Is Separate Still Unequal? New Evidence on School Segregation and Racial Academic Achievement Gaps

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ABSTRACT

U.S. public schools are highly racially and economically segregated. Prior research shows that the desegregation of Southern schools beginning in the 1960s led to significant benefits for Black students. We do not know, however, whether segregation today has the same harmful effects as it did 50 years ago, nor do we have clear evidence about the mechanisms through which segregation affects achievement. We estimate the effects of current-day school segregation on racial achievement gaps using 10 years of data from all public districts in the U.S. We find that racial segregation is strongly associated with the magnitude of achievement gaps in third grade and with the rate at which gaps grow from third to eighth grade. The association of segregation with achievement gaps is completely accounted for by racial differences in school poverty (i.e., "racial economic segregation"). Racial segregation appears to be harmful because it concentrates minority students in high-poverty schools, which are, on average, less effective than lower-poverty schools. Exploratory analyses show that segregation-related between-school differences in teacher characteristics are associated with unequal learning rates, but most of the effect of racial economic segregation is unexplained by between-school differences in the set of measured teacher and school characteristics available.

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ABSTRACT

U.S. public schools are highly racially and economically segregated. Prior research shows that the desegregation of Southern schools beginning in the 1960s led to significant benefits for Black students. We do not know, however, whether segregation today has the same harmful effects as it did 50 years ago, nor do we have clear evidence about the mechanisms through which segregation affects achievement. We estimate the effects of current-day school segregation on racial achievement gaps using 10 years of data from all public districts in the U.S. We find that racial segregation is strongly associated with the magnitude of achievement gaps in third grade and with the rate at which gaps grow from third to eighth grade. The association of segregation with achievement gaps is completely accounted for by racial differences in school poverty (i.e., "racial economic segregation"). Racial segregation appears to be harmful because it concentrates minority students in high-poverty schools, which are, on average, less effective than lower-poverty schools. Exploratory analyses show that segregation-related between-school differences in teacher characteristics are associated with unequal learning rates, but most of the effect of racial economic segregation is unexplained by between-school differences in the set of measured teacher and school characteristics available.

INTRODUCTION

Sixty-five years ago, the Supreme Court ruled that state-mandated racial segregation in schools was unconstitutional. Fifteen years later—now more than fifty years ago—the desegregation of Southern school districts began in earnest. Those efforts were predicated on the belief that racial school segregation *per se* contributed to educational inequality in America. And indeed, following the school desegregation of the late 1960s and 1970s, racial achievement gaps declined substantially in the 1970s and 1980s (Reardon, Robinson-Cimpian, and Weathers 2015), suggesting that desegregation could indeed reduce racial inequality in educational outcomes. The desegregation of Southern school districts during this time had a positive impact on Black students' educational outcomes and no negative impact on those of White students' (Ashenfelter, Collins, and Yoon 2006; Guryan 2004; Johnson 2019).

While educationally beneficial, the desegregation efforts of the late 1960s and early 1970s did not last. Public schools today remain highly segregated both by race and class and there is little broad or sustained national policy interest in creating more integrated schools. Current efforts to integrate schools are largely decentralized. The one recent piece of proposed federal legislation to support desegregation—the Strength in Diversity Act of 2019—paints integration as a voluntary goal driven by local community preferences rather than as a necessary step to improve children's educational outcomes. In other words, it appears the country has retreated from the belief that segregation itself is harmful and quietly assumed that it is possible to have equally high-quality schools in every neighborhood, regardless of racial or economic composition.

This position assumes that school segregation today differs from the historical *de jure* segregation of the South in a way that makes it less harmful to students. There are several reasons one might think this is true. It may be that legally-mandated segregation inflicted psychological harm that limited Black students' educational success in a way that current *de facto* segregation does not. *De jure* segregation also came with stark differences in school resources for White and Black students; indeed, the sharp

decline in funding inequality resulting from Southern desegregation appears to be a key reason why desegregation was beneficial for Black students (Johnson 2019). In recent decades funding disparities between districts in many states have further declined as a result of court-ordered or legislative school finance reforms that increased funding in low-income school districts (Lafortune, Rothstein, and Schanzenbach 2018). Thus, it is not clear that segregation today is attended by the same level of resource inequity as was the case prior to the 1960s. Given both the shift from *de jure* to *de facto* segregation and the decrease in school resource inequalities, we do not know whether—or how—school segregation today leads to unequal educational opportunities.

Our goal here is to provide evidence regarding these questions. Using standardized test scores and segregation data from grades 3-8 in the 2008-09 through 2017-18 school years from nearly all public schools in the U.S., we examine the association between school segregation patterns and racial achievement gaps between White and Black students and between White and Hispanic students within school districts, counties, and metropolitan areas in the U.S.[1] We leverage variation in school segregation both between and within places, across grades and years, to identify the nature and magnitude of the associations between segregation, achievement gaps, and the rate at which the achievement gaps change as children progress through school. Finally, we explore the mechanisms through which school segregation may operate by testing whether and how differences in school and teacher characteristics account for the association between school segregation and racial achievement gaps. Given the unprecedented scale of our data, our analysis provides the most comprehensive evidence to date regarding the relationship between segregation and academic achievement gaps.

We study two dimensions of school segregation. The first is racial segregation *per se*: differences

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[1] While "Hispanic" is officially considered an ethnicity by the U.S. government (Office of Management and Budget, 1997), we use the term "race" to reference the categories of Black, Hispanic, and White. The decision to use the term "race" was made for brevity. Further, we use the term Hispanic to reference a set of individuals who identify with Spanish-speaking heritage or heritage in Latin America.

in the *racial* composition of White, Black, and Hispanic children's schools. Racial segregation was the focus of the court-ordered desegregation efforts of the 1950s, 1960s, and 1970s; it reflects the common understanding of the term "segregation" today. However, racial segregation is often accompanied by a second form of segregation, which we refer to as "racial economic segregation." Racial economic segregation refers to differences in the *economic* composition of White, Black, and Hispanic children's schools. Due to the large and persistent link between race and poverty in the U.S. (Akee, Jones, and Porter 2019; Orfield, Kucsera, and Siegel-Hawley 2012), the two dimensions are highly correlated, but conceptually distinct. Without some racial segregation, there can be no racial economic segregation. If White and Black students are evenly distributed among schools, then the average economic composition of White students' schools will necessarily be identical to that of Black students' schools. However, it is possible to have high levels of racial segregation but low racial economic segregation. This will be the case, for example, if Black and White students attend different schools, but all schools have equal economic composition.

Analyzing both racial segregation *per se* and racial economic segregation allows us to more clearly disentangle whether racial segregation may have consequences for educational achievement because of factors related to school racial composition or because of factors related to school economic composition. In this paper, we use the term "segregation" generally and the terms "racial segregation" and "racial economic segregation" to refer specifically to these two dimensions of school segregation. When necessary, we explicitly distinguish between segregation that occurs among schools and segregation that occurs among neighborhoods.

SEGREGATION AND EDUCATIONAL OPPORTUNITY

We focus on racial differences in average test scores ("achievement gaps") as the key outcome of interest in this paper because such gaps reflect racial differences in access to educational opportunities.

By "educational opportunities," we mean all experiences in a child's life, from birth onward, that provide opportunities to learn, including experiences in children's homes, childcare settings, neighborhoods, peer groups, and schools. In saying that test score gaps reflect differences in opportunities, we underscore that test score gaps are not the result of innate group differences in cognitive skills or other genetic endowments. While differences in two *individual* children's academic performance may reflect both individual differences and differences in educational opportunities, differences in group *average* test scores should be understood as reflecting between-group opportunity gaps, given that there are not between-group average differences in genetic endowments or innate academic ability (Nisbett, Aronson, Blair, Dickens, Flynn, Halpern and Turkheimer, 2012; Nisbett 2009; Nisbett 1998).

Our goal in this paper is to determine whether school segregation is a factor contributing to unequal education opportunity reflected in test score gaps. Certainly, school segregation is not the only factor. Indeed, racial disparities in educational opportunities begin early in children's lives, even before school entry. Racial disparities result in part from large racial differences in average family income and educational resources that parents can provide at home, differences in neighborhood conditions that support learning, and differences in enrollment in high quality early childhood educational programs (Bassok et al. 2016; Bassok and Galdo 2016; Magnuson et al. 2004; Valentino 2018).

But residential segregation may magnify these differences in family resources by isolating minority families in higher poverty neighborhoods. Even among households with the same annual income, Blacks and Hispanics reside in lower income neighborhoods than Whites (Pattillo 2005, 2013; Reardon, Fox, and Townsend 2015; Sharkey 2014). Families residing in economically disadvantaged neighborhoods may have less access to high-quality preschools (Barnett and Lamy 2013), fewer neighbors with high levels of education, more exposure to violence and crime, fewer social services, and fewer opportunities for extracurricular activities (Duncan and Magnuson 2005). Early learning programs are also highly segregated by race and ethnicity (Greenberg and Monnarez 2020) and state-level racial residential

segregation is correlated with gaps in pre-kindergarten program quality (Valentino 2018). As a result of these early differences in educational experiences and opportunities in early childhood, racial achievement gaps are very large when children enter kindergarten (Bassok et al. 2016; Reardon and Portilla 2016).

During K-12 education, racial school segregation may further influence racial achievement gaps by exposing students of different racial groups to inequitable schooling contexts and resources. First, because of segregation, Black and Hispanic students generally attend higher poverty schools, on average, than their White peers. High-poverty schools often have less-skilled, less-experienced, and less-qualified teachers than low-poverty and predominantly White schools (Darling-Hammond 2004; Peske and Haycock 2006). This is in part a result of patterns of teacher preferences, placement, and attrition. Teachers are more likely to exit high-poverty and high-minority schools, which often leaves these schools with more novice and uncredentialed teachers (Hanushek, Kain, and Rivkin 2004; Jackson 2009; Scafidi, Sjoquist, and Stinebrickner 2007). Similar sorting of students and teachers occurs within schools (Kalogrides and Loeb 2013). Though there is not yet definitive evidence, such racial disparities in access to high quality teachers may lead to widening racial achievement gaps (Scafidi et al. 2007).

Second, schools with large proportions of minority and poor students may be less equipped to support student achievement. For example, parents of students in high-poverty schools tend to have substantially less political, social, and economic capital that can be leveraged to support the school and its students relative to parents of students in low-poverty schools (Horvat, Weininger, and Lareau 2003; Lareau and McCrory Calarco 2012). Thus, there may be less potential for beneficial spillover effects of these various forms of capital on students in high poverty schools. Students in high-poverty schools also have lower average academic skills at school entry than students attending schools with lower rates of poverty as a result of unequal early childhood opportunities (Ladd 2012); this may lead teachers in such schools to focus their instruction and curricula more on basic skills or remedial content. There may also

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be fewer advanced courses and curricular offerings (Martin, Karabel, and Jaquez 2005). Such patterns might lead to racial differences in students' opportunities to learn in school.

Finally, segregation may lead to differences in school funding between the schools of White and minority students. In states with weak compensatory school finance systems or inequitable distribution of funds, poorer school districts may have less funding than richer districts (Baker and Corcoran 2012). If minority students are disproportionately concentrated in poorer school districts, their schools will likely have fewer school resources (Sosina and Weathers 2019). Even in places where the funding for high- and low-poverty schools is nominally equal, high-poverty schools often have greater financial needs, as a result of serving more students needing special education services and English Learner students and of their increased need for support services such as social work, counseling, and school-based health services (Baker and Corcoran 2012). Furthermore, wealthier (and often Whiter) school districts receive more private donations than less affluent (and often higher minority) school districts (Nelson and Gazley 2014). Compensatory state and federal revenue may not sufficiently account for such local revenue shortfalls in the context of increasing segregation (e.g., Weathers and Sosina 2019).

Overall, racial disparities in academic achievement are impacted by early childhood experiences, out-of-school experiences that occur throughout childhood, and experiences within K-12 schools. Educational opportunities in early childhood may be affected by residential segregation patterns, while opportunities during the K-12 years may be shaped by both residential and school segregation. However, school segregation may be more relatively important for the growth of the achievement gaps during the K-12 years, given the key role of schooling in providing educational opportunities during that time. Our goal here is to characterize how school segregation affects racial achievement gaps, net of residential segregation and other controls, and to provide evidence regarding the mechanisms through which school segregation may lead to unequal educational opportunities.

PRIOR RESEARCH ON THE EFFECTS OF SCHOOL SEGREGATION

Trends in School Segregation

Studies documenting the extent of racial school segregation leading up to and following *Brown v. Board of Education* (1954) generally show that Black-White segregation did not begin to decline in earnest until after 1968, following the *Green v County School Board of New Kent County* Supreme Court decision (Reardon and Owens 2014). In 1968, segregation remained near its peak. Nationally, 64% of Black students attended schools with 90-100% minority students (Orfield 2001), and the average within-district dissimilarity index was approximately 0.80, indicating that 80% of Black students (or 80% of White students) would have to change schools in order for all schools to have identical racial enrollments (Logan, Zhang, and Oakley 2017; Reardon and Owens 2014). By the early 1980s, only 33% of Black students were in schools with 90-100% minority students (Orfield 2001) and the Black-White dissimilarity index had dropped to 0.51 (Logan et al. 2017). Hispanic-White segregation was not thoroughly documented during this period; however, there is evidence that Hispanic isolation grew from 1968 through the early 1980s (Orfield 2001).

Since the 1980s, levels of racial segregation have been more stable. Black and Hispanic students are somewhat more racially isolated today compared with the 1980s. In 2016, about 40% of Black students and 42% of Hispanic students were in schools with 90-100% minority peers, an 8-9 percentage point increase from 1988 (Orfield et al. 2016). This decline in racial isolation resulted from an increase in the proportion of minority students in the U.S., however, rather than a change in how evenly students are distributed among schools. The dissimilarity index—which measures the evenness of racial compositions across schools—has changed little or declined modestly in the last 3 decades (Fuller et al. 2019; Logan et al. 2017; see Reardon and Owens 2014 for a thorough discussion).

There is less information on the levels and long-term trends in racial economic segregation, due to both data limitations and the fact that racial segregation *per se* was the focus of legal desegregation

efforts. Fahle et al. (2020) show that from 1999 to 2016 the national Black-White and Hispanic-White differences in exposure to school poverty decreased by 8% and 16%, respectively. In contrast, Orfield et al. (2016) report rising racial economic segregation from 1993 to 2013.[2] In addition, Fahle et al. (2020) finds that the decline in racial economic segregation is largely the result of large regional demographic shifts rather than local changes in between- and within-district patterns. That said, there is considerable variation in racial economic segregation across places: in some school districts, metropolitan areas, and states, all students attend schools with similar poverty rates, while in others Black and Hispanic students attend schools with poverty rates that are as much as 40 percentage points higher than White students.

Desegregation, Resources, and Achievement

During the 1960s through 1980s, Black students gained access to more school resources and were able to enroll in historically White and well-resourced schools as a result of school desegregation (Johnson 2019). For example, in Louisiana, not only did Black students gain access to additional school resources through enrolling in traditionally White schools, desegregation was also accompanied by significant changes in the state's school funding system. These changes led to substantial increases in funding for the schools attended by Black students (Reber 2010). The expanded access to school resources, such as higher per pupil expenditures and smaller student-to-teacher ratios, for Black students improved high school completion rates, educational attainment, socioeconomic status, and health outcomes for Blacks (Ashenfelter et al. 2006; Guryan 2004; Johnson 2019; Reber 2010).

Overall, the research on the consequences of desegregation in the 1960s and 1970s makes clear that the unequal funding of schools was an important mechanism linking racial segregation and educational outcomes prior to the 1970s. It also suggests that the negative effects of racial segregation

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[2] The difference between the two results from methodological and data differences. Fahle et al. (2020) uses free and reduced-price lunch eligibility as a measure of student poverty whereas Orfield et al. (2016) uses free lunch eligibility. In addition, Fahle et al (2020) impute missing data and free and reduced-price lunch eligibility; Orfield et al (2016) do not.

per se were mitigated by improving the resource contexts of socioeconomically disadvantaged racial minority students.

Contemporary Segregation and Racial Gaps in Academic Achievement

The empirical literature assessing the relationship between contemporary racial segregation and achievement gaps generally finds a positive association between the two. Using SAT data from 1998 to 2001, Card and Rothstein (2007) find that Black-White SAT score gaps were larger in more residentially segregated cities. Net of racial residential segregation, however, they found that racial school segregation had no independent association with racial gaps in SAT scores. In contrast, Reardon (2016) finds that school segregation is more predictive of racial achievement gaps than residential segregation in grades three through eight. Reardon (2016) suggests that the discrepancy is a result of the fact that Card and Rothstein (2007) did not fully control for other dimensions of segregation. Moreover, Reardon's data is based on standardized test scores taken by all students, rather than a self-selected sample of SAT takers. Reardon (2016) also found that, among many dimensions of segregation, racial disparities in average school poverty rates (school racial economic segregation) were the most powerful correlates of racial achievement gaps. Net of racial economic segregation, racial school segregation *per se* was not associated with achievement gaps. This suggests that segregation is related to achievement gaps because it concentrates minority students in high poverty schools. This finding is consistent with Owens' (2016) study of income segregation, which found that metropolitan area economic segregation was positively associated with achievement gaps both between White and Black students and between economically advantaged and disadvantaged students. Note, however, that Reardon (2016), Card and Rothstein (2007), and Owens (2018) do not examine the association between segregation and the growth of achievement gaps as children progress through school.

Two additional studies provide further evidence regarding the effect of racial segregation on achievement gaps or other educational disparities. Condron et al (2013) assess the association of within-

state, between-school racial segregation and White-Black gaps in NAEP scores between 1991 and 2009. They find that higher levels of racial segregation were associated with larger 4th grade state-level NAEP achievement gaps, net of state and year fixed effects. Lutz (2011) shows that Black students' dropout rates and enrollment in private school increased in school districts outside of the South after they were released from court-ordered desegregation mandates in the late 1990s or 2000s. Whereas in Southern districts (regardless of dismissal status) and non-Southern districts that were not dismissed from court mandates, dropout rates trended downward.

Overall, the existing literature on segregation and student outcomes is relatively sparse. It shows that desegregation in the mid-to-late 20th century improved Black students educational, economic, and social outcomes, primarily through the expansion of school resources. Though a few studies generally show a clear association between contemporary segregation and achievement gaps, they primarily examine segregation at the state or metropolitan area level, rather than the school district level; they focus on the cross-sectional association between segregation and the size—rather than the growth—of achievement gaps; and they provide little evidence about the mechanisms through which segregation operates.

A STYLIZED CONCEPTUAL MODEL

A study of the relationship between school segregation and achievement gaps is a study of the relationship between school segregation and the inequality of educational opportunities. Here we lay out a series of stylized models that form the basis for our estimation strategy. For the purposes of this section, we write the stylized models for the study of the White-Black achievement gap within school districts; however, the same structure can be applied to study the White-Hispanic achievement gap in school districts, as well as White-Black and White-Hispanic gaps within counties and metropolitan areas.

Consider a stylized model that expresses academic performance (Y_{isd}) of student i in school s in

district d as a function of student characteristics (including race and family background and denoted by the vector $\mathbf{X}_i$), school characteristics (denoted by the vector $\mathbf{Z}_s$), district characteristics (expressed here by a district fixed effect $\mathbf{\Lambda}_d$), and an independent, mean-zero error term e_{isd}:

$$Y_{isd} = \mathbf{X}_i \mathbf{B} + \mathbf{Z}_s \mathbf{\Gamma} + \mathbf{\Lambda}_d + e_{isd}.$$

(1)

Taking the average value of this expression for both White and Black students in a given district d yields:

$$\bar{Y}_{wd} = \bar{\mathbf{X}}_{wd} \mathbf{B} + \bar{\mathbf{Z}}_{wd} \mathbf{\Gamma} + \mathbf{\Lambda}_d$$
$$\bar{Y}_{bd} = \bar{\mathbf{X}}_{bd} \mathbf{B} + \bar{\mathbf{Z}}_{bd} \mathbf{\Gamma} + \mathbf{\Lambda}_d,$$

(2)

where $\bar{\mathbf{X}}_{wd}$ and $\bar{\mathbf{X}}_{bd}$ denote the average values of $\mathbf{X}$ among White and Black students, respectively, in district d. Taking the difference of these two expressions yields the White-Black gap in district d, denoted ΔY_d:

$$\Delta Y_d = \bar{Y}_{wd} - \bar{Y}_{bd} = (\bar{\mathbf{X}}_{wd} - \bar{\mathbf{X}}_{bd})\mathbf{B} + (\bar{\mathbf{Z}}_{wd} - \bar{\mathbf{Z}}_{bd})\mathbf{\Gamma} = (\Delta \mathbf{X}_d)\mathbf{B} + (\Delta \mathbf{Z}_d)\mathbf{\Gamma}.$$

(3)

Given the model of achievement described in (1), the White-Black gap in district d is a function of White-Black differences in individual characteristics ($\Delta \mathbf{X}_d = \bar{\mathbf{X}}_{wd} - \bar{\mathbf{X}}_{bd}$) and White-Black differences in average school characteristics ($\Delta \mathbf{Z}_d = \bar{\mathbf{Z}}_{wd} - \bar{\mathbf{Z}}_{bd}$). Note that the district characteristics do not enter into (3), as they are common to White and Black students.

If the vector $\mathbf{Z}$ contains a measure of school composition such as the percent of group g in school s, denoted P_s^g, then $\bar{P}_{wd}^g$ is simply the exposure index of White students to group g (the proportion of group g in the average White student's school in district d), and $\bar{P}_{bd}^g$ is the exposure of Black students to group g. The achievement gap is a function of $\Delta P_d^g = \bar{P}_{wd}^g - \bar{P}_{bd}^g$, the difference in exposure of Whites and Blacks to group g. ΔP_d^g is a standard measure of segregation (Reardon and Owens 2014). If g denotes White or Black students, then ΔP_d^g is a measure of racial segregation; if g denotes poor students,

then ΔP_d^g is a measure of racial economic segregation. This indicates that segregation will be associated with achievement gaps if achievement is described by model (1) and if school composition is associated with individual achievement.

If the vector $\mathbf{Z}$ contains a measure of some school characteristic that affects students' achievement (say, quality of instruction, denoted Q_s), then the achievement gap is a function of ΔQ_d, the difference in average instructional quality experienced by White and Black students in district d. Likewise, if the vector $\mathbf{X}$ contains a measure of some individual or family characteristic that affects students' achievement (say, family income, denoted I_i), then the achievement gap is a function of ΔI_d, the White-Black difference in average family income in d.

This stylized model suggests that we can estimate the parameters of model (1) by fitting a regression model of the form suggested by equation (3):

$$\Delta Y_d = \Delta \mathbf{P}_d \mathbf{A} + \Delta \mathbf{X}_d \mathbf{B} + \Delta \mathbf{Z}_d \mathbf{\Gamma} + u_d.$$

(4)

This stylized model informs the cross-sectional models that we use in this paper to investigate the association between segregation and average test score gaps. We are interested in $\mathbf{A}$, the vector of coefficients on racial and racial economic segregation, and $\mathbf{\Gamma}$, the vector of coefficients on racial differences in school characteristics.

Now consider a modified version of the stylized model in equation (1), one that expresses academic performance (Y_{tisd}) at time t of student i in school s in district d as a function of the accumulated effects of potentially time-varying student characteristics ($\mathbf{X}$), school composition ($\mathbf{P}$), and other school characteristics ($\mathbf{Z}$), accumulated time-varying district fixed effects ($\mathbf{\Lambda}$), a student fixed effect ($\mathbf{\eta}$), and an independent, mean-zero error term (e):

$$Y_{tisd} = \sum_{k=0}^{t} \mathbf{P}_{sk} \mathbf{A} + \sum_{k=0}^{t} \mathbf{X}_{ik} \mathbf{B} + \sum_{k=0}^{t} \mathbf{Z}_{sk} \mathbf{\Gamma} + \sum_{k=0}^{t} \mathbf{\Lambda}_{dk} + \mathbf{\eta}_i + e_{tisd}.$$

Taking the average value of this expression for both White and Black students in a given district d at a given time T, and then taking the White-Black difference, yields an expression for the White-Black achievement gap at time T (denoted ΔY_{Td}):

$$\Delta Y_{Td} = \left(\sum_{k=0}^{T} \Delta \mathbf{P}_{kd}\right)\mathbf{A} + \left(\sum_{k=0}^{T} \Delta \mathbf{X}_{kd}\right)\mathbf{B} + \left(\sum_{k=0}^{T} \Delta \mathbf{Z}_{kd}\right)\mathbf{\Gamma} + \Delta \boldsymbol{\eta}_d,$$

<div align="right">(6)</div>

Where $\Delta \mathbf{P}_{kd}$, $\Delta \mathbf{X}_{kd}$, and $\Delta \mathbf{Z}_{kd}$ are the White-Black disparities in $\mathbf{P}$, $\mathbf{X}$, and $\mathbf{Z}$, respectively, in district d during time period k. Given the model of achievement described in (5), the White-Black gap at time T in district d is a function of a) the accumulated effects of White-Black segregation (both racial and racial economic segregation); b) the accumulated effects of White-Black differences in individual characteristics (for example, White-Black differences in family income trajectories over their lives); c) the accumulated effects of White-Black differences in average school characteristics (for example, White-Black differences in exposure to experienced teachers); and d) White-Black differences in average student fixed effects. Note that the accumulated district characteristics do not enter into (6), as they are common to White and Black students.

A challenge in estimating the coefficients of interest ($\mathbf{\Gamma}$) from Equation 6 is that we may not observe all relevant covariates or we may not be able to observe their full sequence from time 0 to T. To address this, we can difference Equation 6 with respect to time:

$$\delta \Delta Y_{Td} = \Delta Y_{Td} - \Delta Y_{(T-1)d} = (\Delta \mathbf{P}_{Td})\mathbf{A} + (\Delta \mathbf{X}_{Td})\mathbf{B} + (\Delta \mathbf{Z}_{Td})\mathbf{\Gamma},$$

<div align="right">(7)</div>

where $\delta \Delta Y_{Td} = \Delta Y_{Td} - \Delta Y_{(T-1)d}$ is the change in the White-Black achievement gap during grade T. Under this model, the change in the achievement gap during grade T is a function of segregation during grade T as well as between-group differences in individual and school characteristics during grade T.

Note that the temporal difference eliminates both the White-Black difference in fixed effects from the model and all values of the covariates prior to time T.

This stylized model is the basis for the cross-sectional models we use to estimate the association between segregation and the average growth of achievement gaps from third to eighth grade. As in the model described in Equation (4), we are interested in $\mathbf{A}$, the vector of coefficients on racial and racial economic segregation, and $\mathbf{\Gamma}$, the vector of coefficients on racial differences in school characteristics.

In practice we may lack time-specific measures of some individual and school characteristics, however, which may lead to bias in estimates of $\mathbf{\Gamma}$. To partially address this, we use panel data (where we have multiple observations, across grades, years, and subjects, within each district) and include district-grade and district-year fixed effects as well as district-subject fixed effects in these models, in addition to lagged measures of the achievement gap:

$$\delta \Delta Y_{Td} = \alpha \Delta Y_{(T-1)d} + \Delta \mathbf{X}_{Td} \mathbf{B} + \Delta \mathbf{Z}_{Td} \mathbf{\Gamma} + \mathbf{\Lambda}_{dg} + \mathbf{\Lambda}_{dy} + \mathbf{\Lambda}_{db} + u_{td}.$$

(8)

To the extent that $\Delta \mathbf{X}_{td}$, for example, does not vary within a district, net of grade, year, and subject fixed effects, the estimates of $\mathbf{\Gamma}$ will not be biased by the omission of $\Delta \mathbf{X}_{td}$ from the model. The panel models based on this stylized model are used more robustly to estimate the association between segregation and growth in achievement gaps during school years.

In sum, we use a series of cross-sectional and panel regression models with a vector of control variables to estimate the effect of school segregation on achievement gaps—at multiple levels of geography (i.e., districts, counties, metropolitan areas) and for different group comparisons (i.e., White-Black and, White-Hispanic). We reason that if school segregation affects achievement gaps, we would expect to observe two patterns in the data: 1) school segregation will be positively associated with achievement gaps, after controlling for between-group differences in family background and neighborhood segregation; and, 2) school segregation will be associated not just with the size of the

achievement gap but also with its growth as children progress through school. Moreover, we expect that these conditions would hold similarly across geographies and racial groups. Because we use data with near-complete population coverage, our estimates are representative of the full U.S. population of public schools, a substantial advantage over prior research. Nonetheless, the regression approach will yield biased estimates if not all confounding variables are included, so our estimates should be understood as potentially biased.[3]

DATA

Achievement Data

Our analysis requires estimates of average academic achievement, comparable across places, years, and grade, by race, within school districts, counties, and metropolitan areas. Our measures of average achievement come from a restricted version of the Stanford Education Data Archive Version 4.0 (SEDA 4.0; Reardon et al. 2021). SEDA provides average test score estimates and their standard errors, which are constructed from the ED*Facts* state accountability test data (provided by the National Center for Education Statistics), and linked to a common scale using the state National Assessment of Educational Progress (NAEP) data. School, district,[4] county, and metropolitan area achievement estimates are available for all students and for racial, gender, and economic subgroups in math and ELA in grades 3 through 8 from the 2008-09 through 2017-18 school years. For technical details on the SEDA data, see Fahle et al (2021). From SEDA, we use district, county, and metropolitan area test score estimates for Black, Hispanic, and White students in all subjects, grades, and years available. The test scores are

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[3] While an experiment would provide unbiased causal estimates of the effect of segregation on achievement gaps, such an approach is not feasible given that there are no clear instruments for segregation that would meet the exclusion restriction.
[4] SEDA uses geographic school districts, rather than administrative school districts. Geographic school district estimates reflect the test scores of all public school students attending school within their geographic boundaries.

standardized within grades and subjects to the national student-level distribution of scores.[5]

There are 400 metropolitan areas, 3,119 counties, and roughly 13,500 school districts serving

grades 3-8 in the United States.[6] SEDA publishes mean achievement estimates only for subject-grade-year

cells with at least 20 tested students. This restriction eliminates school districts with small overall

populations. Because we are interested in achievement gaps between racial groups, we exclude subject-

grade-year cells that do not include at least 20 White and at least 20 Black or 20 Hispanic tested students.

Following these restrictions, our analytic sample for the White-Black achievement gap models contains

7,800 school districts, 2,560 counties, and 390 metropolitan areas. For the White-Hispanic achievement

gap models, the samples include 9,390 school districts, 2,780 counties, and 390 metropolitan areas.[7]

Although the analytic sample includes estimated achievement gaps from only about half of all public

school districts in the U.S., the excluded districts enroll relatively few minority students. Most Black (91%)

and Hispanic (92%) public school students in grades 3-8 in the U.S. are enrolled in districts included in the

analytic sample. Similarly, the county analytic sample includes 89% of Black and 95% of Hispanic public

school students in the U.S. in grades 3-8, and the metropolitan area analytic sample includes 97% of Black

and 99% of Hispanic students that attend public schools in metropolitan areas in grades 3-8.

School Segregation Measures

We construct segregation measures using counts of students, by race and economic

disadvantage,[8] in each school-grade-year from ED*Facts*.[9] Our primary racial segregation measure is the

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[5] Specifically, we use the "cohort scale" test scores from SEDA; for details, see Fahle et al. (2021).
[6] The Census defines 388 metropolitan areas in the U.S., but some large metropolitan areas are subdivided into "divisions." We count each division as a unique metropolitan area in our analyses. This yields 400 metropolitan areas. Additionally, we include both counties and county equivalents in our analyses. County equivalents are identified by the Census Bureau for states where counties are not the primary administrative divisions and/or in which some cities and areas are not assigned to counties (United States Census Bureau 2013).
[7] Sample sizes are rounded to the nearest 10, per IES disclosure requirements.
[8] States' definitions of economic disadvantage differ but the modal definition is based on whether students qualify for free or reduced priced lunch.
[9] We use ED*Facts* data instead of the Common Core of Data because school-by-year-by-grade free/reduced-price lunch data are not included in the CCD.

Black-White or Hispanic-White difference in exposure to Black and Hispanic ("minority") students. For example, we compute Black-White racial segregation in district d as:

$$\Delta P_d^m = \bar{P}_{bd}^m - \bar{P}_{wd}^m = \sum_{s \in d} \left(\frac{b_s}{B}\right) \pi_{ms} - \sum_{s \in d} \left(\frac{w_s}{W}\right) \pi_{ms} = \sum_{s \in d} \left(\frac{b_s}{B} - \frac{w_s}{W}\right) \pi_{ms},$$

where b_s, w_s, B, and W are the number of Black and White students, respectively, in school s and the whole district, respectively, and where π_{ms} is the proportion of students in school s who are Black or Hispanic. We also calculate the Black-White and Hispanic-White differences in exposure to Black and to Hispanic students separately for use in robustness checks.

Similarly, we construct measures of racial economic segregation as the Black-White and Hispanic-White differences in exposure to poor students. For example, we compute Black-White racial economic segregation as:

$$\Delta P_d^p = \bar{P}_{bd}^p - \bar{P}_{wd}^p = \sum_{s \in d} \left(\frac{b_s}{B}\right) \pi_{ps} - \sum_{s \in d} \left(\frac{w_s}{W}\right) \pi_{ps} = \sum_{s \in d} \left(\frac{b_s}{B} - \frac{w_s}{W}\right) \pi_{ps}$$

(10)

where b_s, w_s, B, and W are defined as above and π_{ps} is the proportion of students in school s who are poor. We compute all segregation measures for each district, county, and metropolitan area, and in each year and grade. In the cross-sectional models, we use an unweighted average of these measures across grades (3-8) and years (2009-2018) within each geographic unit. In the panel models, we use the year- and grade-specific estimates.

School Characteristics

Our cross-sectional models include a set of measures hypothesized to mediate the associations between segregation and achievement gaps. These include White-Black and White-Hispanic differences in peers' 3rd grade test scores (computed from the SEDA 4.0 data); the Black-White and Hispanic-White differences in average student/teacher ratios (computed from the 2009-2018 Common Core of Data

(CCD)[10]); and the logged White-Black and White-Hispanic ratios of average district expenditures (computed from the 2009-2018 CCD[11]). We also include three other variables describing differences in school characteristics: the Black-White and Hispanic-White differences in the proportion of novice (first- or second-year) teachers in the average students' school; the Black-White and Hispanic-White differences in the proportion of chronically absent teachers (10+ days per year) in the average students' school; and the Black-White and Hispanic White differences in the proportion of students that attend schools that offer gifted programs. Each of these are computed from the 2011-12, 2013-14, 2015-16, and 2017-18 Civil Rights Data Collection (CRDC) data. We average all variables across the available grades (three through eight) and years to get a single value for each unit that we use in cross-sectional models.

Control Variables

In all models we include a set of control variables. Most notably we include (in our cross-sectional models) measures of both the average socioeconomic status (SES) of families living in a geographic unit and the White-Black (or White-Hispanic) difference in average SES among families in the unit.[12] We also include a set of residential segregation measures as control variables in the cross-sectional models. Using tract-level data from the American Community Survey (ACS),[13] we compute the Black-White and Hispanic-White racial segregation (differences in exposure to minority neighbors) and racial economic segregation

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[10] CCD universe surveys and finance files are available for download at https://nces.ed.gov/ccd/ccddata.asp.

[11] Note that the CCD only collects data on district expenditures and not on school expenditures, so we are unable to compute a comparable within-district difference in school expenditures measure.

[12] The SES index is computed as the first principal component of the following variables: the log of median family income, the proportion of adults with a bachelor's degree, the poverty rate, the unemployment rate, the SNAP receipt rate, and the single female-headed household rate. See Fahle et al. (2021) for more information. We include two measures of average SES as control variables, one based on data from the 2000 Census, and one based on data from the American Community Survey (ACS) (for the ACS measure, we average values from the 2005-2009 and 2014-2018 ACS waves). Likewise, we include two measures of racial/ethnic differences in SES as control variables, one from the 2000 Census, and one from the ACS. We include multiple measures (and use multiple waves of the ACS in creating one of them) in order to maximize the explanatory power of the SES control variables. We impute missing values of SES from the 2000 Census, and include an indicator variable for observations where data were originally missing as a control variable.

[13] ACS data were obtained at https://www.nhgis.org/. Tract-level ACS data are available as 5-year pooled samples. We use the 2005-2009 to 2014-2018 ACS data and average segregation across these 10 5-year time periods within each unit.

(differences in exposure to poor neighbors). Our cross-sectional models also include the proportion of students in each unit that are Black (or Hispanic), obtained from the 2009-2018 CCD.

Because the panel models include unit-by-grade and unit-by year fixed effects, we include as controls a more parsimonious set of characteristics that we can observe varying within units, across both years and grades. These include racial composition (the proportion of Black students and the proportion of Hispanic students), the proportion of economically disadvantaged students, and the average school size.

ANALYTIC METHODS

The stylized models above motivate a set of regression models in which we regress achievement gaps or changes in achievement gaps on measures of segregation (between-group differences in average racial and socioeconomic school composition) and between-group differences in individual, family, and school characteristics.

Cross-Sectional Models

We first fit a series of cross-sectional models. Given the structure of the SEDA data, in which there are multiple grade-year-subject observations nested within geographic units (districts, counties, or metropolitan areas), we fit these models as hierarchical linear models. The data are structured so that there are up to 120 grade-year-subject observations per unit (we have data for up to 6 grades, 10 years, and 2 subjects per unit); and two observations (one for White and one for either Black or Hispanic students, as relevant) per grade-year-subject. We treat the two groups' observations as nested within grade-year-subject cells, and grade-year-subject cells as nested within geographic units. We define $cohort = year - grade$, so that the model includes a set of parameters describing within-cohort changes in achievement gaps across grades. Specifically, we fit models of the following form:

$$\hat{Y}_{sgcbd} = \alpha_{0gcbd} + \alpha_{1gcbd}(white_s - p_{gcbd}) + e_{sgcbd}$$

$$\alpha_{0gcbd} = \beta_{00d} + \beta_{01d}(grade - 3) + \beta_{02d}(cohort - 2008) + \beta_{03d}(math - 0.5) + r_{0gcbd}$$

$$\alpha_{1gcbd} = \beta_{10d} + \beta_{11d}(grade - 3) + \beta_{12d}(cohort - 2008) + \beta_{13d}(math - 0.5)$$

$$\beta_{00d} = \gamma_{000} + \mathbf{X\Gamma}_{000} + u_{00d}$$

$$\beta_{01d} = \gamma_{010} + \mathbf{X\Gamma}_{010} + u_{01d}$$

$$\beta_{02d} = \gamma_{020} + \mathbf{X\Gamma}_{020} + u_{02d}$$

$$\beta_{03d} = \gamma_{030} + \mathbf{X\Gamma}_{030} + u_{03d}$$

$$\beta_{10d} = \gamma_{100} + \mathbf{X\Gamma}_{100} + u_{10d}$$

$$\beta_{11d} = \gamma_{110} + \mathbf{X\Gamma}_{110} + u_{11d}$$

$$\beta_{12d} = \gamma_{120} + \mathbf{X\Gamma}_{120} + u_{12d}$$

$$\beta_{13d} = \gamma_{130} + \mathbf{X\Gamma}_{130} + u_{13d}$$

$$e_{sgcbd} \sim N\left(0, Var(\hat{Y}_{sgcbd})\right); r_{0d} \sim N(0, \sigma^2); [u_{00d}, \dots, u_{13d}] = \mathbf{U}_d \sim MVN\left(0, \boldsymbol{\tau}^2\right).$$

(11)

In this model, $\hat{Y}_{sgcbd}$ is the estimated standardized mean test score for subgroup s in grade g, cohort c,

and subject b in unit d (district, county, metropolitan area); $white$ is a binary variable indicating whether

an observation refers to White students; and p_{gcbd} is the proportion of White students in grade g, cohort

c, and subject b in in unit d (among White and group s students only, as relevant). The coefficients

α_{0gcbd} and α_{1gcbd} describe, respectively, the average test score (among White and Black or white

Hispanic students, as relevant) and the difference in average scores between White and Black or Hispanic

students in grade g, cohort c, and subject b in unit d. The $u_{..d}$ are multivariate normal district-level errors

with means of 0 and covariance matrix $\boldsymbol{\tau}^2$ to be estimated; r_{0d} is a normally distributed within-unit error

term with mean 0 and variance σ^2 to be estimated; and e_{sgcbd} is the mean 0 normally distributed

sampling error in $\hat{Y}_{sgcbd}$. We treat the sampling variance of $\hat{Y}_{sgcbd}$ as known, and set it equal to the

squared estimated standard error of $\hat{Y}_{sgcbd}$. We fit the model using maximum likelihood using the HLM

program.

In the second level of the model, $grade$ is a continuous variable indicating the tested grade

(ranging from 3 to 8), centered at 3; $cohort$, defined as $year - grade$, is a continuous variable

indicating the year students entered first grade, centered at 2008; and $math$ is an indicator equal to one

if the subject is math. The coefficients β_{10d} and β_{11d} indicate the two outcomes of interest here: the

average achievement gap in grade 3 (averaged over cohorts and subjects) and the average within-cohort,

across-grade growth rate of the gap (averaged over subjects and cohorts) in district d, respectively.

In the third level of the model, $\mathbf{X}$ is a vector of (year-, grade-, and subject-invariant) covariates

consisting of the segregation measures and controls described above. Our focus is on the level 3

equations describing the outcomes of interest, β_{10d} and β_{11d}. The key parameters of interest here are

the coefficients in the vectors $\boldsymbol{\Gamma}_{100}$ and $\boldsymbol{\Gamma}_{110}$ that correspond to the measures of school segregation

included in $\mathbf{X}$. These describe the cross-district relationship between our two measures of school

segregation and achievement gaps and their growth across grades. As noted above, because these

models rely on between-district variation in segregation levels, the estimates are subject to bias from

omitted district-level covariates that are correlated with segregation levels and achievement gaps.

Panel Models

Our second set of models use within-district variation in segregation levels (across grades and

years) to estimate the association between segregation levels and contemporaneous changes in

achievement gaps. To do so, we fit fixed effects panel models of the form below:

$$\delta\Delta\mathrm{Y}_{sgybd} = \sum_{j=1}^{2} \alpha_j \Delta Y_{s(g-j)(y-j)bd} + \mathbf{X}_{sgyd}\mathbf{B} + \Delta\mathbf{Z}_{sgyd}\boldsymbol{\Gamma} + \eta_{gd} + \lambda_{yd} + \theta_{bd} + u_{sgybd},$$

(12)

where $\delta\Delta Y_{sgybd}$ is the estimated change in the achievement gap during grade g and year y for subgroup

combination s (White-Black and White-Hispanic) in subject b in unit d (district, county, metropolitan

area) and $\Delta Y_{s(g-j)(y-j)bd}$ is the gap for the same cohort of students j grades/years earlier. The White-

Black and White-Hispanic achievement gaps are computed as the difference in the means between the

two racial groups (White minus minority) within a unit-grade-year-subject. $\mathbf{X}$ is a vector of grade-year-unit

controls (including percent Black, Hispanic, and ECD, and average school size); $\Delta \mathbf{Z}$ is a vector of

segregation measures; η_{gd} is a vector of unit-by-grade fixed effects; λ_{yd} is a vector of unit-by-year fixed

effects; θ_{bd} is a vector of unit-by-subject fixed effects; and u_{sgybd} is a normally-distributed

homoscedastic error term.

The parameter of interest here is $\mathbf{\Gamma}$, the association between segregation in a given year/grade

and the change in the achievement gap during that same year/grade, conditional on the model. Because

these models rely only on within-unit variation in segregation levels (across grades and years), they are

not biased by the omission of unit-level confounding variables. Moreover, the inclusion of unit-by-grade

and unit-by-year fixed effects eliminates bias due to omitted year- or grade-specific confounders within a

district. For example, segregation is generally higher in earlier grades because students are spread over

more schools in early grades, while achievement gaps are generally smaller in earlier grades, though the

relation between these two patterns may not be causal; the inclusion of unit-grade fixed effects removes

bias that such patterns might cause. Nonetheless, the estimates from the panel models will be biased if

there are omitted confounders that vary within years and grades.

RESULTS

Descriptive Statistics: *Cross-Sectional Model Samples*

Descriptive statistics for our cross-sectional model samples are shown in Table 1. We have six

analytic samples, corresponding to the 3 units (district, county, metropolitan area) and 2 racial group

comparisons (White-Black and White-Hispanic) studied. The White-Black analytic samples include

1,172,590 grade-year-subject observations from 7,800 school districts; 452,080 observations from 2,560 counties; and 79,770 observations from 390 metropolitan areas. The White-Hispanic analytic samples include 1,549,090 observations from 9,390 school districts, 524,790 observations from 2,780 counties, and 80,330 observations from 390 metropolitan areas.

[Table 1 about here]

The average White-Black achievement gap in grade 3 among school districts is 0.497 standard deviation units; among counties and metropolitan areas the average gaps are 0.512 and 0.673 standard deviation units, respectively. For all three aggregations, the standard deviation of the mean achievement gap across units is about 0.2, suggesting substantial variation across districts, counties, and metropolitan areas. It implies that there are districts where the gaps are reasonably small (less than one-fifth of a standard deviation) and others where they are close to 1 standard deviation.

The average White-Hispanic achievement gap is slightly smaller, ranging from 0.348 to 0.492 standard deviations across the three aggregations. Again, there is substantial variation in these gaps among units, similar in magnitude to that of the Black-White gap (standard deviation of the mean achievement gap is approximately 0.2 at all aggregations).

The average per-grade growth in the White-Black achievement gap between third and eighth grades is small in comparison to the average achievement gap, ranging from nearly zero in the average district to 0.010 standard deviations per grade in the average metropolitan area. The average per-grade growth in the White-Hispanic achievement gap is also small relative to the size of the average gap, though White-Hispanic gaps are narrowing from third to eighth grade in the average district, county, and metropolitan area. Importantly, there is substantial variation in the growth rates of test score gaps (SD of approximately 0.02 for all units). For example, there are districts where the White-Black gap is closing at a rate of 0.04 standard deviations per grade (or closing by 0.2 standard deviations from third to eighth grade); and others where the gap grows at a similar pace. This variation suggests that local factors may

play a role in shaping achievement gaps.

In the average district, county, and metropolitan area, Black students attend schools with more economically disadvantaged peers, more Black students, and more Hispanic students, than do their White counterparts. At the district level, the average Black student's school enrolls 2% more poor students (6% more for counties, 18% more for metropolitan areas), 2% more Black students (6% more for counties, 18% more for metropolitan areas), and 1% more Hispanic students (2% more for counties, 6% more for metropolitan areas) than the average White student's school. A similar pattern is found for Hispanic-White measures of school segregation. These average differences are small, in part because they are not weighted to take into account district size, so that small districts with only one or a few schools (where segregation is generally very low) are given the same weight as large urban districts (where segregation is generally high). School districts, particularly small districts, tend to be more demographically homogenous and have fewer schools than larger geographic units (i.e., counties and metropolitan areas); as a result, both achievement gaps and segregation measures are larger on average in metropolitan areas relative to school districts.

Descriptive Statistics: Panel Model Samples.

Table 2 provides descriptive statistics for the panel models samples. Again, we have six analytic samples corresponding to the three aggregations (district, county, metropolitan area) and two racial group comparisons (White-Black, White-Hispanic). These samples are smaller than those used in the cross-sectional models because the panel model samples are restricted to unit-grade-year observations for which we observe both White and Black/Hispanic achievement and the 1- and 2-year lagged versions of both. Some districts and counties with very small Black or Hispanic populations lack measures of the group's mean achievement in many years and grades, making them unusable in the panel models. The Black-White samples include 214,450 observations from 7,470 districts, 94,840 observations from 2,560 counties, and 17,880 observations from 400 metropolitan areas. The Hispanic-White samples include

247,120 observations from 8,860 districts, 103,030 observations from 2,770 counties, and 18,080 observations from 400 metropolitan areas. In this table we show both the overall standard deviation and the within-unit standard deviation of each measure.[14] Our modeling strategy relies on within-unit variation, so we focus on that here.

[Table 2 about here]

The outcome used in the panel models is the within-cohort and -subject grade-to-grade change in the White-minority achievement gap. For White-Black gaps, the average within-cohort grade-to-grade gap change is near zero (ranging from 0.000 in the average district to 0.009 in the average metropolitan area). The standard deviations of changes in the gap within units (0.004 in districts, 0.023 in counties, and 0.040 in metropolitan areas) indicate that the rate of change in the achievement gap varies across grades and years. For the White-Hispanic gaps, the average within-cohort grade-to-grade gap change is -0.010 in districts, -0.007 in counties, and -0.004 in metropolitan areas. The within-unit standard deviations are generally smaller than Black-White gap changes (0.005 in districts, 0.004 in counties, and 0.024 in metropolitan areas).

The average district, county, and metropolitan area in our panel samples has slightly higher average segregation than those included in our cross-sectional models. However, the same trend is apparent: Black and Hispanic students are exposed to larger proportions of poor and minority schoolmates than their White peers. Again, our modeling strategy relies on the fact that these measures vary within unit. The within-unit standard deviations of the difference in exposure to minorities (Black and Hispanic) and the difference in exposure to poor schoolmates are generally 0.03-0.04 for all geographic

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[14] Because the observed standard deviation of changes in achievement gaps is inflated due to sampling and estimation error in the gap estimates, we estimate the true total and within-unit standard deviations using multilevel precision-weighted random effects models, which allow us to decompose the total variance in observed gap changes into between-unit, within-unit, and measurement error components. For the covariates, we estimate the within-unit standard deviation of each variable by computing the root mean squared error (RMSE) from a regression of the variable on a set of unit fixed effects.

units and racial group comparisons.

Bivariate Associations

The bivariate associations between achievement and the school segregation measures are shown in Table 3. Two patterns are apparent. Differences in exposure to minority schoolmates (racial segregation) are modestly positively associated with both grade 3 gaps and the rate at which the gaps grow in districts, counties, and metropolitan areas. The correlations between Black-White differences in exposure to minority schoolmates and White-Black achievement gaps are 0.33 among school districts, 0.57 among counties, and 0.55 among metropolitan areas. The correlations between Hispanic-White differences in exposure to minority schoolmates and White-Hispanic achievement gaps are slightly higher (0.39 among school districts, 0.53 among counties, and 0.65 among metropolitan areas). Meanwhile, correlations between racial differences in exposure to minority schoolmates and gap growth range from 0.00 to 0.31 across all geographic units and samples, with higher correlations again observed in the Hispanic-White samples (Table 3, Figures 1 and A1). Figure 1 shows the association of both White-Black achievement gaps and the rate at which the gap grows with racial differences in exposure to minority schoolmates (Appendix Figure A1 provides the same plots for White-Hispanic achievement gaps and gap growth).

[Table 3 about here]

[Figure 1 about here]

Differences in exposure to poor schoolmates (racial economic segregation) are even more strongly associated with gaps and similarly associated with growth in the gaps. Correlations with racial achievement gaps range from 0.43 to 0.76 and correlations with average gap growth rates range from 0.11 to 0.41, across the samples. Figure 2 illustrates these associations for White-Black achievement gaps and gap growth (Appendix Figure A2 provides the same plots for White-Hispanic achievement gaps and gap growth). The strong correlation of differences in exposure to poor schoolmates with average gaps is

apparent. In comparison to Figure 1, there is a tighter clustering of the scatter in Figure 2 and a steeper

gradient on differences in exposure to school poverty than on differences in exposure to minority

schoolmates. Notably, there are no places where racial differences in exposure to poor schoolmates is

modest or high and achievement gaps are low.

[Figure 2 about here]

Simply put, places with larger racial differences in exposure to poor and minority schoolmates—

more racial and racial economic school segregation—tend to be places with larger racial achievement

gaps and somewhat larger growth in racial achievement gaps. These bivariate associations suggest that

differences in exposure to poverty may be more important for the development of achievement gaps

than are differences in exposure to minority students. That said, these bivariate associations do not

account for other factors that may shape achievement gaps, a concern we address in the next section.

Importantly, while the two segregation measures are highly correlated (0.86 to 0.91), they are not

identical, especially among school districts (see Figure 3). And while not identical, these correlations

indicate that racial segregation is almost invariably accompanied by racial economic segregation. This

implies that we may not be able to reduce economic segregation substantially without also reducing

racial segregation.

[Figure 3 about here]

Racial Segregation Predicts Achievement Gaps

In the cross-sectional models, racial differences in exposure to minority students are strongly and

positively associated with White-Black and White-Hispanic achievement gaps in grade 3 (Table 4, columns

CB1 and CH1). These associations remain strong even after controlling for racial differences in SES, overall

SES, racial composition, and residential segregation (Table 4, columns CB2 and CH2). In these models, the

estimates imply that, net of racial socioeconomic differences and demographic characteristics, a

difference of 0.10 in district racial school segregation (measured as the Black or Hispanic-White

difference in exposure to minority schoolmates) is associated with a 0.05 or 0.08 SD difference in the

White-Black or White-Hispanic grade 3 achievement gap, respectively. The associations are of similar

magnitude for counties and metropolitan areas. The association between segregation and within-cohort

growth in the White-Black and White-Hispanic gaps is weaker but still evident across aggregations in the

cross-sectional models. Racial segregation is a statistically significant predictor of gap growth, net of the

control variables in CB2 district, county, and metropolitan area models and the CH2 district model.

[Table 4 about here]

The panel models yield larger estimates of the associations between racial school segregation

and growth in the White-Black and White-Hispanic gaps. In models including controls for lagged

achievement gaps, proportions of racial and economic composition, among others (Table 4, columns PB2

and PH2), the estimated coefficients are generally around 0.2. The panel models leverage only within-unit

variation in segregation levels across grades and years, net of unit-grade, unit-subject, and unit-year fixed

effects. As such the resulting estimates have a stronger causal warrant than the estimates from the cross-

sectional models. These coefficients show that White-Black and White-Hispanic achievement gaps grow

more in grades and years when the schools in a district or county are more racially segregated, relative to

the average grade or year. We estimate that a 0.10 increase in the difference in exposure to minority

schoolmates (relative to the average grade or year) would correspond to a 0.021 to 0.026 standard

deviation per year differences in the White-Black and the White-Hispanic gap growth rates, respectively,

within a school district.

Racial Segregation Operates Through Racial Economic Segregation

The next set of models estimate the partial associations of achievement gaps and gap growth

with both racial and racial economic school segregation (Table 5). In these models, racial school

segregation (models CB4 and CH4) is generally no longer positively and significantly associated with the

grade 3 achievement gap. This association is significant in only two of the six cross-sectional models and

positive in only one of those two models. Similarly, racial school segregation is no longer associated with the growth of the achievement gap from grade 3 to 8. In all six cross-sectional and all six panel models, the coefficient on racial segregation is not significantly different than zero.

Black-White and Hispanic-White differences in exposure to school poverty, however, are positively associated with gaps in grade 3 and with the growth of the gaps from grade three to eight, net of racial differences in exposure to minority schoolmates. This is true in all six cross-sectional models and all six panel models, except for the coefficients on gap growth in the metropolitan area cross-sectional models.[15]

Again, the panel models suggest that the association between segregation and rate at which racial achievement gaps increase is larger than indicated by the cross-sectional models (PB4 and PH4). Achievement gaps grow faster in grades and years with larger racial differences in exposure to school poverty. But the growth of the achievement gap is not associated with racial differences in exposure to minority schoolmates once we include racial differences in exposure to school poverty in the model. Note that this is true despite very high correlation (0.88 to 0.94) between differences in exposure to minority and poor schoolmates. Therefore, these models strongly suggest that, while racial segregation plays a role in shaping racial achievement gaps, it does so primarily because it leads to differences in exposure to poor schoolmates.

[Table 5 about here]

How do Observable Differences in School Characteristics Relate to Segregation?

Thus far, our model results suggest that racial segregation predominantly affects racial achievement gaps through differences in exposure to school poverty. Guided by some of our theorized mechanisms, we estimate a series of cross-sectional models to test whether differences in several rough

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[15] In the White-Hispanic metropolitan area cross-sectional models, the coefficient on differences in exposure to poor schoolmates on gap growth is negative, which is driven by several significant outliers (the Chicago and Elgin metropolitan areas, both of which have high racial economic segregation and low rates of gap growth).

indicators of school quality can explain the association between differences in exposure to school poverty and achievement gaps and gap growth.

Table 6 provides correlations among the segregation measures and measures of differences in school resources and peer characteristics. Differences in classmates' average test scores, in exposure to novice school teachers, and in school offerings of gifted programs are all significantly, positively correlated with both Black-White and Hispanic-White gaps in exposure to poor schoolmates and minority schoolmates at all aggregations. Differences in exposure to chronically absent teachers is positively associated with the four segregation measures in the district samples, though these associations are not consistent among the county or metropolitan area samples. This suggests that in places that have higher levels of racial and racial economic segregation, there are larger racial differences in these school quality measures. In contrast, differences in student-teacher ratios are weakly negatively associated with segregation in districts. This pattern does not always hold true for the county or metropolitan area samples. In the county and metropolitan area samples, racial differences in district per pupil expenditures are also negatively associated with segregation. These suggest that class size and funding disparities are smaller in more segregated places, on average. This is likely a result of federal compensatory funding policies, like Title I, that aim to provide additional funds to high poverty districts, and states' efforts to provide more resources for disadvantaged districts (Chingos and Blagg 2017).

[Table 6 about here]

Although there are modest and statistically significant correlations between the measures of differences in school quality and the segregation measures, adding them to the cross-sectional models explains none of the association between racial differences in exposure to poor schoolmates and the size of achievement gaps in third grade. Nor do they explain any of the association between racial differences in exposure to poor schoolmates and the growth of achievement gaps from grade three to eight: the coefficients on racial economic segregation in models CB11 and CH11, which include measures of

differences in school and teacher characteristics, are very similar to those in models CB4 and CH4, which do not include such measures (compare Tables 5 and 7; for more detail, see Appendix Tables A1-A6). Note, however, that the measures we include represent a very limited set of school characteristics, and are at best only rough proxies for differences in school quality, so our analyses do not definitively rule out that differences in school resources contribute to the association between racial economic segregation and achievement gaps.

[Table 7 about here]

That said, one pattern of coefficients in Table 7 is worth noting. In many of the models, one or both measures of differences in teacher characteristics (differences in exposure to novice teachers and to chronically absent teachers) is significantly associated with the growth of the achievement gap. In all three of the models predicting the White-Hispanic achievement gap growth (but not in the White-Black models), differences in exposure to novice teachers are significantly associated with gap growth. In both the White-Black and White-Hispanic district and county models, differences in exposure to chronically absent teachers are significantly associated with gap growth. Together these findings suggest that racial differences in students' exposure to teacher experience and absenteeism (or other teacher characteristics that these measures are proxies for) play a role shaping achievement gaps.

DISCUSSION

At the outset of this paper, we asked: does racial segregation of schools today limit Black and Hispanic students' educational opportunities? Our analyses indicate that the answer, in short, is yes. Using scores from hundreds of millions of state accountability tests taken in the last decade by elementary and middle school students in thousands of school districts, we find a very strong link between racial school segregation and academic achievement gaps. More racially segregated school systems have larger achievement gaps, on average, and their gaps grow faster during elementary and

middle schools than in less segregated school systems. Indeed, every school district in the U.S. where segregation is even moderately high has a large achievement gap.

Notably, the association between racial segregation and achievement gaps appears to operate entirely through racial economic segregation – racial differences in exposure to poor schoolmates. Once we control for racial economic segregation, racial segregation *per se* is no longer predictive of achievement gaps or the growth in the gaps. This implies that high-poverty schools provide, on average, lower educational opportunity than low-poverty schools. Segregation matters, therefore, because it concentrates Black and Hispanic students in high-poverty schools, not because of the racial composition of their schools. To make this concrete, consider the New York City and Fulton County, Georgia school districts, two of the most racially segregated districts in the country. Both districts are equally highly racially segregated: Black students in both attend schools where the average proportion of minority students is more than 50 percentage points higher than in their White peers' schools. But in Fulton County, racial economic segregation is 30 percentage points higher than in New York: The Black-White difference in school poverty rates is 22 percentage points in New York, compared to 52 points in Fulton County. Correspondingly, the White-Black achievement gap is one third of a standard deviation larger in Fulton (1.1 standard deviations) than in New York City (0.77 standard deviations).

Our analyses are less conclusive, however, on the question of *why* the concentration of minority students in high-poverty schools leads to larger achievement gaps. One possibility is that high poverty schools attended by minority students tend to have fewer resources, less experienced and skilled teachers, and less challenging curricula than low-poverty schools. Our analyses show that this is the case. In more segregated school districts, counties, and metropolitan areas, White students are more likely to be concentrated in schools with more experienced teachers and more gifted and talented programs, for example. But while some of these disparities are predictive of the growth of the achievement gap, they explain virtually none of the association between segregation and achievement gaps.

That said, our measures of school resources and teacher skills do not fully capture all aspects of school quality, so we cannot say for sure whether differences in school resources, teacher skills, or curricula are part of the reason why segregation leads to larger achievement gaps. Moreover, even the associations between teacher characteristics and the growth of the achievement gap that we observe are not conclusive with respect to mechanisms. Although racial achievement gaps grow faster in school systems where Black or Hispanic students disproportionately attend schools with novice and chronically absent teachers, that does not necessarily mean that teachers themselves are the source of unequal educational opportunity. The presence of many novice or absent teachers, for example, may be a signal of poor school leadership or of a school culture that does not foster sustained engagement of its teaching staff; these and related aspects of schools' cultures and climates may lead to unequal expectations and opportunities and resulting achievement gaps. Our findings are suggestive that operational school features play a role in the growth of the gaps, but they are not dispositive regarding the exact mechanisms.

A second possibility is that racial economic segregation results in the concentration of minority students in schools where their schoolmates have low prior test scores relative to the schools where more White students are enrolled. This might lead to differences in curricula or instructional rigor, differences in teachers' expectations of students, differences in student motivation, or differences in school norms and academic press (Lee and Smith 1999). We find no evidence that prior test scores of schoolmates explain why the concentration of minority students in high-poverty schools leads to larger achievement gaps. Although segregation is almost always accompanied by large differences in the prior academic performance of minority and White students' schoolmates, these differences are not associated with achievement gaps. So-called "peer effects" do not appear to explain the link between segregation and widening achievement gaps.

In sum, our analyses provide evidence that school segregation is closely linked to racial inequality

in academic performance. This implies that segregation creates unequal educational opportunities. Although our analyses do not identify the specific mechanisms through which segregation leads to educational inequality, they make it clear that it is differences in schools' *poverty rates*, not differences in schools' *racial composition* that matter for academic achievement. Our results suggest that racial segregation would not produce unequal outcomes so long as White and minority students attended schools with equal socioeconomic composition. But such a configuration is not mathematically possible, given the large racial disparities in poverty rates.

The evidence that segregation leads to unequal educational opportunities has important implications for not only education policy and practice, but broader social policies. If America is serious about reducing racial inequality in educational opportunity, then we must systematically reduce racial segregation among schools, which would effectively reduce racial economic segregation as well. But the systematic reduction of racial segregation cannot be left entirely to individual school districts. Roughly two-thirds of school segregation is the result of *between-district residential segregation* patterns (Jang 2021; Owens, Reardon, and Jencks 2016; Reardon, Yun, and Eitle 2000), a dimension of segregation that no form of within-district integration strategy can change. This means that, even if every school district in the country changed its student assignment policies so that all schools in a district had exactly the same racial and economic composition, total racial segregation in the country would be reduced by only one-third. And even eliminating within-district segregation is challenging today, particularly in large, residentially segregated districts like New York City (Shapiro 2021). Although we have effectively reduced within-district segregation in the past with court mandates to end *de jure* school segregation, most court-ordered desegregation plans have been dismissed by the courts in recent decades (Fiel and Zhang 2019; Lutz 2011; Reardon et al. 2012).

But if reducing within-district school segregation is challenging, then reducing between-district segregation through the courts or via educational policy is even more so. Although there is certainly

evidence that federal and state policies and actions have contributed to between-district school segregation (see, for example, Rothstein (2017)), the courts have generally not been willing to allow inter-district desegregation remedies (Holme, Finnigan, and Diem 2016; Siegel-Hawley 2014). State policies to consolidate school districts might help to reduce segregation, by making it possible to combine or integrate schools that had previously been in separate, and demographically different, districts. But recent trends have worked against this possibility: a recent report from EdBuild (2017) listed 47 school districts that seceded since 2000 and 17 districts in on-going secession process; school districts created by secessions were, on average, more affluent and enrolled a higher proportion of White students than the districts from which they seceded, thereby aggravating between-district segregation (Richards 2020).

An alternative response might be to leave schools' racial and socioeconomic composition unchanged and focus resources on improving high-poverty schools. This has been the intent of many school improvement efforts over the last few decades. And while there are examples of highly-effective high-poverty schools, it is not clear we know how to do so systematically in the context of high levels of segregation. As Figure 2 shows, we have no example of a school district where minority students disproportionately attend high poverty schools that does not have a large racial achievement gap. If it were possible to create equal educational opportunity under conditions of segregation and economic inequality, some community—among the thousands of districts in the country—would have done so. None have. Separate is still unequal.

To systematically reduce school segregation, be it racial segregation or racial economic segregation, we will likely need strategies that stretch beyond the courts and the education policy landscape to ensure equality of educational opportunity for all students in K-12 schools across America. A key to systematically reducing racial *school* segregation is reducing racial *residential* segregation, particularly between-district residential segregation. Housing policies are one approach, but such policies are ultimately limited by racial economic inequality. As long as Black and Hispanic families have

dramatically lower wealth and lower average incomes than White families (Wolff 2018), a competitive housing market will lead to high levels of racial segregation (even if there were no discrimination in the housing and lending market and no racial animus among Whites that led some Black and Hispanic families to prefer predominantly non-White communities). As such, reducing racial income and wealth inequality (and economic inequality generally) may be a more effective way to systematically decrease racial *school* segregation (and by proxy, racial economic school segregation) than strategies that focus solely on reducing residential segregation via housing policy. In the end, racial segregation—and the educational inequality it engenders—is likely to be substantially reduced only when racial socioeconomic inequality is substantially eliminated.

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TABLES

Table 1. Means, Standard Deviations and Sample Sizes Used in Cross-Sectional Models

	Districts		Counties		Metropolitan Areas	
	Mean	SD	Mean	SD	Mean	SD
Sample in Models Predicting White-Black Achievement Gaps						
White-Black Gap, Mean Achievement	0.497	0.213	0.512	0.213	0.673	0.199
White-Black Gap, Achievement Growth Across Grades	-0.003	0.020	0.003	0.020	0.013	0.017
Black-White Gap in Exposure to Poor Schoolmates	0.018	0.047	0.063	0.097	0.180	0.116
Black-White Gap in Exposure to Minority (Black+Hispanic) Schoolmates	0.024	0.059	0.089	0.125	0.236	0.164
Black-White Gap in Exposure to Black Schoolmates	0.018	0.055	0.066	0.111	0.177	0.163
Black-White Gap in Exposure to Hispanic Schoolmates	0.005	0.027	0.022	0.051	0.058	0.073
Black-White Differences in Exposure to Poor Neighbors	0.015	0.031	0.036	0.044	0.083	0.048
Black-White Differences in Exposure to Minority Neighbors	0.038	0.071	0.083	0.099	0.189	0.133
Proportion Black	0.105	0.179	0.130	0.199	0.145	0.140
Proportion Hispanic	0.146	0.197	0.126	0.168	0.190	0.198
Standardized EB SES Composite (2007-11 & 2012-16 ACS Average)	0.328	0.892	-0.205	0.695	-0.033	0.479
White-Black Difference in Standardized EB SES Composite (2007-11 & 2012-16 ACS Average)	1.952	0.540	2.361	0.592	2.463	0.740
White-Black Difference in Standardized SES Composite (From 2000 Census)	1.213	1.296	2.053	1.594	3.391	1.717
N, Units	7,800		2,560		390	
N, Observations	1,172,590		452,080		79,770	
Sample in Models Predicting White-Hispanic Achievement Gaps						
White-Hispanic Gap, Mean Achievement	0.348	0.199	0.354	0.207	0.492	0.201
White-Hispanic Gap, Achievement Growth Across Grades	-0.015	0.019	-0.010	0.018	-0.003	0.016
Hispanic-White Gap in Exposure to Poor Schoolmates	0.016	0.045	0.053	0.086	0.155	0.111
Hispanic-White Gap in Exposure to Minority (Black+Hispanic) Schoolmates	0.019	0.048	0.071	0.099	0.190	0.129
Hispanic-White Gap in Exposure to Black Schoolmates	0.005	0.024	0.024	0.052	0.066	0.069
Hispanic-White Gap in Exposure to Hispanic Schoolmates	0.014	0.039	0.048	0.077	0.124	0.114
Hispanic-White Differences in Exposure to Poor Neighbors	0.010	0.022	0.022	0.031	0.056	0.036
Hispanic-White Differences in Exposure to Minority Neighbors	0.023	0.044	0.053	0.063	0.123	0.078
Proportion Black	0.085	0.162	0.117	0.188	0.145	0.140
Proportion Hispanic	0.149	0.200	0.130	0.174	0.190	0.198
Standardized EB SES Composite (2007-11 & 2012-16 ACS Average)	0.358	0.852	-0.175	0.687	-0.033	0.479
White-Hispanic Difference in Standardized EB SES Composite (2007-11 & 2012-16 ACS Average	1.102	0.285	1.302	0.348	1.435	0.522
White-Hispanic Difference in Standardized SES Composite (From 2000 Census)	0.823	1.205	1.286	1.550	2.407	1.384
N, Units	9,390		2,780		390	
N, Observations	1,549,090		524,790		80,330	

NOTE: Sample sizes are rounded to the nearest 10, per IES disclosure requirements. Summary statistics are calculated using one observation per unit (district, county, metropolitan area).

SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations; U.S. Department of Commerce, Bureau of the Census, American Community Survey (ACS), survey years 2005-09 through 2014-18, authors' calculations; U.S. Department of Education, National Center for Education Statistics, The NCES Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," survey years 2008-09 through 2017-18, authors' calculations.

Table 2. Means, Standard Deviations and Sample Sizes Used in Panel Models

	Districts			Counties			Metropolitan Areas		
	Mean	Overall SD	Within Unit SD	Mean	Overall SD	Within Unit SD	Mean	Overall SD	Within Unit SD
Sample in Models Predicting White-Black Achievement Gaps									
Change in Achievement Gap Relative to Prior Year	0.000	0.011	0.004	0.005	0.028	0.023	0.009	0.043	0.040
Black-White Gap in Exposure to Poor Schoolmates	0.023	0.060	0.029	0.072	0.110	0.041	0.179	0.122	0.039
Black-White Gap in Exposure to Minority (Black+Hispanic) Schoolmates	0.030	0.073	0.029	0.104	0.136	0.036	0.243	0.167	0.031
Black-White Gap in Exposure to Black Schoolmates	0.025	0.070	0.024	0.081	0.123	0.028	0.189	0.167	0.026
Black-White Gap in Exposure to Hispanic Schoolmates	0.006	0.033	0.016	0.023	0.055	0.021	0.054	0.075	0.017
Proportion Black	0.147	0.191	0.017	0.161	0.199	0.014	0.167	0.150	0.010
Proportion Hispanic	0.149	0.186	0.022	0.119	0.153	0.018	0.171	0.186	0.017
Proportion Economically Disadvantaged	0.501	0.232	0.049	0.563	0.169	0.047	0.525	0.126	0.037
Average School Size	39.9	15.2	4.2	33.6	13.1	3.1	38.8	9.4	1.9
N, Units		7,470			2,560			400	
N, Observations		214,450			94,840			17,880	
Sample in Models Predicting White-Hispanic Achievement Gaps									
Change in Achievement Gap Relative to Prior Year	-0.010	0.011	0.005	-0.007	0.015	0.004	-0.004	0.028	0.024
Hispanic-White Gap in Exposure to Poor Schoolmates	0.020	0.055	0.027	0.057	0.094	0.035	0.144	0.114	0.036
Hispanic-White Gap in Exposure to Minority (Black+Hispanic) Schoolmates	0.023	0.059	0.027	0.077	0.106	0.034	0.181	0.131	0.030
Hispanic-White Gap in Exposure to Black Schoolmates	0.007	0.033	0.018	0.028	0.060	0.026	0.070	0.071	0.018
Hispanic-White Gap in Exposure to Hispanic Schoolmates	0.016	0.046	0.020	0.049	0.079	0.021	0.111	0.112	0.023
Proportion Black	0.114	0.169	0.015	0.130	0.180	0.012	0.160	0.146	0.010
Proportion Hispanic	0.163	0.196	0.023	0.130	0.163	0.018	0.176	0.190	0.017
Proportion Economically Disadvantaged	0.489	0.226	0.047	0.551	0.164	0.046	0.523	0.128	0.037
Average School Size	38.4	15.4	4.1	32.3	13.4	3.0	38.8	9.5	1.9
N, Units		8,860			2,770			400	
N, Observations		247,120			103,030			18,080	

NOTE: Sample sizes are rounded to the nearest 10, per IES disclosure requirements. Summary statistics are calculated using all observations for all units (district, county, metropolitan area).

SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations; U.S. Department of Education, National Center for Education Statistics, The NCES Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," survey years 2008-09 through 2017-18, authors' calculations.

Table 3. Correlations Among Achievement Gap Measures and Segregation Measures

Districts

	Average Test Score Gap	Gap Growth Rate	Difference in Exposure to Minority Schoolmates	Difference in Exposure to Poor Schoolmates
Average Test Score Gap		-0.182	0.389	0.447
Gap Growth Rate	-0.072		0.330	0.331
Difference in Exposure to Minority Schoolmates	0.330	0.289		0.914
Difference in Exposure to Poor Schoolmates	0.425	0.383	0.863	

Counties

	Average Test Score Gap	Gap Growth Rate	Difference in Exposure to Minority Schoolmates	Difference in Exposure to Poor Schoolmates
Average Test Score Gap		-0.076	0.534	0.617
Gap Growth Rate	0.037		0.365	0.411
Difference in Exposure to Minority Schoolmates	0.574	0.305		0.891
Difference in Exposure to Poor Schoolmates	0.663	0.384	0.875	

Metropolitan Areas

	Average Test Score Gap	Gap Growth Rate	Difference in Exposure to Minority Schoolmates	Difference in Exposure to Poor Schoolmates
Average Test Score Gap		-0.092	0.647	0.755
Gap Growth Rate	-0.032		0.298	0.291
Difference in Exposure to Minority Schoolmates	0.551	0.000		0.912
Difference in Exposure to Poor Schoolmates	0.684	0.107	0.879	

NOTE: In each panel, White-Black correlations are shown below the diagonal; White-Hispanic correlations are above the diagonal.
SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations.

Table 4. Achievement Gaps and Differences in Exposure to Minority Schoolmates

	White-Black Gap Models				White-Hispanic Gap Models			
	Cross-Sectional Models		Panel Models		Cross-Sectional Models		Panel Models	
	CB1	CB2	PB1	PB2	CH1	CH2	PH1	PH2
Districts								
Coefficients on Grade 3 Gap								
Minority-White Difference in Exposure to Minority Schoolmates	1.101 ***	0.507 ***			1.397 ***	0.785 ***		
	(0.042)	(0.047)			(0.044)	(0.051)		
Coefficients on Growth of Gap								
Minority-White Difference in Exposure to Minority Schoolmates	0.071 ***	0.027 ***	0.036	0.210 ***	0.085 ***	0.030 ***	0.086 **	0.262 ***
	(0.006)	(0.008)	(0.032)	(0.027)	(0.006)	(0.008)	(0.032)	(0.027)
N (Districts)	7,800	7,800	7,160	7,160	9,390	9,390	8,760	8,760
Counties								
Coefficients on Grade 3 Gap								
Minority-White Difference in Exposure to Minority Schoolmates	0.920 ***	0.428 ***			0.992 ***	0.581 ***		
	(0.029)	(0.044)			(0.035)	(0.055)		
Coefficients on Growth of Gap								
Minority-White Difference in Exposure to Minority Schoolmates	0.046 ***	0.029 ***	0.113 ***	0.258 ***	0.055 ***	0.013	0.042	0.213 ***
	(0.004)	(0.008)	(0.032)	(0.027)	(0.005)	(0.009)	(0.031)	(0.026)
N (Counties)	2,560	2,560	2,510	2,510	2,780	2,780	2,790	2,790
Metropolitan Areas								
Coefficients on Grade 3 Gap								
Minority-White Difference in Exposure to Minority Schoolmates	0.693 ***	0.329 ***			0.960 ***	0.908 ***		
	(0.049)	(0.093)			(0.062)	(0.111)		
Coefficients on Growth of Gap								
Minority-White Difference in Exposure to Minority Schoolmates	0.008	0.053 ***	0.081	0.261 ***	0.038 ***	0.005	0.042	0.209 ***
	(0.006)	(0.015)	(0.064)	(0.054)	(0.007)	(0.016)	(0.056)	(0.048)
N (Metropolitan Areas)	390	390	400	400	390	390	400	400
Controls Included?	-	X	-	X	-	X	-	X

* p<.05; ** p<.01; *** p<.001

NOTE: All models also include measures of grade (centered on grade 3), cohort (centered on 2008) and math (centered on .5). Control variables in cross-sectional models include overall standardized SES composite, Black-White or Hispanic-White difference in exposure to minority neighbors, White-Black or White-Hispanic difference in SES, proportion Black, and proportion Hispanic. Control variables in panel models include: 1- and 2-year lags of the gaps, proportion Black, proportion Hispanic, proportion economically disadvantaged, and average school size. Sample sizes are rounded to the nearest 10, per IES disclosure requirements.

SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations; U.S. Department of Commerce, Bureau of the Census, American Community Survey (ACS), survey years 2005-09 through 2014-18, authors' calculations; U.S. Department of Education, National Center for Education Statistics, The NCES Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," survey years 2008-09 through 2017-18, authors' calculations.

Table 5. Achievement Gaps and Differences in Exposure to Poor Schoolmates

	White-Black Gap Models						White-Hispanic Gap Models					
	Cross-Sectional Models			Panel Models			Cross-Sectional Models			Panel Models		
	CB2	CB3	CB4	PB2	PB3	PB4	CH2	CH3	CH4	PH2	PH3	PH4
Districts												
Coefficients on Grade 3 Gap												
Minority-White Difference in Exposure to	0.507 ***		-0.243 **				0.785 ***		-0.048			
Minority Schoolmates	(0.047)		(0.077)				(0.051)		(0.101)			
Minority-White Difference in Exposure to		0.965 ***	1.103 ***					1.065 ***	1.022 ***			
Poor Schoolmates		(0.053)	(0.093)					(0.050)	(0.107)			
Coefficients on Growth of Gap												
Minority-White Difference in Exposure to	0.027 ***		-0.019	0.210 ***		-0.037	0.030 ***		-0.003	0.262 ***		0.044
Minority Schoolmates	(0.008)		(0.013)	(0.027)		(0.036)	(0.008)		(0.017)	(0.027)		(0.037)
Minority-White Difference in Exposure to		0.042 ***	0.066 ***		0.340 ***	0.364 ***		0.043 ***	0.037 *		0.329 ***	0.300 ***
Poor Schoolmates		(0.009)	(0.016)		(0.026)	(0.035)		(0.008)	(0.018)		(0.025)	(0.035)
N (Districts)		7,800			7,160			9,390			8,760	
Counties												
Coefficients on Grade 3 Gap												
Minority-White Difference in Exposure to	0.428 ***		0.020				0.581 ***		0.073			
Minority Schoolmates	(0.044)		(0.061)				(0.055)		(0.079)			
Minority-White Difference in Exposure to		0.708 ***	0.639 ***					0.771 ***	0.750 ***			
Poor Schoolmates		(0.046)	(0.073)					(0.054)	(0.088)			
Coefficients on Growth of Gap												
Minority-White Difference in Exposure to	0.029 ***		-0.004	0.258 ***		-0.020	0.013		-0.021	0.213 ***		0.007
Minority Schoolmates	(0.008)		(0.011)	(0.027)		(0.034)	(0.009)		(0.014)	(0.026)		(0.033)
Minority-White Difference in Exposure to		0.035 ***	0.046 ***		0.428 ***	0.440 ***		0.036 ***	0.046 **		0.330 ***	0.326 ***
Poor Schoolmates		(0.008)	(0.013)		(0.027)	(0.034)		(0.009)	(0.015)		(0.025)	(0.032)
N (Counties)		2,560			2,510			2,780			2,790	
Metropolitan Areas												
Coefficients on Grade 3 Gap												
Minority-White Difference in Exposure to	0.329 ***		-0.022				0.908 ***		0.348 *			
Minority Schoolmates	(0.093)		(0.120)				(0.111)		(0.166)			
Minority-White Difference in Exposure to		0.411 ***	0.541 ***					0.772 ***	0.708 ***			
Poor Schoolmates		(0.090)	(0.128)					(0.106)	(0.168)			
Coefficients on Growth of Gap												
Minority-White Difference in Exposure to	0.053 ***		0.036	0.261 ***		-0.021	0.005		0.042	0.209 ***		-0.017
Minority Schoolmates	(0.015)		(0.020)	(0.054)		(0.072)	(0.016)		(0.024)	(0.048)		(0.065)
Minority-White Difference in Exposure to		0.028	0.026		0.397 ***	0.410 ***		-0.016	-0.053 *		0.319 ***	0.330 ***
Poor Schoolmates		(0.016)	(0.022)		(0.051)	(0.068)		(0.015)	(0.025)		(0.047)	(0.064)
N (Metropolitan Areas)		390			400			390			400	
Controls Included?	X	X	X	X	X	X	X	X	X	X	X	X

* p<.05; ** p<.01; *** p<.001

NOTE: All models also include measures of grade (centered on grade 3), cohort (centered on 2008) and math (centered on .5). Control variables in cross-sectional models include overall standardized SES composite, Black-White or Hispanic-White difference in exposure to minority neighbors and poor neighbors, White-Black or White-Hispanic difference in SES, proportion Black, and proportion Hispanic. Control variables in panel models include: 1- and 2-year lags of the gaps, proportion Black, proportion Hispanic, proportion economically disadvantaged, and average school size. Sample sizes are rounded to the nearest 10, per IES disclosure requirements.

SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations; U.S. Department of Commerce, Bureau of the Census, American Community Survey (ACS), survey years 2005-09 through 2014-18, authors' calculations; U.S. Department of Education, National Center for Education Statistics, The NCES Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," survey years 2008-09 through 2017-18, authors' calculations.

Table 6. Correlations between Segregation and School Quality Measures

	Black-White Gap in Exposure to ECD Students	Black-White Gap in Exposure to Minority Students	Hispanic-White Gap in Exposure to ECD Students	Hispanic-White Gap in Exposure to Minority Students
Districts				
Minority-White Difference in Exposure to Poor Schoolmates	1.000 ***	0.863 ***	1.000 ***	0.914 ***
Minority-White Difference in Exposure to Minority Schoolmates	0.863 ***	1.000 ***	0.914 ***	1.000 ***
Minority-White Difference in Exposure to Black Schoolmates	0.684 ***	0.890 ***	0.400 ***	0.582 ***
Minority-White Difference in Exposure to Hispanic Schoolmates	0.485 ***	0.363 ***	0.875 ***	0.870 ***
White-Minority Difference in Classmates' Average Test Scores	0.859 ***	0.801 ***	0.887 ***	0.842 ***
Minority-White Difference in Exposure to Novice Teachers	0.343 ***	0.353 ***	0.266 ***	0.286 ***
Minority-White Difference in Exposure to Chronically Absent Teachers	0.121 ***	0.124 ***	0.100 ***	0.107 ***
Minority-White Difference in Schools' Student/Teacher Ratios	-0.228 ***	-0.198 ***	-0.157 ***	-0.141 ***
White-Minority Difference in Schools' Offerings of Gifted Programs	0.152 ***	0.166 ***	0.105 ***	0.099 ***
Counties				
Minority-White Difference in Exposure to Poor Schoolmates	1.000 ***	0.875 ***	1.000 ***	0.891 ***
Minority-White Difference in Exposure to Minority Schoolmates	0.875 ***	1.000 ***	0.891 ***	1.000 ***
Minority-White Difference in Exposure to Black Schoolmates	0.762 ***	0.914 ***	0.505 ***	0.644 ***
Minority-White Difference in Exposure to Hispanic Schoolmates	0.491 ***	0.466 ***	0.810 ***	0.857 ***
White-Minority Difference in Classmates' Average Test Scores	0.880 ***	0.822 ***	0.861 ***	0.784 ***
Minority-White Difference in Exposure to Novice Teachers	0.429 ***	0.459 ***	0.348 ***	0.388 ***
Minority-White Difference in Exposure to Chronically Absent Teachers	0.046 *	0.030	0.063 **	0.064 **
Minority-White Difference in Schools' Student/Teacher Ratios	-0.035	-0.048 *	-0.010	-0.022
White-Minority Difference in Schools' Offerings of Gifted Programs	0.161 ***	0.170 ***	0.168 ***	0.169 ***
White-Minority Difference in Log of Districts' Per Pupil Expenditures	-0.240 ***	-0.265 ***	-0.138 ***	-0.107 ***
Metros				
Minority-White Difference in Exposure to Poor Schoolmates	1.000 ***	0.879 ***	1.000 ***	0.912 ***
Minority-White Difference in Exposure to Minority Schoolmates	0.879 ***	1.000 ***	0.912 ***	1.000 ***
Minority-White Difference in Exposure to Black Schoolmates	0.740 ***	0.899 ***	0.282 ***	0.476 ***
Minority-White Difference in Exposure to Hispanic Schoolmates	0.320 ***	0.235 ***	0.864 ***	0.847 ***
White-Minority Difference in Classmates' Average Test Scores	0.916 ***	0.853 ***	0.923 ***	0.875 ***
Minority-White Difference in Exposure to Novice Teachers	0.521 ***	0.535 ***	0.385 ***	0.435 ***
Minority-White Difference in Exposure to Chronically Absent Teachers	-0.067	-0.136 **	0.036	0.018
Minority-White Difference in Schools' Student/Teacher Ratios	-0.011	0.029	0.153 **	0.171 **
White-Minority Difference in Schools' Offerings of Gifted Programs	0.282 ***	0.292 ***	0.215 ***	0.228 ***
White-Minority Difference in Log of Districts' Per Pupil Expenditures	-0.437 ***	-0.495 ***	-0.166 ***	-0.244 ***

* p<.05; ** p<.01; *** p<.001.

SOURCE: U.S. Department of Education, National Center for Education Statistics, EDFacts Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations; U.S. Department of Commerce, Bureau of the Census, American Community Survey (ACS), survey years 2005-09 through 2014-18, authors' calculations; U.S. Department of Education, National Center for Education Statistics, The NCES Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," survey years 2008-09 through 2017-18, authors' calculations.

Table 7. Achievement Gaps and School Resource Disparities

	White-Black Gap Models			White-Hispanic Gap Models		
	CB11			CH11		
	Districts	Counties	Metros	Districts	Counties	Metros
Coefficients on Grade 3 Gap						
Minority-White Difference in Exposure	-0.252 **	-0.002	-0.048	-0.021	0.111	0.384 *
to Minority Schoolmates	(0.078)	(0.062)	(0.121)	(0.101)	(0.080)	(0.169)
Minority-White Difference in Exposure	1.093 ***	0.627 ***	0.438 ***	1.017 ***	0.753 ***	0.708 ***
to Poor Schoolmates	(0.094)	(0.073)	(0.129)	(0.107)	(0.088)	(0.169)
Minority-White Difference in Exposure	0.174	0.236	0.390	-0.331 *	-0.372 **	-0.346
to Novice Teachers	(0.190)	(0.131)	(0.232)	(0.152)	(0.121)	(0.241)
Minority-White Difference in Exposure	0.137	-0.009	0.213	-0.147	-0.069	-0.029
to Chronically Absent Teachers	(0.137)	(0.074)	(0.120)	(0.116)	(0.070)	(0.128)
White-Minority Difference in Schools'	-0.003	-0.019	0.036	-0.019	-0.016	-0.011
Offerings of Gifted Programs	(0.079)	(0.034)	(0.047)	(0.082)	(0.045)	(0.071)
Minority-White Difference in Schools'	0.001	-0.000	-0.012 **	-0.004 *	-0.000	-0.004
Student/Teacher Ratios	(0.002)	(0.001)	(0.004)	(0.002)	(0.001)	(0.004)
White-Minority Difference in Log of		-0.064	-0.233 *		-0.038	0.015
Districts' Per Pupil Expenditures		(0.055)	(0.097)		(0.065)	(0.122)
Coefficients on Growth of Gap						
Minority-White Difference in Exposure	-0.024	-0.001	0.025	-0.005	-0.029 *	0.032
to Minority Schoolmates	(0.014)	(0.011)	(0.022)	(0.017)	(0.014)	(0.025)
Minority-White Difference in Exposure	0.071 ***	0.075 ***	0.001	0.043 *	0.036 *	-0.069 *
to Poor Schoolmates	(0.019)	(0.016)	(0.026)	(0.020)	(0.017)	(0.028)
Minority-White Difference in Exposure	0.057	-0.009	-0.006	0.052 *	0.063 **	0.072 *
to Novice Teachers	(0.038)	(0.024)	(0.041)	(0.027)	(0.021)	(0.035)
Minority-White Difference in Exposure	0.062 *	0.046 ***	0.012	0.048 *	0.029 *	0.014
to Chronically Absent Teachers	(0.027)	(0.014)	(0.021)	(0.021)	(0.012)	(0.019)
White-Minority Difference in Schools'	0.003	-0.019 **	-0.005	0.011	-0.005	-0.007
Offerings of Gifted Programs	(0.015)	(0.006)	(0.008)	(0.014)	(0.008)	(0.011)
Minority-White Difference in Schools'	-0.001	-0.000	0.001	0.000	0.000	0.001
Student/Teacher Ratios	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
White-Minority Difference in Districts'		-0.011	-0.020		-0.003	0.007
Per Pupil Expenditures		(0.011)	(0.017)		(0.011)	(0.018)
White-Minority Difference in	-0.008	-0.022 **	0.027 *	-0.006	0.008	0.015
Classmates' Average Test Scores	(0.008)	(0.007)	(0.012)	(0.008)	(0.007)	(0.011)
N (Units)	7,800	2,560	390	9,390	2,780	390

* p<.05; ** p<.01; *** p<.001.

NOTE: All models also include measures of grade (centered on grade 3), cohort (centered on 2008) and math (centered on .5). Control variables in cross-sectional models include overall standardized SES composite, Black-White or Hispanic-White difference in exposure to minority neighbors and poor neighbors, White-Black or White-Hispanic difference in SES, proportion Black, and proportion Hispanic. Sample sizes are rounded to the nearest 10, per IES disclosure requirements.

SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations; U.S. Department of Commerce, Bureau of the Census, American Community Survey (ACS), authors' calculations; U.S. Department of Education, Office of Civil Rights, Civil Rights Data Collection (CRDC), survey years 2009-10, 2011-12, 2013-14, 2015-16, 2017-18, authors' calculations; U.S. Department of Education, National Center for Education Statistics, The NCES Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," survey years 2008-09 through 2017-18, authors' calculations.

FIGURES

Figure 1. Association between Differences in Exposure to Minority Schoolmates and Achievement Gaps and Gap Growth Rates, White-Black Gaps
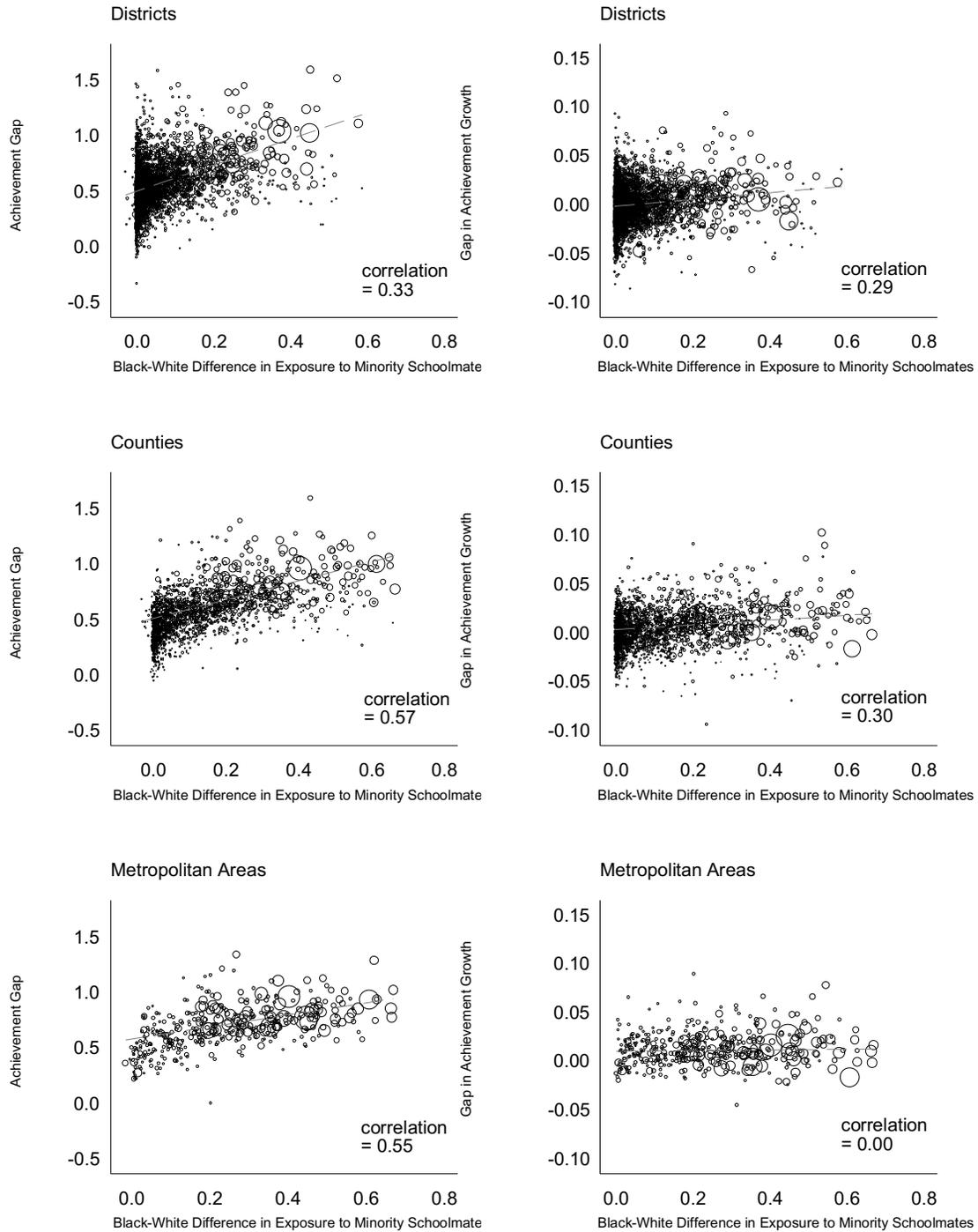
Figure 2. Association between Differences in Exposure to Poor Schoolmates and Achievement Gaps and Gap Growth Rates, White-Black Gaps
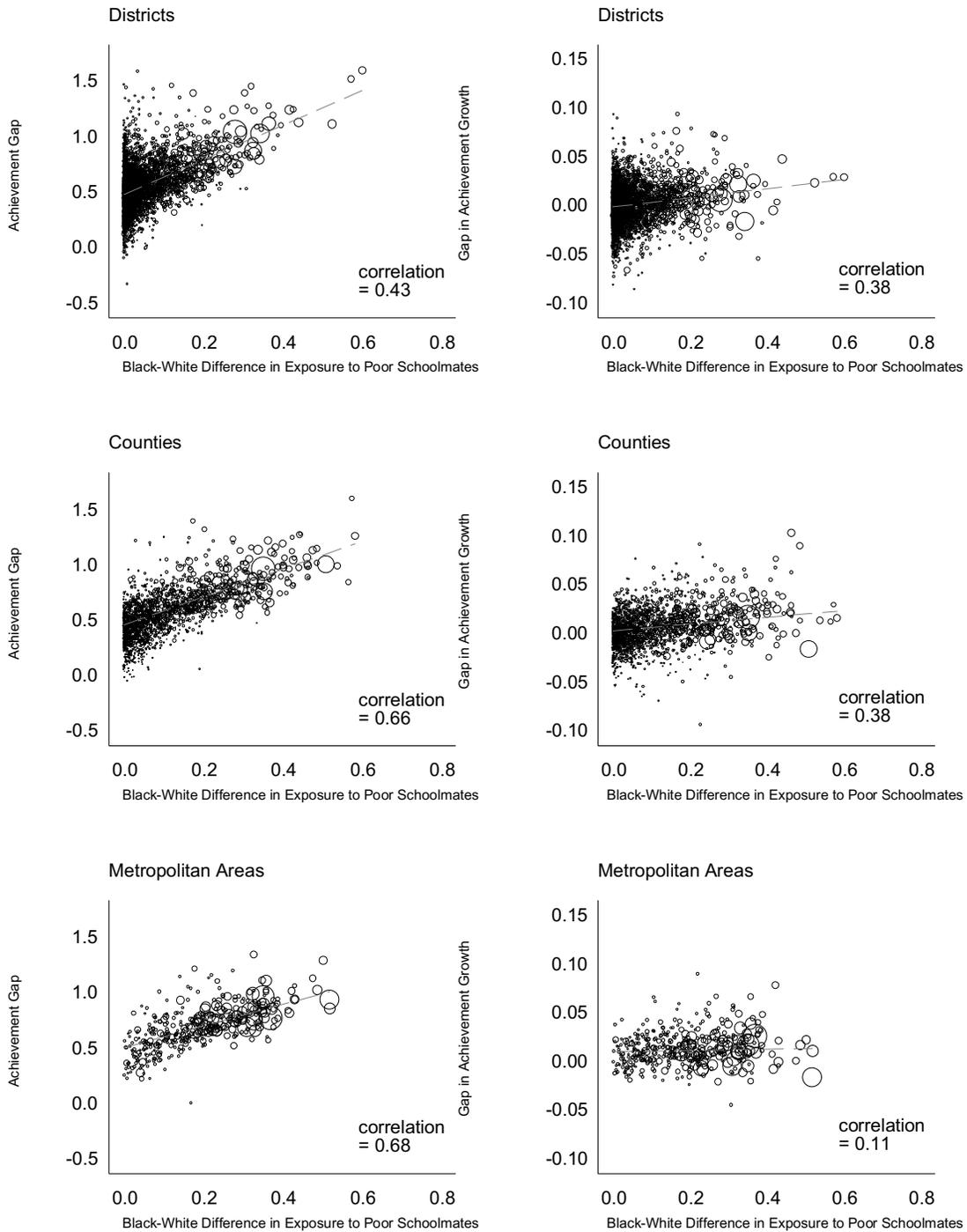
SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations.

Figure 3. Association between Racial Segregation and Differences in Exposure to Poor Schoolmates

SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations.

Table A1. White-Black School Resource Disparities and Achievement Gaps, Districts

	CB4	CB5	CB6	CB7	CB8	CB9	CB11
Coefficients on Grade 3 Gap							
Minority-White Difference in Exposure to Minority Schoolmates	-0.243 **	-0.246 **	-0.245 **	-0.243 **	-0.242 **	-0.241 **	-0.252 **
	(0.077)	(0.078)	(0.077)	(0.077)	(0.077)	(0.077)	(0.078)
Minority-White Difference in Exposure to Poor Schoolmates	1.103 ***	1.100 ***	1.102 ***	1.103 ***	1.106 ***	1.101 ***	1.093 ***
	(0.093)	(0.094)	(0.093)	(0.093)	(0.094)	(0.093)	(0.094)
Minority-White Difference in Exposure to Novice Teachers		0.065					0.174
		(0.176)					(0.190)
Minority-White Difference in Exposure to Chronically Absent Teachers			0.060				0.137
			(0.126)				(0.137)
White-Minority Difference in Schools' Offerings of Gifted Programs				-0.005			-0.003
				(0.078)			(0.079)
Minority-White Difference in Schools' Student/Teacher Ratios					0.001		0.001
					(0.002)		(0.002)
Coefficients on Growth of Gap							
Minority-White Difference in Exposure to Minority Schoolmates	-0.019	-0.021	-0.020	-0.019	-0.020	-0.019	-0.024
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)
Minority-White Difference in Exposure to Poor Schoolmates	0.066 ***	0.065 ***	0.065 ***	0.066 ***	0.064 ***	0.071 ***	0.071 ***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.019)	(0.019)
Minority-White Difference in Exposure to Novice Teachers		0.030					0.057
		(0.037)					(0.038)
Minority-White Difference in Exposure to Chronically Absent Teachers			0.051 *				0.062 *
			(0.025)				(0.027)
White-Minority Difference in Schools' Offerings of Gifted Programs				0.000			0.003
				(0.015)			(0.015)
Minority-White Difference in Schools' Student/Teacher Ratios					-0.001		-0.001
					(0.000)		(0.000)
White-Minority Difference in Classmates' Average Test Scores						-0.004	-0.008
						(0.008)	(0.008)
N (Districts)	7,800	7,800	7,800	7,800	7,800	7,800	7,800
Controls Included?	X	X	X	X	X	X	X

* p<.05; ** p<.01; *** p<.001.

NOTE: All models also include measures of grade (centered on grade 3), cohort (centered on 2008) and math (centered on .5). Control variables in cross-sectional models include overall standardized SES composite, Black-White or Hispanic-White difference in exposure to minority neighbors and poor neighbors, White-Black or White-Hispanic difference in SES, proportion Black, and proportion Hispanic. Sample sizes are rounded to the nearest 10, per IES disclosure requirements.

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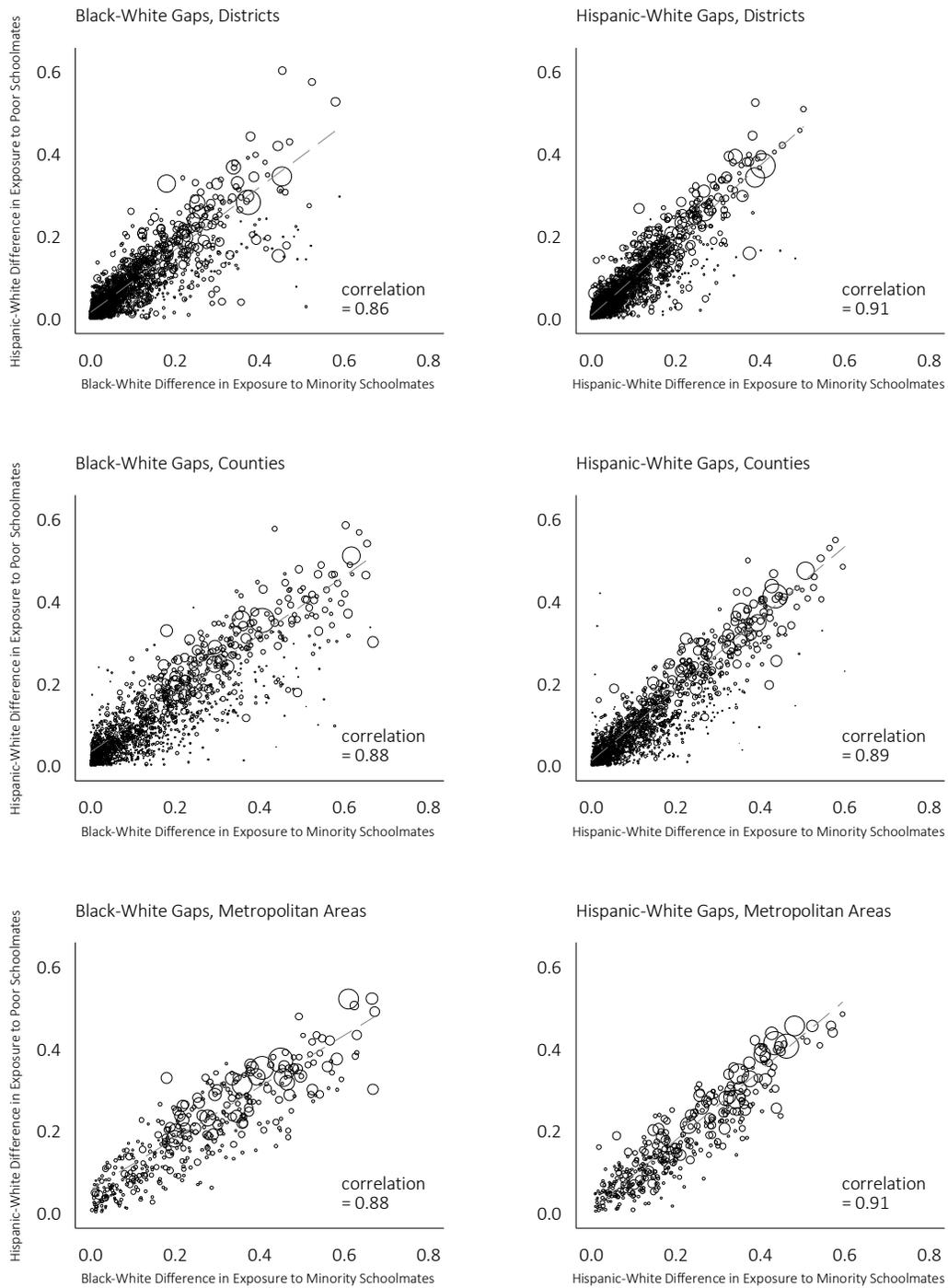
Table A2. White-Black School Resource Disparities and Achievement Gaps, Counties

	CB4	CB5	CB6	CB7	CB8	CB9	CB10	CB11
Coefficients on Grade 3 Gap								
Minority-White Difference in Exposure to Minority Schoolmates	0.020	0.001	0.020	0.021	0.019	0.014	0.024	-0.002
	(0.061)	(0.062)	(0.061)	(0.061)	(0.061)	(0.062)	(0.061)	(0.062)
Minority-White Difference in Exposure to Poor Schoolmates	0.639 ***	0.631 ***	0.637 ***	0.641 ***	0.638 ***	0.636 ***	0.637 ***	0.627 ***
	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)	(0.073)
Minority-White Difference in Exposure to Novice Teachers		0.228						0.236
		(0.131)						(0.131)
Minority-White Difference in Exposure to Chronically Absent Teachers			-0.022					-0.009
			(0.074)					(0.074)
White-Minority Difference in Schools' Offerings of Gifted Programs				-0.018				-0.019
				(0.034)				(0.034)
Minority-White Difference in Schools' Student/Teacher Ratios					-0.000			-0.000
					(0.001)			(0.001)
White-Minority Difference in Log of Districts' Per Pupil Expenditures						-0.063		-0.064
						(0.055)		(0.055)
Coefficients on Growth of Gap								
Minority-White Difference in Exposure to Minority Schoolmates	-0.004	-0.002	-0.004	-0.003	-0.004	-0.006	-0.001	-0.001
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Minority-White Difference in Exposure to Poor Schoolmates	0.046 ***	0.047 ***	0.047 ***	0.048 ***	0.046 ***	0.046 ***	0.074 ***	0.075 ***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.016)	(0.016)
Minority-White Difference in Exposure to Novice Teachers		-0.028						-0.009
		(0.024)						(0.024)
Minority-White Difference in Exposure to Chronically Absent Teachers			0.045 **					0.046 ***
			(0.014)					(0.014)
White-Minority Difference in Schools' Offerings of Gifted Programs				-0.022 ***				-0.019 **
				(0.006)				(0.006)
Minority-White Difference in Schools' Student/Teacher Ratios					-0.000			-0.000
					(0.000)			(0.000)
White-Minority Difference in Log of Districts' Per Pupil Expenditures						-0.014		-0.011
						(0.011)		(0.011)
White-Minority Difference in Classmates' Average Test Scores							-0.024 **	-0.022 **
							(0.007)	(0.007)
N (Counties)	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560
Controls Included?	X	X	X	X	X	X	X	X

* p<.05; ** p<.01; *** p<.001.

NOTE: All models also include measures of grade (centered on grade 3), cohort (centered on 2008) and math (centered on .5). Control variables in cross-sectional models include overall standardized SES composite, Black-White or Hispanic-White difference in exposure to minority neighbors and poor neighbors, White-Black or White-Hispanic difference in SES, proportion Black, and proportion Hispanic. Sample sizes are rounded to the nearest 10, per IES disclosure requirements.

SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations; U.S. Department of Commerce, Bureau of the Census, American Community Survey (ACS), authors' calculations; U.S. Department of Education, Office of Civil Rights, Civil Rights Data Collection (CRDC), survey years 2009-10, 2011-12, 2013-14, 2015-16, 2017-18, authors' calculations; U.S. Department of Education, National Center for Education Statistics, The NCES Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," survey years 2008-09 through 2017-18, authors' calculations.

Table A3. White-Black School Resource Disparities and Achievement Gaps, Metropolitan Areas

	CB4	CB5	CB6	CB7	CB8	CB9	CB10	CB11
Coefficients on Grade 3 Gap								
Minority-White Difference in Exposure to Minority Schoolmates	-0.022	-0.052	-0.020	-0.015	0.018	-0.071	-0.022	-0.048
	(0.120)	(0.121)	(0.119)	(0.121)	(0.119)	(0.120)	(0.120)	(0.121)
Minority-White Difference in Exposure to Poor Schoolmates	0.541 ***	0.524 ***	0.538 ***	0.529 ***	0.492 ***	0.516 ***	0.540 ***	0.438 ***
	(0.128)	(0.129)	(0.128)	(0.130)	(0.128)	(0.128)	(0.128)	(0.129)
Minority-White Difference in Exposure to Novice Teachers		0.363						0.390
		(0.237)						(0.232)
Minority-White Difference in Exposure to Chronically Absent Teachers			0.194					0.213
			(0.122)					(0.120)
White-Minority Difference in Schools' Offerings of Gifted Programs				0.024				0.036
				(0.048)				(0.047)
Minority-White Difference in Schools' Student/Teacher Ratios					-0.013 **			-0.012 **
					(0.004)			(0.004)
White-Minority Difference in Log of Districts' Per Pupil Expenditures						-0.261 **		-0.233 *
						(0.098)		(0.097)
Coefficients on Growth of Gap								
Minority-White Difference in Exposure to Minority Schoolmates	0.036	0.036	0.036	0.035	0.034	0.033	0.033	0.025
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.021)	(0.022)
Minority-White Difference in Exposure to Poor Schoolmates	0.026	0.026	0.026	0.028	0.029	0.024	0.002	0.001
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.026)	(0.026)
Minority-White Difference in Exposure to Novice Teachers		0.000						-0.006
		(0.040)						(0.041)
Minority-White Difference in Exposure to Chronically Absent Teachers			0.016					0.012
			(0.021)					(0.021)
White-Minority Difference in Schools' Offerings of Gifted Programs				-0.003				-0.005
				(0.008)				(0.008)
Minority-White Difference in Schools' Student/Teacher Ratios					0.001			0.001
					(0.001)			(0.001)
White-Minority Difference in Log of Districts' Per Pupil Expenditures						-0.016		-0.020
						(0.017)		(0.017)
White-Minority Difference in Classmates' Average Test Scores							0.023	0.027 *
							(0.012)	(0.012)
N (Metropolitan Areas)	390	390	390	390	390	390	390	390
Controls Included?	X	X	X	X	X	X	X	X

* p<.05; ** p<.01; *** p<.001.

NOTE: All models also include measures of grade (centered on grade 3), cohort (centered on 2008) and math (centered on .5). Control variables in cross-sectional models include overall standardized SES composite, Black-White or Hispanic-White difference in exposure to minority neighbors and poor neighbors, White-Black or White-Hispanic difference in SES, proportion Black, and proportion Hispanic. Sample sizes are rounded to the nearest 10, per IES disclosure requirements.

SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations; U.S. Department of Commerce, Bureau of the Census, American Community Survey (ACS), authors' calculations; U.S. Department of Education, Office of Civil Rights, Civil Rights Data Collection (CRDC), survey years 2009-10, 2011-12, 2013-14, 2015-16, 2017-18, authors' calculations; U.S. Department of Education, National Center for Education Statistics, The NCES Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," survey years 2008-09 through 2017-18, authors' calculations.

Table A4. White-Hispanic School Resource Disparities and Achievement Gaps, School Districts

	CH4	CH5	CH6	CH7	CH8	CH9	CH11
Coefficients on Grade 3 Gap							
Minority-White Difference in Exposure to Minority Schoolmates	-0.048	-0.032	-0.049	-0.048	-0.045	-0.049	-0.021
	(0.101)	(0.101)	(0.101)	(0.101)	(0.101)	(0.101)	(0.101)
Minority-White Difference in Exposure to Poor Schoolmates	1.022 ***	1.025 ***	1.023 ***	1.023 ***	1.007 ***	1.024 ***	1.017 ***
	(0.107)	(0.107)	(0.107)	(0.107)	(0.107)	(0.107)	(0.107)
Minority-White Difference in Exposure to Novice Teachers		-0.232					-0.331 *
		(0.136)					(0.152)
Minority-White Difference in Exposure to Chronically Absent Teachers			-0.007				-0.147
			(0.103)				(0.116)
White-Minority Difference in Schools' Offerings of Gifted Programs				-0.027			-0.019
				(0.082)			(0.082)
Minority-White Difference in Schools' Student/Teacher Ratios					-0.004		-0.004 *
					(0.002)		(0.002)
Coefficients on Growth of Gap							
Minority-White Difference in Exposure to Minority Schoolmates	-0.003	-0.005	-0.003	-0.003	-0.003	-0.001	-0.005
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Minority-White Difference in Exposure to Poor Schoolmates	0.037 *	0.037 *	0.036 *	0.037 *	0.038 *	0.043 *	0.043 *
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.020)	(0.020)
Minority-White Difference in Exposure to Novice Teachers		0.023					0.052 *
		(0.023)					(0.027)
Minority-White Difference in Exposure to Chronically Absent Teachers			0.025				0.048 *
			(0.018)				(0.021)
White-Minority Difference in Schools' Offerings of Gifted Programs				0.010			0.011
				(0.014)			(0.014)
Minority-White Difference in Schools' Student/Teacher Ratios					0.000		0.000
					(0.000)		(0.000)
White-Minority Difference in Classmates' Average Test Scores						-0.005	-0.006
						(0.008)	(0.008)
N (Districts)	9,390	9,390	9,390	9,390	9,390	9,390	9,390
Controls Included?	X	X	X	X	X	X	X

* p<.05; ** p<.01; *** p<.001.

NOTE: All models also include measures of grade (centered on grade 3), cohort (centered on 2008) and math (centered on .5). Control variables in cross-sectional models include overall standardized SES composite, Black-White or Hispanic-White difference in exposure to minority neighbors and poor neighbors, White-Black or White-Hispanic difference in SES, proportion Black, and proportion Hispanic. Sample sizes are rounded to the nearest 10, per IES disclosure requirements.

SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations; U.S. Department of Commerce, Bureau of the Census, American Community Survey (ACS), authors' calculations; U.S. Department of Education, Office of Civil Rights, Civil Rights Data Collection (CRDC), survey years 2009-10, 2011-12, 2013-14, 2015-16, 2017-18, authors' calculations; U.S. Department of Education, National Center for Education Statistics, The NCES Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," survey years 2008-09 through 2017-18, authors' calculations.

Table A5. White-Hispanic School Resource Disparities and Achievement Gaps, Counties

	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11
Coefficients on Grade 3 Gap								
Minority-White Difference in Exposure to Minority Schoolmates	0.073	0.105	0.074	0.074	0.072	0.073	0.074	0.111
	(0.079)	(0.080)	(0.079)	(0.079)	(0.079)	(0.079)	(0.079)	(0.080)
Minority-White Difference in Exposure to Poor Schoolmates	0.750 ***	0.756 ***	0.749 ***	0.751 ***	0.750 ***	0.745 ***	0.749 ***	0.753 ***
	(0.088)	(0.087)	(0.087)	(0.088)	(0.088)	(0.088)	(0.088)	(0.088)
Minority-White Difference in Exposure to Novice Teachers		-0.357 **						-0.372 **
		(0.121)						(0.121)
Minority-White Difference in Exposure to Chronically Absent Teachers			-0.048					-0.069
			(0.070)					(0.070)
White-Minority Difference in Schools' Offerings of Gifted Programs				-0.018				-0.016
				(0.045)				(0.045)
Minority-White Difference in Schools' Student/Teacher Ratios					-0.000			-0.000
					(0.001)			(0.001)
White-Minority Difference in Log of Districts' Per Pupil Expenditures						-0.053		-0.038
						(0.065)		(0.065)
Coefficients on Growth of Gap								
Minority-White Difference in Exposure to Minority Schoolmates	-0.021	-0.026	-0.022	-0.021	-0.021	-0.021	-0.023	-0.029 *
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Minority-White Difference in Exposure to Poor Schoolmates	0.046 **	0.045 **	0.046 **	0.046 **	0.046 **	0.045 **	0.035 *	0.036 *
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.017)	(0.017)
Minority-White Difference in Exposure to Novice Teachers		0.057 **						0.063 **
		(0.021)						(0.021)
Minority-White Difference in Exposure to Chronically Absent Teachers			0.026 *					0.029 *
			(0.012)					(0.012)
White-Minority Difference in Schools' Offerings of Gifted Programs				-0.004				-0.005
				(0.007)				(0.008)
Minority-White Difference in Schools' Student/Teacher Ratios					0.000			0.000
					(0.000)			(0.000)
White-Minority Difference in Log of Districts' Per Pupil Expenditures						-0.000		-0.003
						(0.011)		(0.011)
White-Minority Difference in Classmates' Average Test Scores							0.009	0.008
							(0.007)	(0.007)
N (Counties)	2,780	2,780	2,780	2,780	2,780	2,780	2,780	2,780
Controls Included?	X	X	X	X	X	X	X	X

* p<.05; ** p<.01; *** p<.001.

NOTE: All models also include measures of grade (centered on grade 3), cohort (centered on 2008) and math (centered on .5). Control variables in cross-sectional models include overall standardized SES composite, Black-White or Hispanic-White difference in exposure to minority neighbors and poor neighbors, White-Black or White-Hispanic difference in SES, proportion Black, and proportion Hispanic. Sample sizes are rounded to the nearest 10, per IES disclosure requirements.

SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations; U.S. Department of Commerce, Bureau of the Census, American Community Survey (ACS), authors' calculations; U.S. Department of Education, Office of Civil Rights, Civil Rights Data Collection (CRDC), survey years 2009-10, 2011-12, 2013-14, 2015-16, 2017-18, authors' calculations; U.S. Department of Education, National Center for Education Statistics, The NCES Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," survey years 2008-09 through 2017-18, authors' calculations.

Table A6. White-Hispanic School Resource Disparities and Achievement Gaps, Metropolitan Areas

|	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11
Coefficients on Grade 3 Gap								
Minority-White Difference in Exposure to Minority Schoolmates	0.348 *	0.368 *	0.349 *	0.345 *	0.357 *	0.350 *	0.349 *	0.384 *
	(0.166)	(0.166)	(0.167)	(0.167)	(0.167)	(0.168)	(0.166)	(0.169)
Minority-White Difference in Exposure to Poor Schoolmates	0.708 ***	0.713 ***	0.707 ***	0.710 ***	0.703 ***	0.708 ***	0.708 ***	0.708 ***
	(0.168)	(0.168)	(0.168)	(0.169)	(0.168)	(0.168)	(0.168)	(0.169)
Minority-White Difference in Exposure to Novice Teachers		-0.322						-0.346
		(0.239)						(0.241)
Minority-White Difference in Exposure to Chronically Absent Teachers			-0.009					-0.029
			(0.128)					(0.128)
White-Minority Difference in Schools' Offerings of Gifted Programs				-0.016				-0.011
				(0.071)				(0.071)
Minority-White Difference in Schools' Student/Teacher Ratios					-0.004			-0.004
					(0.004)			(0.004)
White-Minority Difference in Log of Districts' Per Pupil Expenditures						0.014		0.015
						(0.123)		(0.122)
Coefficients on Growth of Gap								
Minority-White Difference in Exposure to Minority Schoolmates	0.042	0.037	0.040	0.041	0.040	0.044	0.037	0.032
	(0.024)	(0.024)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
Minority-White Difference in Exposure to Poor Schoolmates	-0.053 *	-0.054 *	-0.052 *	-0.053 *	-0.053 *	-0.054 *	-0.075 **	-0.069 *
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.028)	(0.028)
Minority-White Difference in Exposure to Novice Teachers		0.069 *						0.072 *
		(0.034)						(0.035)
Minority-White Difference in Exposure to Chronically Absent Teachers			0.012					0.014
			(0.019)					(0.019)
White-Minority Difference in Schools' Offerings of Gifted Programs				-0.006				-0.007
				(0.010)				(0.011)
Minority-White Difference in Schools' Student/Teacher Ratios					0.000			0.001
					(0.001)			(0.001)
White-Minority Difference in Log of Districts' Per Pupil Expenditures						0.009		0.007
						(0.017)		(0.018)
White-Minority Difference in Classmates' Average Test Scores							0.020	0.015
							(0.011)	(0.011)
N (Metropolitan Areas)	390	390	390	390	390	390	390	390
Controls Included?	X	X	X	X	X	X	X	X

* p<.05; ** p<.01; *** p<.001.

NOTE: All models also include measures of grade (centered on grade 3), cohort (centered on 2008) and math (centered on .5). Control variables in cross-sectional models include overall standardized SES composite, Black-White or Hispanic-White difference in exposure to minority neighbors and poor neighbors, White-Black or White-Hispanic difference in SES, proportion Black, and proportion Hispanic. Sample sizes are rounded to the nearest 10, per IES disclosure requirements.

SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations; U.S. Department of Commerce, Bureau of the Census, American Community Survey (ACS), authors' calculations; U.S. Department of Education, Office of Civil Rights, Civil Rights Data Collection (CRDC), survey years 2009-10, 2011-12, 2013-14, 2015-16, 2017-18, authors' calculations; U.S. Department of Education, National Center for Education Statistics, The NCES Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," survey years 2008-09 through 2017-18, authors' calculations.
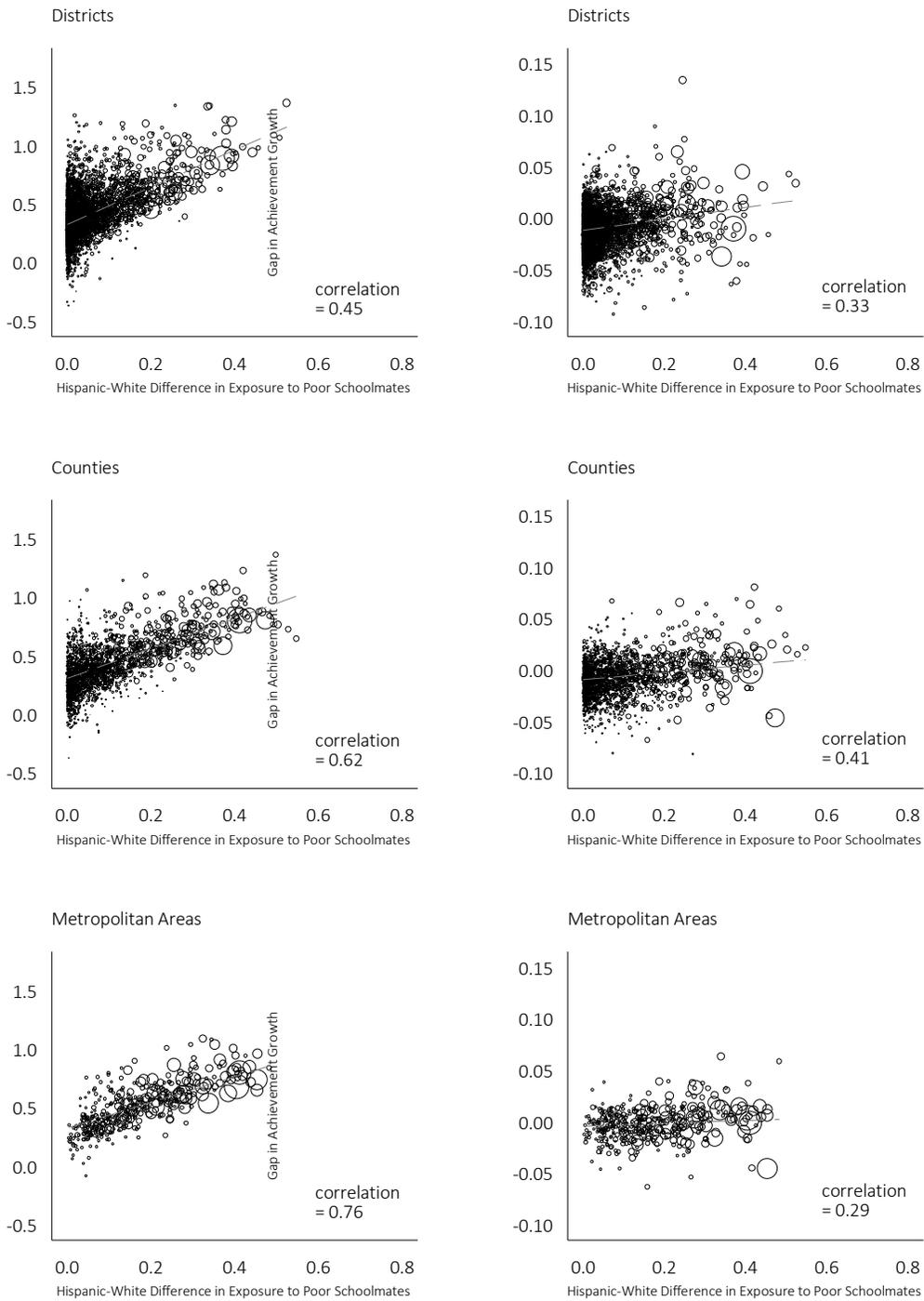
APPENDIX FIGURES

Figure A1. Association between Differences in Exposure to Minority Schoolmates and Achievement Gaps and Gap Growth Rates, White-Hispanic Gaps
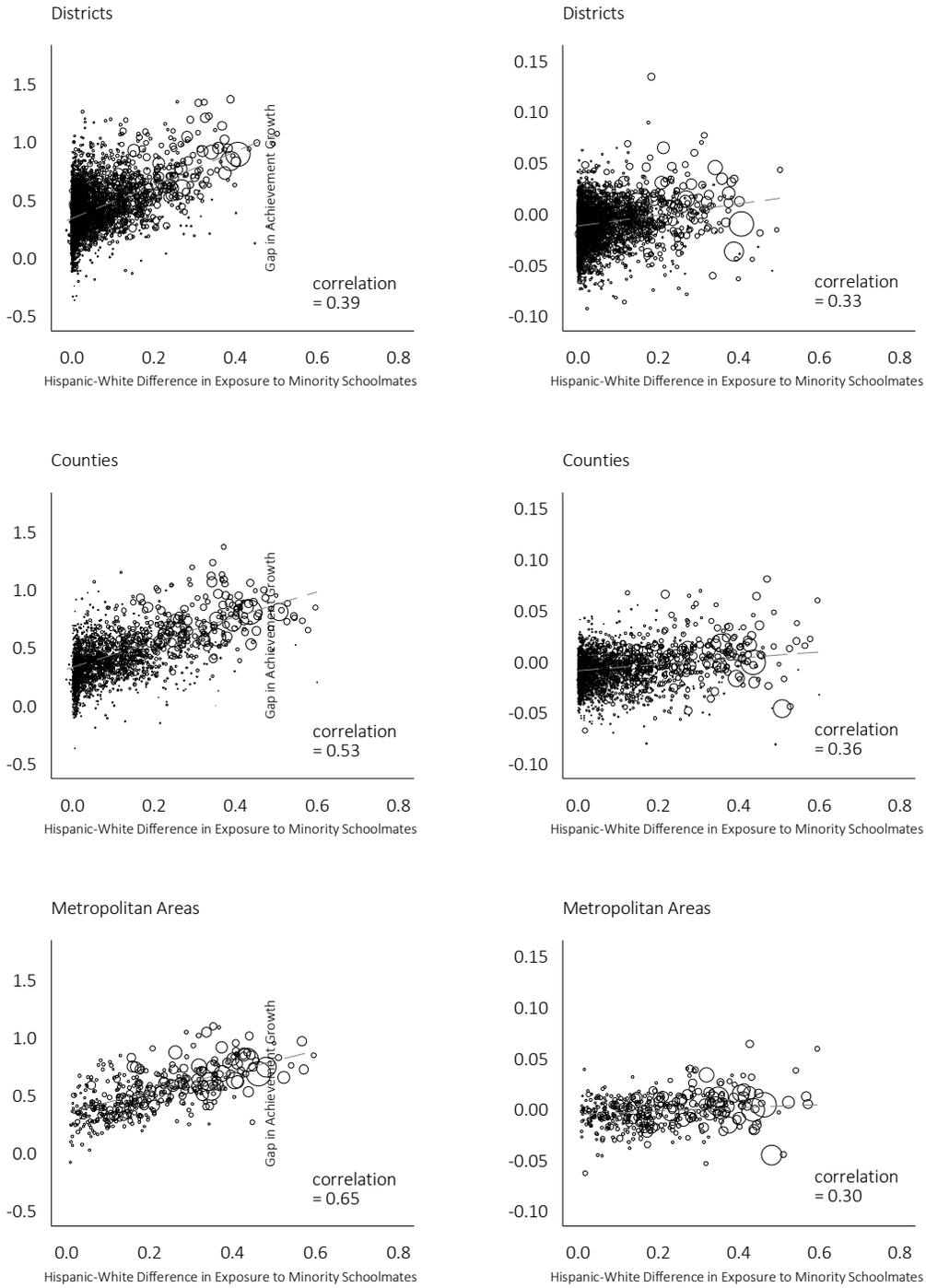
SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations.

Figure A2. Association between Differences in Exposure to Poor Schoolmates and Achievement Gaps and Gap Growth Rates, White-Hispanic Gaps

SOURCE: U.S. Department of Education, National Center for Education Statistics, ED*Facts* Assessment Data, "State Achievement by Performance Levels," years 2009-2018, authors' calculations.