods as long as they can enroll their child in White schools, or White parents may not leave diversifying neighborhoods if their child can attend a non-neighborhood school. Our findings

also suggest that parents may prioritize homogenous schools over homogeneous neighborhoods, demonstrating tradeoffs between these interconnected contexts.

We do not find that White-Hispanic school segregation is sensitive to charter school expansion, consistent with past research and our own descriptive findings that this group is less racially segmented in charter schools than Black or White students. We do find that White-Hispanic residential segregation declines as charter enrollment share increases, a finding worthy of further investigation that emphasizes the varied dynamics of segregation for different racial/ethnic dyads and for the neighborhood versus school spheres. Further research could also examine whether charter expansion affects school or residential segregation between Black and Hispanic, as well as Asian families.

Our study provides fruitful ground for future research in several directions. First, we focused our analysis on segregation within school districts, where most of the change in White-Black segregation occurred in the 2000s, but school and residential segregation also occurs between districts (Bischoff, 2008; Owens, 2017; Stroub & Richards, 2013). Future research could examine the relationship between charter expansion and all the components of residential and school segregation highlighted in our decomposition to understand if segregation dynamics within and between districts and sectors offset or amplify one another.

Second, we measure charter expansion as district-wide enrollment. The spatial structure of charter school expansion—where charters open and whether this has changed over time—could be an important mechanism in accounting for our findings if they are more or less proximate to neighborhoods of different racial compositions (Candipan & Brazil, Forthcoming.). More broadly, our study of school districts as the primary units of analysis allows us to analyze systemic effects

of charter school expansion, but the perspective from this ecological level prevents us from evaluating micro-level mechanisms of mobility and enrollment.

Finally, our study shares the challenges of causal identification common to many segregation studies. We attend to an extensive set of control variables and potential alternative explanations, but threats to causal interpretation remain. That said, one of the strengths of our analysis is the simultaneous investigation of neighborhood and school segregation. To undermine our results, any unmeasured variable would have to operate in opposite directions for school and neighborhood segregation, which we believe limits the pool of potential confounders. One important omitted variable is the availability of open enrollment and inter-district school choice programs, which might also shape school and residential segregation patterns. Unfortunately, longitudinal national data on comprehensive school choice options are not currently available, to the detriment of education researchers.

Housing and educational policies have long affected segregation patterns. We emphasize the interrelated nature of these two contexts and show how two processes that historically moved in tandem—neighborhood and school segregation—are decoupled by choice-oriented changes to school assignment policy. A half-century ago, legal desegregation arguments defined “de facto” school segregation as being a downstream result of residential segregation, itself the product of racist housing and urban policies. This characterization downplays the extent to which school and residential segregation are (and have always been) more like eddies in a stream, circling and reinforcing one another via policies and preferences. In a residentially-based school assignment system, school segregation not only reflects but contributes to neighborhood segregation, as local school options enter into residential decisions. When charters break the residential-school link, segregation patterns move in opposite directions—families live in slightly more integrated

neighborhoods and use charters to enroll their child in segregated schools. Though unintended, charter policy thus exposes a status quo of school-driven residential segregation that has been hidden in plain sight.

Should policymakers concerned about equality consider school choice a new tool for reducing residential segregation? We do not draw that conclusion. School choice represents districts ceding responsibility for providing equitable educational opportunities to parents, letting residents sort according to their own will as consumers and addressing public goals with private choices. Most charters operate independent of any integration imperative; they were never part of a desegregation toolkit, and state charters typically have only cursory nondiscrimination or racial balance language in their laws (Archbald, Hurwitz, & Hurwitz, 2018). Unfettered choice does not lead to equality, and the other half of our findings—that school segregation increased—makes that starkly clear. Small gains in residential integration do not outweigh the costs in school segregation. Instead, we interpret our findings as demonstrating to policymakers that residential and school sorting patterns are linked, and policy choices should not be siloed between these two arenas.

We conclude by wedding our results to a growing body of scholarship arguing that when ostensibly “race-neutral” policies fail to account for the racialized structure of U.S. schooling, they produce results that exacerbate, rather than neutralize, the color line (Lewis & Diamond, 2015; Neckerman, 2008; Rich & Jennings, 2015). Charter schools prove no exception because they are vulnerable to market-based racial sorting. As shown in our analyses, charter schools have, on average, led to White and Black children attending more racially homogenous schools. Thus, even if unintended, the allure of expanding charter schools provides a quasi-private option through which parental choices undermine integrated schooling. Local school districts could limit the intensity of this sorting problem by adopting diverse-by-design charter school policies, using

levers such as weighted lotteries, controlled-choice, and diversity-conscious admissions algorithms to ensure that charter schools operate more like racially inclusive magnet schools (Potter & Quick, 2018). The federal Charter School Program could change its grants competition to reward such efforts (Potter & Nunberg, 2019). As we argue, educational policies also have consequences for residential outcomes, and intentional integration policies in schools must be complemented by housing, zoning, and transportation policies that promote integration in neighborhoods to prevent White flight. Policymakers must respond strategically to both school and residential sorting issues in tandem in order to unleash the full promise of the Brown v. Board decision.

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Compliance with Ethical Standards

Ethics and Consent

The authors report no ethical issues.

Conflict of Interest

The authors declare no conflicts of interest.

Author's Contributions

All authors conceived and designed the study. PR led the development of methodology, data preparation, and analysis. All authors wrote and revised the manuscript. All authors read and approved the final manuscript.

Data Availability

Replication files to this article are available at PR's website: <http://www.peter-rich.com>. The empirical analysis in this article employed secondary data and geographic boundary shapefiles provided by: 1) the NCES Common Core of Data (<https://nces.ed.gov/ccd/>), 2) the NCES Education Demographic and Geographic Estimates program (<https://nces.ed.gov/programs/edge/Home>), and 3) NHGIS (<https://www.nhgis.org/>).

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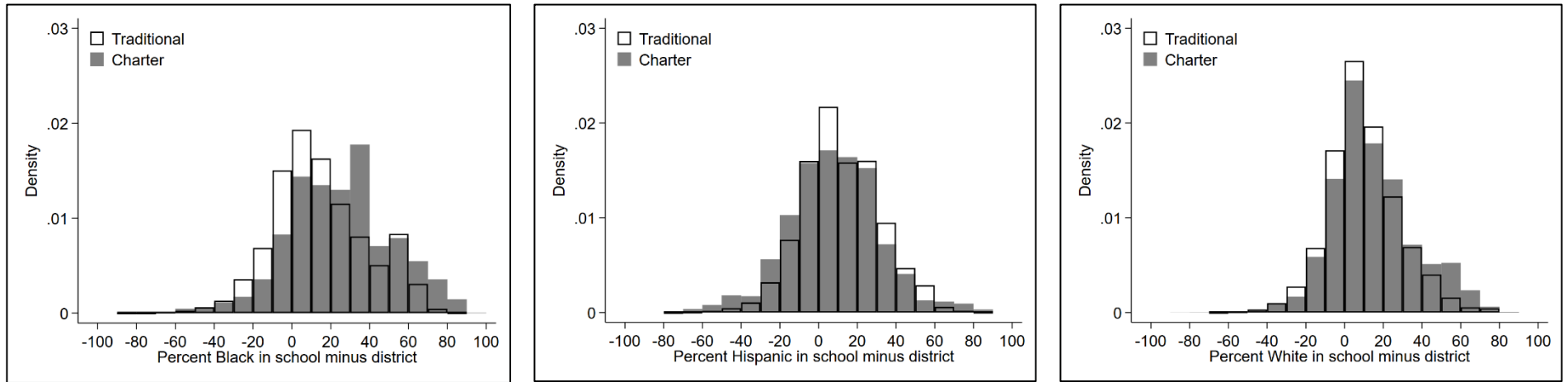
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Tables and Figures

Figure 1. Racial composition of charter and traditional public schools attended by 4th graders in 2010



Black students

Traditional: n = 1,065,893
 Charter: n = 84,356

Hispanic students

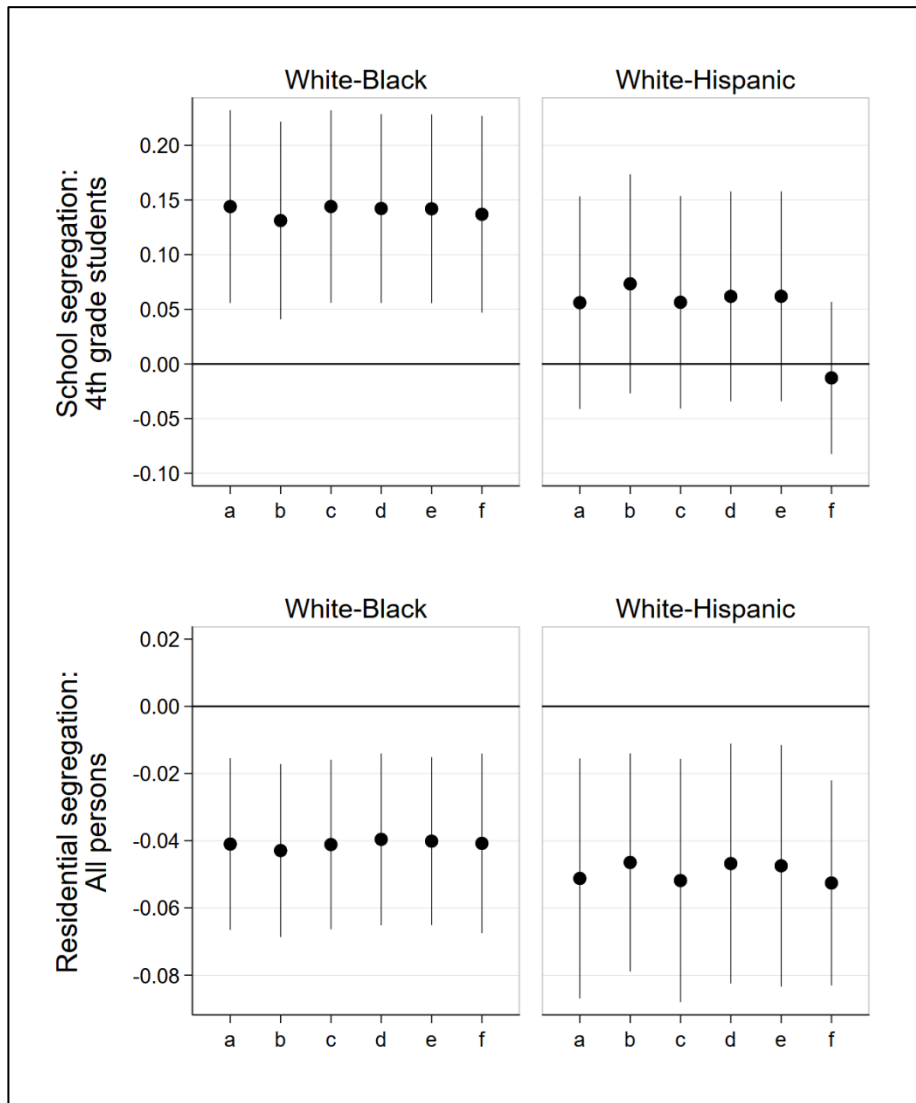
Traditional: n = 1,357,279
 Charter: n = 78,858

White students

Traditional: n = 1,789,349
 Charter: n = 95,493

Note: Limited to MSA school districts with a non-zero elementary charter school presence in 2010 (2,484 districts). Each panel contains overlapping histograms that are weighted by the race-specific count of 4th-grade students attending each school type.

Figure 2. Robustness checks of the estimated effect of a one percentage point increase in charter school enrollment share on school and residential segregation (Variance Ratio Index)



Note: Each column of results reports the estimated coefficient for the effect of charter school enrollment change from 2000 to 2010 on segregation within school districts (see Model 1 of Table 3). The letters indicate modifications to the preferred model as follows: a) main effect; b) drops baseline covariates; c) adds control for change in magnet and private enrollment from 2000 to 2010; d) adds control for change in racial composition and district share of MSA racial composition from 2000 to 2010; e) adds all covariates from modification c and d; f) main effect model with controls for baseline district per pupil spending, student-teacher ratio, and number of schools, as well as change from 2000 to 2010. Samples are slightly smaller in Model “f” due to missing data in CCD (White-Black n=1,441; White-Hispanic n=1,250). Full models available by request. Lines represent 95 percent confidence intervals.

Table 1. Percentage of children enrolled in different school types, 2000 to 2010

	Full sample of school districts			Districts with any charter presence		
	2000	2010	Change	2000	2010	Change
White-Black district sample						
Public students in traditional schools	97.74	94.39	-3.35	94.95	85.82	-9.12
Public students in charter schools	0.63	2.59	1.96	2.22	9.15	6.93
Public students in magnet schools	1.63	3.02	1.39	2.83	5.02	2.19
Resident children in private schools	11.35	11.05	-0.30	11.28	10.83	-0.44
White-Hispanic district sample						
Public students in traditional schools	97.46	94.14	-3.31	95.05	86.53	-8.52
Public students in charter schools	0.85	3.05	2.20	2.53	9.07	6.54
Public students in magnet schools	1.69	2.81	1.12	2.42	4.40	1.98
Resident children in private schools	10.66	10.17	-0.49	10.52	10.14	-0.38

Note: Mean percentage points reported. Public students include all 4th-grade children attending traditional, charter, or magnet schools. Resident children include all children age 5-17 living within the school district boundaries. "Districts to ever have charters" is a subset of the sample with a nonzero percentage of students attending charters in 2000 or 2010. This includes 453 of 1,601 total White-Black sample districts and 455 of 1,354 total White-Hispanic sample districts.

Table 2. Segregation levels and change within school districts, 1990 to 2010

	White-Black		White-Hispanic	
	Mean	SD	Mean	SD
School segregation (4th graders)				
Level in 1990	7.05	11.48	5.72	9.34
Level in 2000	8.36	12.04	7.85	10.55
Level in 2010	10.51	12.92	10.80	12.23
Change, 1990 to 2000	1.31	6.40	2.13	6.95
Change, 2000 to 2010	2.15	7.33	2.95	7.77
Residential segregation (all persons)				
Level in 1990	12.89	16.30	5.97	8.56
Level in 2000	12.12	14.41	8.07	9.14
Level in 2010	11.30	12.73	8.96	9.10
Change, 1990 to 2000	-0.76	5.03	2.09	4.67
Change, 2000 to 2010	-0.82	4.43	0.89	3.61
School districts	1,601		1,354	

Notes: Segregation is measured with the Variance Ratio Index on a scale of 0 to 100, corrected for index bias (Fossett, 2017). White and Black populations reported in the table are non-Hispanic. Residential segregation uses neighborhood census tracts as accounting units; when bisected by a school district line, we aggregate block population up to each unsplit portion of the tract to form a perfectly nested set of neighborhoods within school districts.

Table 3. Decomposition of metropolitan area school and residential segregation by racial dyad, 2000-2010

	White-Black		White-Hispanic	
	2000	2010	2000	2010
Decomposition of school segregation (4th graders)				
1. Total MSA school segregation (all schools)	29.99	32.31	20.86	26.11
2. School segregation due to private versus public enrollment	1.25	1.21	0.65	0.98
3. Segregation among private schools in MSA	1.28	1.01	1.34	1.01
4. Segregation between public school districts in MSA	16.52	17.38	9.91	12.67
5. Segregation within public school districts	10.95	12.71	8.96	11.45
6. Segregation between traditional, charter, and magnet sectors	0.36	0.82	0.23	0.55
7. Segregation among traditional public schools	10.21	10.96	8.37	10.24
8. Segregation among charter schools	0.06	0.36	0.03	0.27
9. Segregation among magnet schools	0.32	0.56	0.33	0.39
Decomposition of residential segregation (all persons)				
10. Total MSA residential segregation (all neighborhoods)	26.94	24.25	14.31	15.90
11. Segregation between school district jurisdictions in MSA	9.06	9.35	5.60	6.69
12. Segregation between neighborhoods within school districts	17.88	14.90	8.71	9.21
<hr/>				
MSAs	309		273	
School districts	6,142	6,044	5,930	5,835
Schools	44,922	46,297	43,631	45,322
Neighborhoods	70,015	74,884	67,715	72,837

Notes: Segregation is measured with the Variance Ratio Index on a scale of 0 to 100. The MSA sample requires at least 50 White and 50 non-White (either Black or Hispanic) 4th-graders. We use 2003 Core Based Statistical Area definitions of metropolitan areas, adjusted so that bisected school district boundaries are assigned to the MSA containing the largest share of its resident population. All districts nested within a sample MSA are included in this analysis, even if they do not meet the school district sample criteria used in the school district-level analyses.

Table 4. Change in charter school enrollment share predicting change in White-Black school and residential segregation, 2000 to 2010

	Full sample		Restricted sample	
	Model 1	Model 2	Model 3	Model 4
Outcome: change in school segregation (4th graders)				
Change in charter school enrollment share, 2000-10	.144 ** (.045)	.145 ** (.045)	.096 * (.043)	.093 * (.043)
Change in charter school enrollment share, 2010-16		-.012 (.021)		-.027 (.026)
Outcome: change in residential segregation (all persons)				
Change in charter school enrollment share, 2000-10	-.041 ** (.013)	-.040 ** (.013)	-.040 * (.018)	-.040 * (.018)
Change in charter school enrollment share, 2010-16		-.005 (.013)		-.002 (.013)
School districts	1,601	1,601	562	562
BIC	19,477.5	19,492.0	7,079.6	7,091.5

Note: Standard errors in parentheses are clustered by MSA. Each outcome is the change in segregation (Variance Ratio Index) between 2000 and 2010, estimated simultaneously in a generalized structural equation model with unstructured error correlation. Change in charter school enrollment is a linear measure of the percent of 4th-grade public students enrolled in 2010 minus the percent of 4th-grade public students enrolled in 2000. Models include level of segregation in 2000 and change in segregation in 1990s, as well as district covariates for proportion of students enrolled in charter schools in 2000, proportion enrolled in magnet schools in 2000, proportion enrolled in private schools in 2000, whether the district ever was under desegregation order, whether a desegregation order had been dismissed since 1990, school size in 2000, log population in 2000, district land area in 2000, racial composition in 2000, percent of metropolitan area residents living in the district in 2000 by race, whether the district includes a downtown area, whether the district is in a southern or border state, White-Black differences in poverty rates, and White-Black differences in median income. Models 2 and 4 provide falsification checks against reverse causal ordering by including a measure of change in charter enrollment for the period after the outcome variables are measured. Models 3 and 4 are estimated only for the subset of school districts with any charter enrollment in 2000, 2010, or 2016 (109 sample districts added charter schools between 2010 and 2016). * p<.05, ** p<.01, ***p <.001

Table 5. Estimated relative effect of charter school enrollment increase on school and residential segregation under varying charter growth conditions

	School segregation (4th graders)			Residential segregation (All persons)		
	Lower	Estimate	Upper	Lower	Estimate	Upper
White-Black segregation (n=1,601)						
Scale of charter enrollment increase:						
a. 1 percentage point	0.67	1.72	2.78	-0.55	-0.34	-0.13
b. 1.96 percentage points (mean)	1.31	3.38	5.45	-1.08	-0.66	-0.25
c. 6.93 percentage points (mean charter presence)	4.63	11.94	19.25	-3.80	-2.34	-0.88
d. 17.66 percentage points (90th pctl charter presence)	11.78	30.41	49.03	-9.69	-5.97	-2.25
White-Hispanic segregation (n=1,354)						
Scale of charter enrollment increase:						
a. 1 percentage point	<i>-0.53</i>	<i>0.72</i>	<i>1.96</i>	-1.08	-0.64	-0.19
b. 2.20 percentage points (mean)	<i>-1.15</i>	<i>1.57</i>	<i>4.29</i>	-2.37	-1.40	-0.42
c. 6.54 percentage points (mean charter presence)	<i>-3.43</i>	<i>4.67</i>	<i>12.78</i>	-7.05	-4.15	-1.26
d. 16.47 percentage points (90th pctl charter presence)	<i>-8.65</i>	<i>11.77</i>	<i>32.20</i>	-17.75	-10.46	-3.17

Note: Effect sizes are the estimated change in mean segregation (Variance Ratio Index) relative to observed baseline segregation in 2000 (reported as a percent). All estimates are transformations of coefficients reported in Model 1 of Tables 4 and 6. The effect of growth in charter enrollment is presented at four scales: a) 1 percentage point increase, b) mean change in charter enrollment across all sample districts, c) mean change in charter enrollment among the subset of districts with any charter presence, and d) the 90th percentile of charter enrollment growth among the subset of districts with any charter presence. Lower and upper 95 percent confidence intervals are reported. Estimates of charter growth effects on White-Hispanic school segregation are not statistically significant at a $p < .05$ level and reported in italics.

Table 6. Change in charter school enrollment share predicting change in White-Hispanic school and residential segregation, 2000 to 2010

	Full sample		Restricted sample	
	Model 1	Model 2	Model 3	Model 4
Outcome: change in school segregation (4th graders)				
Change in charter school enrollment share, 2000-10	.056 (.050)	.053 (.050)	.018 (.062)	.018 (.062)
Change in charter school enrollment share, 2010-16		.020 (.038)		.007 (.038)
Outcome: change in residential segregation (all persons)				
Change in charter school enrollment share, 2000-10	-.051 ** (.018)	-.052 ** (.019)	-.048 * (.022)	-.048 * (.022)
Change in charter school enrollment share, 2010-16		.002 (.016)		.001 (.017)
School districts	1,354	1,354	551	551
BIC	16,316.3	16,330.2	6,891.2	6,903.7

Note: Standard errors in parentheses are clustered by MSA. See Table 4 notes for additional estimation model information. Ninety-six White-Hispanic sample districts added charter schools between 2010 and 2016. * p<.05, ** p<.01, ***p <.001

Appendix

Alternative Segregation Indices

Our study foregrounds measures school and residential segregation using the Variance Ratio Index because of its simple interpretation and because, when estimated for racial dyads, it can be decomposed into different administrative or geographic levels (Reardon and Firebaugh, 2002). Another popular, decomposable segregation index is Theil's binary information theory index (H) (Stroub and Richards 2013; Reardon 2009; Lichter, Parisi, and Taquino 2015). Similar to the Variance Ratio Index, H is less sensitive to bias than other common segregation indices when evaluating segregation among small units (Fossett, 2017) such as schools with as few as 10 students enrolled. Unlike indices of Exposure and Isolation (Frankenberg et al., 2011), the Variance Ratio Index and H are also insensitive to changes in the overall school district racial composition, making it suitable for comparison over time (Reardon and Owens 2014).

Appendix Figure 1 reports selected results from analyses of the association between charter school growth and school and residential segregation, measured with H . Other than changing the segregation index in our outcome (and related segregation control variables), all other specifications in Appendix Figure 1 are identical to those presented in Figure 2. Results from the preferred model (letter "a" in each plot) lead to the same substantive conclusion: charter school expansion is associated with a simultaneous increase in White-Black school segregation and decrease in White-Black residential segregation. Charter school growth does not appear to have affected White-Hispanic school segregation, though White-Hispanic residential segregation did decline in response, mirroring our results using the Variance Ratio Index. Robustness checks (see Figure 2 notes and text) lettered "b" through "f" do not alter these conclusions. We presented results measuring segregation with the Variance Ratio Index due to its ease of interpretation.

Nonetheless, the results from Appendix Figure 1 give us confidence that our finding is not an artifact specific to index choice.

We further conducted a parallel analysis evaluating the association between charter growth and segregation measured with D , the Index of Dissimilarity. D is the most common index of segregation used in studies of residential segregation, popularized because it expresses an intuitive idea—the percentage of one racial group that would need to swap neighborhoods (or schools) with a second racial group so that all neighborhoods within the school district have the same racial composition (Massey & Denton, 1988). Like both the Variance Ratio Index and H , D has the advantage of measuring relative segregation rather than absolute exposure and is thus suitable for comparison over time. However, despite its popularity, D has an important limitation: it centers attention on change that is above or below racial parity in the *overall* school district. On the other hand, the Variance Ratio Index and H register changes across the racial composition distribution rather than at a select inflection point, and thus do not suffer from this issue (see Fossett (2017) for a thorough discussion).

Charter schools may influence segregation at points of the racial composition distribution without ever leading to a switch in school enrollment (or neighborhood choice) that is above or below racial parity. To test for this possibility, we present in Appendix Figure 2 a set of models that measure segregation using D . We emphasize that this is not a test of the robustness of our findings, as D measures a different phenomenon than the Variance Ratio Index or H . Still, Appendix Figure 2 shows that charters led to an increase in White-Black school dissimilarity and a decrease in residential dissimilarity as shown in the main analysis. Results also reveal a decline in White-Hispanic residential dissimilarity consistent with the main analysis. We find declining White-Hispanic school segregation (only in some model specifications) when measured with D

rather than the Variance Ratio Index or H . This deviation from the main results suggests that charter expansion led to a decline in White-Hispanic school dissimilarity relative to the school district overall in some districts; the estimated effects on D have wider confidence intervals, however, suggesting that in other school districts, charters affected changes at other points of the racial composition distribution.

Decomposition of the Variance Ratio Index

Table 3 reports results from a decomposition analysis of total MSA school and neighborhood segregation. Our approach takes advantage of the fact that, in dyadic measures of segregation, the Variance Ratio Index can be decomposed into additive components (Reardon and Firebaugh, 2002). This requires the common practice of ignoring all other non-dyad racial groups from the denominator when computing percent White and percent Black (for simplicity, we refer only to the White-Black decomposition, though we apply parallel procedures for White-Hispanic segregation).

Our school segregation decomposition uses a framework similar to the one developed in Clotfelter (2004) and Fiel (2013). Notably, these studies measure the White-Black Exposure Index under various counterfactual scenarios in which school racial composition is adjusted to reflect sector, school district, or aggregate MSA composition. Comparison between observed and adjusted counterfactual scenarios reveals how racial imbalance within versus between sectors and school districts contributes to overall observed segregation levels. Clotfelter (2004) applies this approach to evaluate the Coleman Segregation Index, which is another name (and formulaic derivation) of the Variance Ratio Index (Coleman, Kelley, & Moore, 1975; see also Fossett, 2017 and Monarrez et al., 2019).

We begin by identifying public schools by their sector type (TPS, charter, magnet) within their geographic school district nested within MSA. We treat private schools as part of a separate, MSA-wide sector because enrollment is not defined by student residence, and many students travel across district lines to attend private schools in other areas. Note that our nesting structure, unlike Fiel (2013), considers charter schools as nested within geographic school districts rather than as sectors spanning across districts (Fahle et al., 2019 define nesting levels similar to ours). For each MSA-year observation, we decompose segregation using the following sequential procedure (Stata code is available in an online replication package):

1. Calculate the Variance Ratio Index for White and Black students as observed in their MSA ($=VR_1$).
2. Rebalance White and Black student enrollment in all charter, magnet, and private schools so that their total student enrollment count does not change but their percent White and percent Black reflect the composition of their respective sector within the district (note: for private schools, their composition is set to match the racial composition of all private school students in the MSA). Calculate the Variance Ratio Index ($=VR_2$).

For Steps 3-5, we follow the same formula in Step 2 for rebalancing White and Black student enrollment in the following sectors, then calculate the Variance Ratio Index for each combination:

3. All traditional, magnet, and private schools ($=VR_3$).
4. All traditional, charter, and private schools ($=VR_4$).
5. All traditional, charter, and magnet schools ($=VR_5$).

Steps 6-8 require that we aggregate student enrollment counts by race to the following levels, then calculate the Variance Ratio Index for each:

6. Sector (traditional, charter, magnet, private) within each school district (or, for private schools, throughout the MSA) ($=VR_6$).
7. School district (or, for private schools, throughout the MSA). ($=VR_7$).
8. All public schools throughout the MSA and all private schools throughout the MSA. ($=VR_8$).

9. Next, we use the values for each Variance Ratio Index derived in Steps 1-8 to calculate additive components of segregation for each MSA-year observation¹:

- a. Total MSA segregation = VR_1
- b. School segregation due to private versus public enrollment = VR_8
- c. Segregation among private schools in MSA = $VR_5 - VR_6$
- d. Segregation between public school districts in MSA = $VR_7 - VR_8$
- e. Segregation within public school districts = $VR_1 - VR_7 - (VR_5 - VR_6)$
- f. Segregation between traditional, charter, and magnet sectors = $VR_6 - VR_7$
- g. Segregation among traditional public schools = $VR_2 - VR_6$
- h. Segregation among charter schools = $VR_3 - VR_6$
- i. Segregation among magnet schools = $VR_4 - VR_6$

10. Lastly, to produce results reported in Table 3, we take the unweighted mean of each segregation component in Step 9 across sample MSAs within year.

¹ Note that adding terms in steps 9b through 9e yields total segregation (step 9a). Segregation within districts (9e) also equals the sum of steps 9f through 9i. An equivalent computation of 9e measures unique segregation scores for schools within each public school district in the MSA, then takes the average across districts, weighted by the size and diversity (Simpson's Interaction Index) of the district relative to the MSA overall—an approach that yields identical results (Reardon and Firebaugh, 2002).

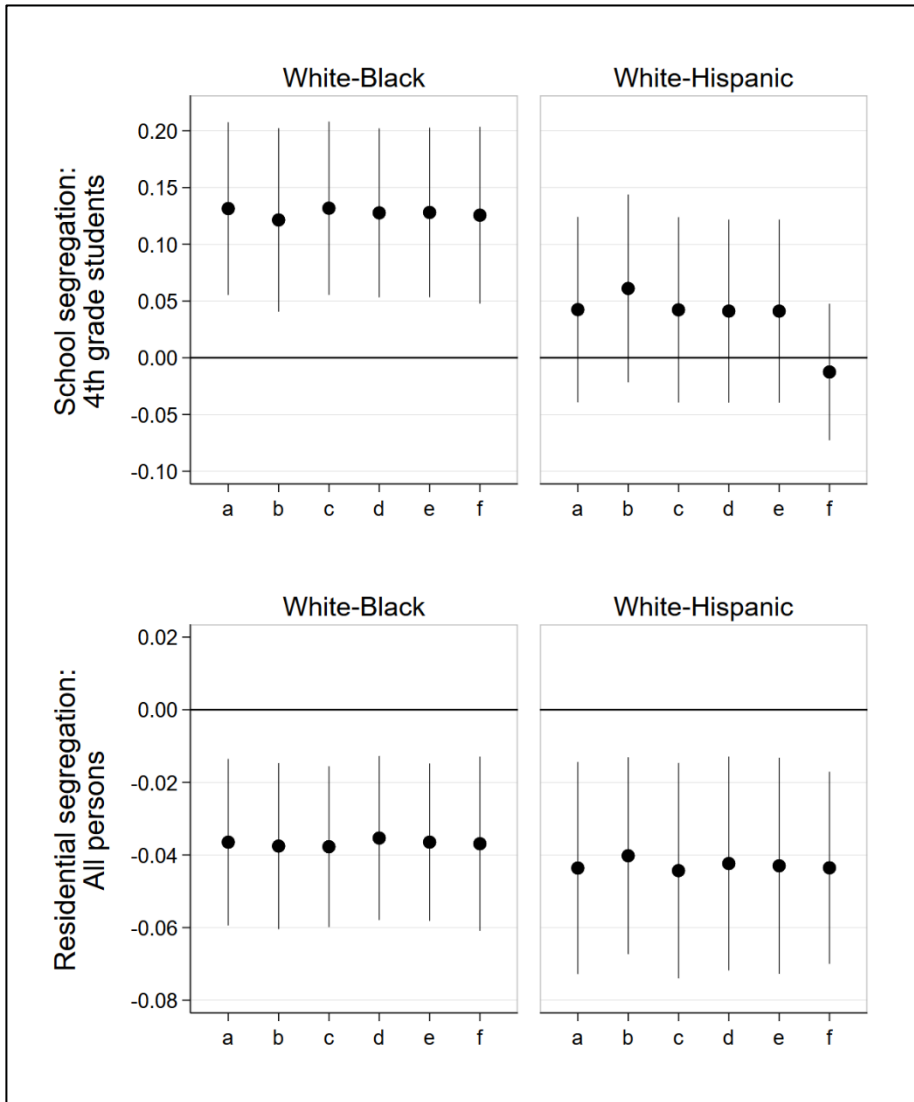
The bottom panel of Table 3 decomposes residential segregation to components between versus within jurisdictional school district boundaries. We compute residential segregation components separately by MSA and year, and report their unweighted means across MSAs in Table 3. Total segregation (row 10) is the Variance Ratio Index for all neighborhoods in the MSA. Segregation between school district jurisdictions (row 11) is the Variance Ratio Index computed after neighborhood population counts by race are aggregated to the school district level. Segregation within school district jurisdictions (row 12) equals total segregation minus segregation between districts.

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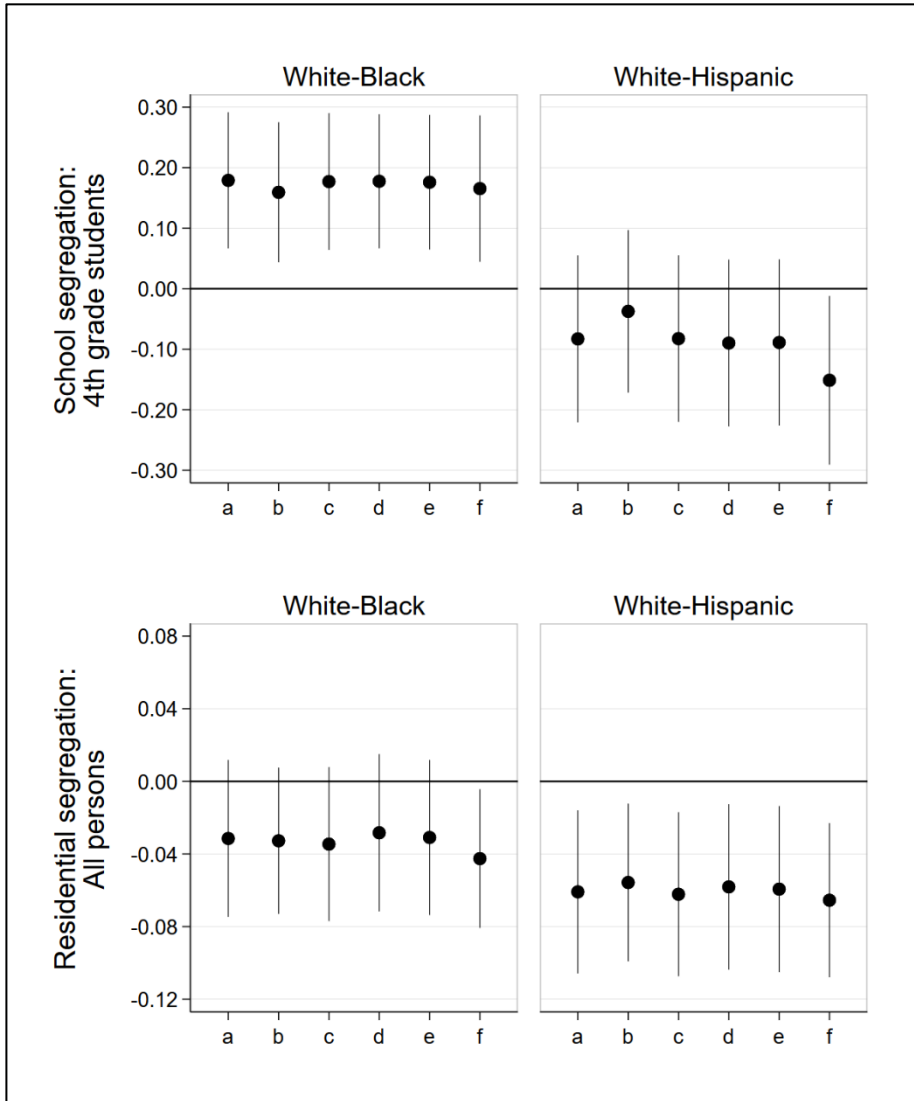
Appendix Figures and Tables

Appendix Figure 1. Robustness checks of the estimated effect of a one percentage point increase in charter school enrollment share on school and residential segregation (Theil's Index)



Note: This figure is identical to the one presented in Figure 2, but segregation is measured using Theil's Information Theory Index (H). Full models available by request. Lines represent 95 percent confidence intervals.

Appendix Figure 2. Robustness checks of the estimated effect of a one percentage point increase in charter school enrollment share on school and residential segregation (Dissimilarity Index)



Note: This figure is identical to the one presented in Figure 2, but segregation is measured using the Dissimilarity Index (D). Full models available by request. Lines represent 95 percent confidence intervals.

Appendix Table 1. School district sample criteria

Year and sample criteria	School districts	Elementary schools	Public school 4th graders	Public 4th grade enrollment by race		
				White	Black	Hispanic
1990						
All unified and elementary school districts	12,870	44,362	3,135,046	2,126,871	525,698	354,938
1. Valid metropolitan districts	6,534	32,348	2,488,854	1,610,420	443,181	325,762
2. Minimum 2 schools, 2 neighborhoods	3,406	28,917	2,223,920	1,402,841	412,142	305,832
3a. White-Black pairwise sample	1,601	21,619	1,755,219	1,022,211	388,650	
3b. White-Hispanic pairwise sample	1,354	19,305	1,590,463	887,680		289,516
2000						
All unified and elementary school districts	12,477	46,428	3,645,993	2,220,125	635,751	602,827
1. Valid metropolitan districts	6,466	35,248	3,013,153	1,731,847	557,978	559,423
2. Minimum 2 schools, 2 neighborhoods	3,385	31,841	2,706,645	1,498,340	519,896	533,559
3a. White-Black pairwise sample	1,601	24,050	2,114,586	1,047,893	487,796	
3b. White-Hispanic pairwise sample	1,354	21,817	1,949,442	909,938		495,326
2010						
All unified and elementary school districts	12,003	48,129	3,664,408	1,938,437	605,799	824,049
1. Valid metropolitan districts	6,394	37,888	3,077,454	1,515,793	535,484	760,325
2. Minimum 2 schools, 2 neighborhoods	3,386	34,681	2,792,865	1,305,684	508,398	729,137
3a. White-Black pairwise sample	1,601	26,083	2,132,246	866,300	469,287	
3b. White-Hispanic pairwise sample	1,354	24,126	1,982,150	741,833		652,525

Note: Sample restriction criteria is reported in stepwise order. First, we restrict to districts that are located in metropolitan Core Based Statistical Areas (2003 definitions), have a non-zero 4th-grade enrollment as reported in the NCES Common Core of Data, and have a non-zero residential population count as reported in the decennial Census. Second, we restrict to school districts with a minimum of 2 schools and 2 neighborhoods; we also drop Campbell Union (CA), Detroit (MI), Fort Leavenworth (KS), New Orleans (LA), Salt Lake City (UT), and Williamsburg-James City (VA) school districts due to unreliable data and/or extreme population changes (see text). Finally, for each pairwise sample, we restrict to the subset of districts meeting the first two criteria that also have at least 5 White and Black or Hispanic 4th graders enrolled and who meet all sample criteria in 1990, 2000, and 2010.

Appendix Table 2. School district characteristics, by pairwise analytical sample

	Min	Max	White-Black		White-Hispanic	
			Mean	SD	Mean	SD
Change in charter school enrollment share, 2000-10						
Amount of change	-72	69	1.96	5.95	2.20	5.83
Type of change						
Increase			.26		.31	
No charter school presence			.72		.66	
Decrease			.02		.03	
School enrollment context						
Share of public students enrolled in charters	0	100	.63	3.06	.85	4.17
Share of public students enrolled in magnets	0	100	1.63	8.06	1.69	8.25
Ever mandated to desegregate schools	0	1	.24		.18	
Desegregation order dismissed since 1990	0	1	.06		.04	
Elementary schools (n)	2	660	15.02		16.11	
District size						
2 to 5 elementary schools			.36		.36	
6 to 15 elementary schools			.43		.41	
16 or more elementary schools			.21		.24	
Residential context						
Neighborhoods (n)	2	2,220	28.28	73.25	30.16	79.18
Share of resident children in private school	0	56	11.35	5.89	10.66	5.44
Population (1,000)	5.5	8,005.3	104.0	279.1	112.1	302.0
Area (square miles)	1.0	24,960.0	192.1	481.1	215.8	876.5
Percent White	4	97	70.22	20.41	65.70	21.99
Percent Black	0	89	12.12	13.67	8.90	12.07
Percent Hispanic	0	96	11.38	14.83	17.81	18.64
Poverty rate gap (Black - White)	-14.18	72.30	11.98	8.27	10.66	9.24
Poverty rate gap (Hispanic - White)	-19.77	62.34	10.32	8.09	10.26	6.87
Income ratio (White / Black)	.545	9.716	1.278	.409	1.368	.695
Income ratio (White / Hispanic)	.559	12.602	1.222	.555	1.155	.200
District share of MSA White residents	.088	100	14.37	21.13	13.85	21.43
District share of MSA Black residents	.002	100	18.21	28.07	17.22	27.89
District share of MSA Hispanic residents	.009	100	16.44	24.46	16.38	24.93
District includes downtown area	0	1	.16		.14	
South	0	1	.36		.23	
School districts			1,601		1,354	
MSAs			342		289	

Note: All covariates are measured in 2000 except where noted. The amount of change in charter school enrollment is the percentage of 4th-graders in 2010 attending charter schools minus the percentage of 4th-graders in 2000 attending charter schools. Elementary schools are identified as regular public schools with at least 10 fourth grade students enrolled in 2000. White and Black populations reported in the table are all non-Hispanic, except for the poverty rate gap and income ratio gap measures (in those measures only, Black statistics include both Hispanic and non-Hispanic subgroups).

Appendix Table 3. Predictors of change in White-Black school and residential segregation (Variance Ratio Index), 2000 to 2010

	School segregation (4th graders)		Residential segregation (All persons)	
	Coeff	SE	Coeff	SE
Change in charter school enrollment share, 2000-10	.144 **	(.045)	-.041 **	(.013)
Segregation level in 2000	-.303 ***	(.036)	-.191 ***	(.018)
Segregation change, 1990-2000	.166 ***	(.048)	.213 ***	(.045)
School enrollment context				
Share of public students enrolled in charters	.052	(.067)	-.053 **	(.020)
Share of public students enrolled in magnets	.032	(.025)	-.001	(.011)
Ever mandated to desegregate schools	.257	(.612)	-.169	(.254)
Desegregation order dismissed since 1990	1.581	(1.175)	-.104	(.417)
District size (ref = 2 to 5 schools)				
6 to 15 schools	-.713	(.428)	-.266	(.211)
16 or more schools	-1.140	(.824)	-.157	(.369)
Residential context				
Percent resident children in private school	.066	(.041)	.021	(.023)
Population (log)	2.356 ***	(.474)	.929 ***	(.227)
Area (log)	-.095	(.185)	-.019	(.109)
Percent White	-.088 **	(.030)	.022	(.014)
Percent Black	-.050	(.032)	.086 ***	(.015)
Percent Hispanic	-.059	(.037)	.030	(.018)
Poverty rate gap (Black - White)	.090 ***	(.023)	-.002	(.013)
Income ratio (White / Black)	-.369	(.472)	.303	(.216)
District share of MSA White residents	-.011	(.024)	-.005	(.012)
District share of MSA Black residents	.046 *	(.021)	-.016	(.009)
District share of MSA Hispanic residents	-.039	(.025)	.003	(.012)
District includes downtown area	.024	(.742)	.194	(.311)
South	1.741 **	(.626)	.350	(.318)
Constant	-15.579 **	(5.717)	-11.543 ***	(2.711)
Variance of residuals	45.355 ***	(4.248)	12.482 ***	(1.564)
Covariance of residuals	6.376 ***	(1.055)		

Note: Estimates are reported from the preferred model (Model 1 in Table 3, n=1,601 school districts). Standard errors in parentheses are clustered by MSA. Each outcome is the change in segregation between 2000 and 2010, estimated simultaneously in a generalized structural equation model with unstructured error correlation. Change in charter school enrollment is a linear measure of the percent of 4th-grade public students enrolled in 2010 minus the percent of 4th-grade public students enrolled in 2000. "Segregation level in 2000" and "Segregation change, 1990-2000" are measured uniquely to match the school or residential segregation outcome.

* p<.05, ** p<.01, ***p <.001

Appendix Table 4. Predictors of change in White-Hispanic school and residential segregation (Variance Ratio Index), 2000 to 2010

	School segregation (4th graders)		Residential segregation (All persons)	
	Coeff	SE	Coeff	SE
Change in charter school enrollment share, 2000-10	.056	(.050)	-.051 **	(.018)
Segregation level in 2000	-.265 ***	(.032)	-.178 ***	(.023)
Segregation change, 1990-2000	.161 *	(.070)	.177 ***	(.041)
School enrollment context				
Share of public students enrolled in charters	.103 *	(.046)	-.023	(.030)
Share of public students enrolled in magnets	.076 *	(.037)	-.008	(.010)
Ever mandated to desegregate schools	-1.151	(.755)	-.168	(.339)
Desegregation order dismissed since 1990	2.745	(1.818)	.190	(.629)
District size (ref = 2 to 5 schools)				
6 to 15 schools	.062	(.535)	-.261	(.265)
16 or more schools	.329	(.908)	-.372	(.375)
Residential context				
Percent resident children in private school	.091	(.047)	.099 *	(.044)
Population (log)	2.082 ***	(.411)	.667 ***	(.155)
Area (log)	.389 *	(.168)	.198 *	(.087)
Percent White	-.003	(.031)	.007	(.014)
Percent Black	.020	(.036)	.055 **	(.020)
Percent Hispanic	-.062	(.032)	.007	(.021)
Poverty rate gap (Hispanic - White)	.123 **	(.039)	.036 *	(.018)
Income ratio (White / Hispanic)	.681	(1.188)	-.040	(.472)
District share of MSA White residents	-.020	(.028)	-.024	(.014)
District share of MSA Black residents	.037	(.028)	.004	(.010)
District share of MSA Hispanic residents	-.041	(.035)	.009	(.015)
District includes downtown area	.192	(.904)	-.224	(.340)
South	-.696	(.579)	.317	(.278)
Constant	-21.579 ***	(5.432)	-8.195 ***	(2.479)
Variance of residuals	49.047 ***	(5.051)	10.335 ***	(1.040)
Covariance of residuals	7.409 ***	(1.292)		

Note: Estimates are reported from the preferred model (Model 1 in Table 5, top panel, n=1,354 school districts). Standard errors in parentheses are clustered by MSA. Each outcome is the change in segregation between 2000 and 2010, estimated simultaneously in a generalized structural equation model with unstructured error correlation. Change in charter school enrollment is a linear measure of the percent of 4th-grade public students enrolled in 2010 minus the percent of 4th-grade public students enrolled in 2000. "Segregation level in 2000" and "Segregation change, 1990-2000" are measured uniquely to match the school or residential segregation outcome.

* p<.05, ** p<.01, ***p <.001

Appendix Table 5. Selected results from alternative models measuring residential segregation of households (Variance Ratio Index)

Regression model	School (4th graders)	Residential (HH w/ children)	Residential (HH w/o children)
A. White-Black residential segregation (n=1,601)			
Change in charter school enrollment share, 2000-10	.145 ** (.045)	-.038 * (.018)	-.020 (.011)
B. White-Hispanic residential segregation (n=1,354)			
Change in charter school enrollment share, 2000-10	.054 (.050)	-.062 ** (.023)	-.037 ** (.011)

Note: Structural equation models with three outcomes include the same specifications and covariates as the preferred model (Model 1 of Table 4), but measure residential segregation separately for households with children and for households without children. Household census counts are not reported by race and Hispanic ethnicity for White and Black households in 1990 and for Black households in 2000. To adjust, in control variables drawing on 1990 data, we use population counts instead of household counts. In outcome variables drawing on 2000 and 2010 data, White counts are limited to non-Hispanic households; Black counts include an unknown combination of Hispanic and non-Hispanic households.

* p<.05, ** p<.01, ***p <.001

Appendix Table 6. Selected results from alternative models measuring school segregation at different grade levels (Variance Ratio Index)

Regression model	Elementary school (4th graders)	Middle school (8th graders)	High school (10th graders)
A. White-Black school segregation			
Change in charter school enrollment share, 2000-10	.144 ** (.045)	.186 *** (.054)	.193 ** (.068)
N districts	1,601	991	615
B. White-Hispanic school segregation			
Change in charter school enrollment share, 2000-10	.056 (.050)	.093 * (.044)	.069 (.049)
N districts	1,354	800	475

Note: Results from six separate regression models, with specifications identical to those presented in Model 1 of Table 4. We apply the sample criteria apply as in all previous analyses, but there are fewer districts at the middle school and high school levels. The reason for this is that some in-sample districts have two or more elementary schools but only one middle school or only one high school. * $p < .05$, ** $p < .01$, *** $p < .001$