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ABSTRACT

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Abstract

Although it is clear that racial segregation is linked to academic achievement gaps, the mechanisms underlying this link have been debated since Coleman published his eponymous 1966 report. In this paper, I examine 16 distinct measures of segregation to determine which is most strongly associated with academic achievement gaps. I find very clear evidence that one aspect of segregation in particular—the disparity in average school poverty rates between white and black students' schools—is consistently the single most powerful correlate of achievement gaps, a pattern that holds in both bivariate and multivariate analyses. This implies that high-poverty schools are, on average, much less effective than lower-poverty schools, and suggests that strategies that reduce the differential exposure of black, Hispanic, and white students to poor classmates may lead to meaningful reductions in academic achievement gaps.

School Segregation and Racial Academic Achievement Gaps

Introduction

Does segregation exacerbate racial educational inequality? And if so, through what mechanism? Is it racial segregation *per se* that matters, or the association of racial segregation with unequal schooling or neighborhood conditions? When the Supreme Court ruled, in *Brown v. Board of Education*, that "separate educational facilities are inherently unequal," its argument was that legally-sanctioned segregation based on race necessarily inflicted on black children a psychological wound that could not be salved by the provision of materially equivalent schooling facilities and resources. In the Court's view, it was the very act of legal exclusion that created inequality and violated the Fourteenth Amendment. Even if separate schools, in practice, had equivalent material conditions (that is, if the *Plessy v Ferguson* standard of "separate but equal" were met in strictly material terms), the Court argued, black children would nonetheless be harmed by virtue of their state-sanctioned exclusion from schools enrolling white students.

This argument suggests that there is something explicitly racialized about the effects of segregation, particularly in the context of *de jure* segregation. The Court's argument does not, however, imply that the race-specific nature of school segregation laws is the only way that segregation may harm children; it merely suggests that there would be harm even if the material conditions of racially segregated schools were equalized.

Twelve years after the *Brown* decision, when Coleman wrote his *Equality of Educational Opportunity* report, he was concerned less with the psychological harms of *de jure* segregation and more with the material inequalities that existed (or were presumed to exist) in both *de jure* and *de facto* segregated school systems of the 1960s. By 1966, *Brown* had yet to substantially reduce segregation in the South, and one aim of the Coleman Report was to investigate the extent to which black and white

students attended schools of different quality, and the relationship between measures of material school quality and academic achievement.

Coleman reported several facts about school segregation in the U.S. First, unsurprisingly, racial segregation was very high. Two-thirds of black students attended schools that were 90-100% black; 80% of white students attended schools that were 90-100% white. More importantly, he found that academic achievement of both white and black students was higher in predominantly white schools than in predominantly minority schools. In addition, black students who had spent more time in desegregated schools had modestly higher average scores than others, a pattern that held when controlling for individual student socioeconomic background (see pages 331-332). Little of the association of test scores with school racial composition could be explained with the set of school quality measures he had available, however. Instead, Coleman wrote, "the higher achievement of all racial and ethnic groups in schools with greater proportions of white students is largely, perhaps wholly, related to effects associated with the student body's educational background and aspirations" (p. 307). In other words, the negative association of segregation with academic achievement disparities appears to have been largely driven by the differences in the socioeconomic composition of the schools where black and white students were enrolled.

Borman and Dowling (2010), in their reanalysis of Coleman's data likewise find that both the racial and socioeconomic composition of schools are strongly related to student outcomes (as have numerous other studies). These findings, although correlational rather than causal in nature, suggest that any effects of racial segregation on achievement patterns are at least partly driven by factors associated with school socioeconomic composition rather than racial composition per se. These factors might include material resources; instructional focus and quality; parental social/economic capital; social norms; and peer effects. The Coleman data (and other subsequent studies) have not, however, convincingly identified if and how such mechanisms link school segregation to unequal outcomes.

In this paper, I use new data that includes over 100 million test score records from all grade 3-8 students in public schools in 2009-2012 in over 300 metropolitan areas, to further investigate the association between racial segregation and racial academic achievement gaps. In particular, I assess whether it is the racial or socioeconomic composition of schools that drives the persistent association between segregation and achievement inequality. A better understanding of the mechanisms driving the effects of segregation may be useful in counteracting those effects.

This paper proceeds in 4 parts. I first describe four related but conceptually distinct dimensions of segregation, each of which might affect academic achievement gaps. These four dimensions yield 16 different measures of segregation, each of which I use in this analysis. I next describe the data and measures used in the paper. These are measures of academic achievement gaps and segregation patterns in roughly 330 metropolitan areas in the United States. The third section of the paper describes the analyses and results. Here I demonstrate that all 16 measures of segregation are correlated with racial achievement gaps, but that one in particular—the disparity in average school poverty rates between white and black students' schools—is consistently the single most powerful correlate of achievement gaps, a pattern that holds in both bivariate and multivariate analyses. In the final section of the paper, I discuss the implications of these findings.

Dimensions of Segregation

One of the challenges in understanding the potential effect of segregation on academic achievement patterns is that there are many different aspects of segregation, each of which might affect achievement through a different set of mechanisms. In this paper I consider four dimensions of segregation. First is the distinction between *residential and school segregation* (which I will call here the *context* dimension). Second, is the distinction between *between-district and between-school or between-neighborhood segregation* (what I will call the *scale* dimension). Third is the distinction between absolute

and relative segregation (the *exposure/unevenness* dimension). And fourth is the distinction between *racial and socioeconomic composition* as the key processes through which segregation affects students (the *process* dimension). I discuss these different dimensions in some detail below.

Table 1 illustrates that these four dimensions give rise to 16 possible features of segregation that may affect students. The columns of Table 1 distinguish the *context* (school or residential) and *scale* (between-school or between-district) dimensions; the rows distinguish the *exposure/evenness* (exposure or differences in exposure) and *process* (racial or socioeconomic composition) dimensions. It is worth noting that Coleman et al (1966) focused on the segregation dimensions represented in the far upper left of the table – measures of student exposure to black and poor schoolmates. The Coleman report did not attend to residential segregation, to the distinction between between-school and between-district segregation, or to measures of unevenness.

Table 1 here

The Context Dimension: Residential and School Segregation

Both residential and school segregation might independently affect students. If, in segregated school systems, schools' racial composition and quality are correlated, then school segregation will lead to racial achievement gaps. Certainly there is considerable evidence indicating that white, black, and Hispanic students' schools often differ in important ways (Hanushek & Rivkin, 2007; Johnson, 2011; Kozol, 1991; Lankford, Loeb, & Wycoff, 2002). Residential segregation (by which I mean the patterns of where children live, as opposed to which school they attend) means that white and black or Hispanic children live in different neighborhoods. Because neighborhood conditions appear to affect children's cognitive development and long-term educational outcomes (Burdick-Will et al., 2011; Chetty, Hendren, & Katz, 2015; Sampson, Sharkey, & Raudenbush, 2008; Sharkey, 2010; Wodtke, Harding, & Elwert, 2011), residential segregation may lead to achievement gaps and other forms of educational disparities if it leads

to children of different races living in systematically higher- and lower-quality neighborhoods.

Because school and residential segregation are linked (because many children attend schools near their homes) and because school and neighborhood quality are linked (schools in communities with abundant resources can draw on those resources in ways that schools in poor communities cannot), it is not clear whether school or residential segregation patterns are most important in shaping achievement gaps. If school quality is the key factor shaping schooling outcomes, then residential segregation may matter only to the extent that it leads to school segregation. On the other hand, if neighborhood conditions in early childhood lead to hard-to-change patterns of inequality in school readiness, then school segregation may matter little, net of residential segregation. Or it may be that both neighborhood and school segregation contribute independently to academic achievement gaps.

The Scale Dimension: Between-School/Neighborhood and Between-District Segregation

The overall residential or school segregation of a population (a metropolitan area for example) can be thought of as the sum of two distinct organizational/geographic components: between- and within-district segregation. Most metropolitan areas contain multiple school districts (sometimes only a few, but often dozens or more). In the average metropolitan area, roughly two-thirds of between-school racial segregation is due to differences in the racial composition of school districts (Reardon, Yun, & Eitle, 2000; Stroub & Richards, 2013); the same is true of residential segregation (Bischoff, 2008). There is, however, considerable variation in the proportions of both school and residential segregation that lie between districts.

It is not clear how the scale of segregation is related to patterns of educational outcomes. Consider two metropolitan areas with the same level of total between-school segregation; suppose that in one all of the segregation is due to between-district segregation (within each district, all schools have equal racial composition), while in the other all of the segregation is due to within-district segregation (all

districts have equal racial composition, but are internally segregated). Depending on the processes that link segregation to students' opportunities to learn, we might expect one or the other to have larger achievement gaps.

Between-district segregation may be particularly consequential for achievement gaps because there are often substantial differences in school and community resources among school districts. If racial between-district segregation is linked to disparities in either the quality of school districts or the availability of other municipal or community resources that benefit children, then between-district segregation may lead to large achievement gaps. And if school resources and learning opportunities were relatively evenly distributed within school districts (for example, if a district provided equal funding for all schools and randomly assigned teachers to schools, and if municipalities randomly assigned spaces in high-quality publicly-funded pre-schools regardless of where in the city one lived) then within-district segregation patterns might matter less.

On the other hand, If the effects of segregation are largely driven by processes at the school-level—for example if schools' ability to attract and retain the most skilled teachers is largely driven by their racial and socioeconomic composition, regardless of their district characteristics—then total segregation may be more important in driving achievement patterns than between-district segregation. More generally, if resources are allocated unevenly among schools and neighborhoods in ways that are correlated with racial composition and if these allocation processes operate within districts as strongly as they do between districts, then the organizational scale of segregation will be less important than total segregation.

Exposure and Unevenness

Segregation is generally measured in one of two ways. First are exposure measures (sometimes called isolation measures), which describe the average racial or socioeconomic composition of the

schools or neighborhoods of children of a given race. For example, the average proportion of students in a black student's school (or neighborhood) who are black is a measure of the racial exposure/isolation of black children. The average proportion of poor children in the black students' schools or neighborhoods is likewise an exposure measure. Second are evenness (or unevenness) measures, which describe the *difference* in the average racial or socioeconomic composition of the schools or neighborhoods between children of different races. That is, exposure measures describe the average contexts of children of a given race; unevenness measures describe the difference in average contexts between two racial groups: unevenness measures can be thought of as simply differences in exposure measures. For example, if the average black student enrolls in a school where 60% of students are poor; black exposure to poverty will be 0.60—a very high exposure to poverty. But if the average white student in the same school district is also enrolled in a school where 60% of students are poor, the unevenness in exposure to poverty will be zero.

If the racial or socioeconomic composition of schools or neighborhoods affects students of all races equally, then unevenness measures of segregation should be more strongly associated with achievement gaps than black or Hispanic exposure measures. But if attending a high-poverty school or living in a high-poverty neighborhood were harmful for black and Hispanic students but not for white students (perhaps because white students have access to other resources that buffer them against any negative effects of high-poverty contexts), then the exposure of black students to poor classmates and neighbors may be more strongly associated with achievement gaps than the black-white difference in such exposure. In other words, if school composition (and factors associated with it) affects both white and black students equally, then the composition of black students' schools (exposure) will only be associated with achievement gaps to the extent that black and white students' schools differ, on average, in composition.

The Process Dimension: Racial and Socioeconomic Contexts

As noted above, both Coleman et al (1966) and other studies find that both the racial and socioeconomic composition of schools are strongly related to student outcomes. The distinction between segregation processes that operate through racial composition *per se* and those that operate through other processes that are correlated with racial composition is important, though difficult to disentangle. Given the correlation between race and socioeconomic status, children in predominantly black or Hispanic schools and neighborhoods are typically exposed to much higher poverty rates than those in predominantly white schools. Indeed, the black-white and Hispanic-white difference in exposure to poverty is generally much greater than would be predicted based on racial differences in family income alone: even middle-class black and Hispanic children live in neighborhoods and attend schools with higher poverty rates than most poor white children (Reardon, Fox, & Townsend, 2015; Saporito & Sohoni, 2007). As a result, schools with high proportions of black students tend also to be schools with high proportions of poor students. Nonetheless, the correlation is not perfect, and it would be useful to know whether it is exposure to minority students or exposure to poverty that is more strongly predictive of achievement gaps.

Analytic Strategy

The discussion above suggests that many or all of the 16 types of segregation defined in Table 1 may be related to achievement patterns. The goal of this paper is to investigate which of these dimensions are most strongly predictive of racial achievement gaps. My strategy will be to measure achievement gaps and each of the 16 types of segregation in metropolitan areas of the U.S., and then to assess the correlation of each measure with achievement gaps, both with and without a set of control variables. This analysis cannot determine the *effect* of any specific dimension of segregation (nor their aggregate effect). It does, nonetheless, provide detailed descriptive information about the relative

strength of association among segregation measures and achievement gaps, and so is useful for guiding future analyses and providing a set of stylized facts that a model of segregation's effects should be able to explain.

The one study I am aware of that is similar to this is Card and Rothstein's (2007) study of the relationship between achievement gaps on the SAT and patterns of residential and school segregation. That study found that residential segregation was at least as strong, or stronger, a predictor of racial achievement gaps as school segregation. Moreover, the analyses suggest that the association between residential segregation and achievement gaps is driven largely by black-white differences in neighborhood income levels: in metropolitan areas where black children live in much poorer neighborhoods than white children, achievement gaps tend to be larger. The Card and Rothstein (2007) study is quite valuable, but has several shortcomings relative to my purpose here. First, it relies on SAT tests, which are not taken by all students. Although Card and Rothstein use a selection model to adjust for differences in SAT-taking rates, this relies on a set of assumptions that cannot be verified and so may be subject to bias. Second, the Card and Rothstein analysis does not examine all the dimensions of segregation that I do here. In particular, they do not consider between-district segregation or exposure measures of segregation. And third, I examine both black-white and Hispanic-white segregation and achievement gap patterns; their analysis is restricted to black-white achievement gaps.

Data

Achievement Gap Data

I use students' state accountability test scores in grades 3-8 in the years 2009-2012 in every public district in the United States. These data were provided by the National Center for Education Statistics under a restricted data use license. The data include, for each public school district in the United States, counts of students scoring in each of several academic proficiency levels (often labeled something

like “Below Basic,” “Basic,” “Proficient,” and “Advanced”). These counts are disaggregated by race (I use counts of non-Hispanic white, non-Hispanic Black, and Hispanic students in this paper), grade (grades 3-8), test subject (math and ELA), and year (school years 2008-09 through 2011-12). I combine the proficiency counts in charter schools with those of the public school district in which they are formally chartered or, if not chartered by a district, in the district in which they are physically located. Thus, a “school district” includes students in all local charter schools as well as in traditional public schools.

There are 384 metropolitan areas and roughly 13,700 school districts serving grades 3-8 in the United States. In order to construct metropolitan area achievement gaps, I aggregate data from all public school districts (including their charter schools) within a given metropolitan area, so long as the metropolitan area falls entirely within a single state. Because districts in different states use different achievement tests, proficiency categories in different states are not comparable, so I cannot construct aggregated data for the 45 (of 384) metropolitan areas that cross state boundaries. The 339 metropolitan areas in the analytic sample include 81% of black and 92% of Hispanic public school grade 3-8 students in metropolitan areas (and 69% and 79% of black and Hispanic students in the U.S.).

The EdFacts data span 6 grades, 2 subjects, and 4 years, making a total of 16,272 possible metropolitan area-grade-subject-year combinations (in the 339 metropolitan areas). Several states do not have sufficient data to compute achievement gaps in some years (Colorado, Wyoming, and Florida each are missing one or more years of data). In addition, some metropolitan areas have too few minority students to reliably estimate achievement gaps: I exclude cells with fewer than 20 white and/or 20 black/Hispanic students. After excluding cells with too few students, I am able to estimate white-black and white-Hispanic achievement gaps in at least one grade-year-subject for all but a few metropolitan areas. In total, the sample includes roughly 14,200 white-black and white-Hispanic metropolitan area achievement gaps, an average of roughly 42 gaps per area.

I estimate achievement gaps in each metropolitan area using the methods described by Ho and

Reardon (Ho & Reardon, 2012; Reardon & Ho, 2015). The achievement gaps are measured using the V-statistic, which measures the difference between two distributions in pooled standard deviation units. The advantage of V is that it relies only on the ordered nature of test scores, which allows comparability of gap estimates across tests that measure achievement in on different scales. Given that the data include achievement measured on roughly 600 different standardized tests (typically one for each state-grade-subject combination, sometimes with variation across years), this comparability is a key feature of the V-statistic for measuring gaps.

Measures of Segregation

I compute 32 measures of segregation for each metropolitan area (16 for white-black segregation and 16 for white-Hispanic segregation), corresponding to the 16 cells of Table 1. School segregation measures are computed from 2008-09, 2009-10, and 2010-11 enrollment data from the Common Core of Data (CCD), which includes racial composition and counts of students by free/reduced-price lunch eligibility status for every public school and district in the United States. Residential segregation measures are computed from 2006-10 American Community Survey data, which includes racial composition and poverty rates for each census tract in the United States.

The exposure measures are computed by averaging school, district, or census tract racial composition or poverty rates within each metropolitan area, weighting by the number of black or Hispanic students in the school, district, or tract as appropriate. The unevenness measures are simply the difference in black (or Hispanic) and white students' exposure relevant measures. Because the ACS and CCD data are based on full population counts (in CCD) or large samples pooled ever 5 years (in ACS), the segregation measures are very precise.

Not surprisingly, the 16 segregation measures are correlated, often quite highly, with one another (see Appendix Tables A1 and A2). Nonetheless, in some cases the correlations are quite modest,

suggesting that we may be able to distinguish their associations with achievement gaps.

Additional Covariates

I include a set of additional variables as controls in some models below. The controls are constructed from CCD and the School District Demographic System (SDDS) data. The SDDS is a special tabulation of the 2006-10 ACS data that includes tabulations of demographic characteristics of families living in each school district and who have children enrolled in the public schools. I aggregate these to the metropolitan area level and construct measures of family socioeconomic characteristics (income inequality, median family income, parental educational attainment, occupational status, poverty rates, unemployment rates, single-parent household rates, home value and median rent, racial disparities in family socioeconomic characteristics, and racial composition; in each case these measures apply to families in the metropolitan area with children enrolled in public schools. From the CCD, I construct a measure of metropolitan area school district fragmentation; this is the Herfindahl index applied to school district enrollment; it measures the degree to which students are concentrated in a small number of large districts or dispersed among many small districts, and has been shown to be related to between-district segregation patterns (Bischoff, 2008; Reardon & Yun, 2001). From the CCD I also include a measure of metropolitan area average per pupil public school spending. These variables are used in controls in some of the models below.

Bivariate and partial correlations between segregation and achievement gaps

To begin, I examine the bivariate correlations among various segregation measures and racial achievement gaps. Table 2 reports the correlation of each of the 16 segregation measures with the white-black achievement gap. Note that almost all of the segregation measures are positively correlated with the achievement gap. However the correlations range from 0.002 to 0.623. Table 2 makes clear several

patterns. First, each measure of school segregation is more highly correlated with achievement gaps than the corresponding measure of residential segregation. Second, in every case, segregation among schools or census tracts is more correlated with achievement gaps than is segregation between school districts. Third, racial differences in exposure to black or poor classmates or neighbors are more strongly related to achievement gaps than are simple exposure, though this pattern holds more consistently to exposure to poverty than racial exposure. Fourth, although achievement gaps are more highly correlated with black students' exposure to other black students/neighbors than with exposure to poor classmates/neighbors, this pattern is reversed when we consider the association between achievement gaps and racial *differences* in exposure to black or poor peers. The bottom panel of Table 2 shows that differences in exposure to poverty are more strongly correlated with achievement gaps than are differences in exposure to same race peers.

Table 2 here

Table 3 shows the corresponding correlations between white-Hispanic achievement gaps and measure of Hispanic students' segregation. The magnitude of the correlations is roughly similar to those in Table 2, except for the correlations with exposure to poverty, where the correlations with white-Hispanic gaps are smaller than those in Table 2 (and negative in one case). Likewise the general pattern of correlations is similar.

Table 3 here

With only a few exceptions then, the bivariate correlations follow a clear pattern: achievement gaps are more highly correlated with school segregation than residential segregation; more highly correlated with segregation among schools/tracts than among districts; and more highly correlated with differences in exposure to poor or same-race classmates/neighbors than with simple exposure measures. The measure of segregation most highly correlated with the metropolitan achievement gap is the racial difference in students' exposure to poor schoolmates (white-black $r = 0.623$; white-Hispanic $r = 0.678$).

I next examine the partial correlations between achievement gaps and measures of segregation, conditional on a set of metropolitan area characteristics. For the exposure measures, I control for racial differences in family socioeconomic characteristics in the metropolitan area and the fragmentation of the metropolitan area. I do not include measures of the racial or socioeconomic composition of the metropolitan area because these are mechanically related to the exposure measures (all else being equal, black students will have more black classmates in a predominantly black metropolitan area); their inclusion in the model would change the interpretation of the coefficient on the exposure measure to be similar to that of the differential exposure measures. The coefficients would indicate the extent to which achievement gaps are larger, on average, in metropolitan areas where black students attend schools with more black classmates than would be expected given the racial composition of the metropolitan area public school population. This is essentially what the evenness segregation measures capture. To preserve the interpretation of the exposure measure coefficients, then, I do not include covariates indicating the racial or socioeconomic composition of the metropolitan area in computing the partial correlations in the top panels of Tables 4 and 5.

I do include such measures in the models for the bottom panels, however. Here the segregation measures are not mechanically related to composition (that is the virtue of the evenness measures), so the composition measures can be used as controls without altering the interpretation of the coefficients on the segregation measures. Therefore the estimates in the bottom panel control for metropolitan area racial composition, family socioeconomic characteristics, racial differences in these characteristics, metropolitan fragmentation, and metropolitan area average per pupil public school spending.

Table 4 reports these partial correlations for the white-black achievement gaps. In general, the partial correlations are weaker than the bivariate correlations. This is particularly true in the top panel of Table 4: after controlling for racial differences in family socioeconomic characteristics, measures of black students' exposure to black and poor classmates/neighbors are at best only very weakly correlated with

achievement gaps. The correlations with the unevenness measures of segregation are generally about 20% smaller than the uncontrolled correlations in Table 2. They are modest in size, but not trivial, ranging from roughly 0.21 to 0.46. Just as in Table 2, the largest correlation is the correlation with racial differences in exposure to poor schoolmates ($r = 0.464$).

Table 4 here

Table 5 reports the analogous correlations of the segregation measures and the white-Hispanic achievement gap. Here the correlations with exposure to Hispanic schoolmates/neighbors are slightly larger than in the white-black table above (Table 4) and are all statistically different from 0. Interesting, white-Hispanic achievement gaps are slightly negatively correlated with Hispanic students' exposure to poor peers and neighbors. This correlation reverses, however, in the bottom panel of the table, once the models include metropolitan area racial and socioeconomic composition measures. Thus, the negative correlations with exposure to poverty may simply reflect a correlation between achievement gaps and overall poverty rates.

In the bottom panel of Table 5, white-Hispanic achievement gaps remain correlated with differences in exposure to poverty after controlling for metropolitan socioeconomic characteristics and composition in addition to racial socioeconomic disparities. Nonetheless, the correlations are only modest in size, and are considerably smaller than their counterparts in Table 4.

Table 5 here

Tables 4 and 5 together reveal a clear pattern: net of a set of key covariates, achievement gaps are more highly correlated with school segregation than residential segregation; more highly correlated with segregation among schools/tracts than among districts; and is generally more highly correlated with differences in exposure to poor or same-race classmates/neighbors than with simple exposure measures (though the last point is not true of exposure to Hispanic students/neighbors in Table 5). Net of the set of covariates in the models, the racial difference in students' exposure to poor schoolmates remains the

measure of segregation most highly correlated with metropolitan area achievement gaps (white-black $r = 0.464$; white-Hispanic $r = 0.350$).

Disentangling Multiple Aspects of Segregation

The bivariate and partial correlations in Tables 2-5 are useful for assessing whether segregation measures are associated with achievement gaps, net of a vector of metropolitan area socioeconomic conditions and disparities. But because the segregation measures are correlated with one another (see Appendix Tables A1 and A2), the individual correlations do not indicate which of the segregation dimensions are most important.

To investigate the relative importance of the different dimensions of segregation, I regress achievement gaps on various measures of segregation, controlling for the full set of metropolitan covariates included in the bottom panels of Tables 4 and 5. In these models I include various combinations of the differential exposure segregation measures; I exclude the simple exposure measures because, as noted above, they are mechanically related to the other measures once racial and socioeconomic composition are included in the models.

Tables 6 and 7 display selected coefficients from a series of models designed to isolate the primary dimensions of segregation driving the general association between segregation and achievement gaps. Each model includes the metropolitan covariates described above. The first column (model 0) simply reports the R^2 statistic from the model that includes the covariates but none of the segregation measures ($R^2 = 0.62$ in the white-black model; $R^2 = 0.73$ in the white-Hispanic model). Model 1 includes the four between-district segregation measures; Model 2 includes the four total segregation measures (between-school enrollment segregation and between-tract residential segregation); Model 3 includes all eight measures.

Table 6 here

Table 7 here

Below the coefficients are the *p*-values from a set of hypothesis tests. The first tests the null hypothesis that the coefficients on the residential segregation terms in the model are all equal to 0 (that is, the coefficients in the rows labeled b, d, f, and h in the table are all 0). The second tests the hypothesis that the school segregation terms are all non-significant. The third and fourth test the hypotheses that the four between-district terms are all non-significant and that the four total segregation terms are all non-significant, respectively. The fifth tests that the coefficients on the four racial exposure terms are 0; the sixth tests that those on the four poverty exposure terms are all zero. The seventh tests the hypothesis that all of the terms other than the two describing the differential exposure to poor school- or district-mates are zero. The final tests the null hypothesis that all the coefficients except that on the differential exposure to poor schoolmates are zero. This effectively tests whether that one measure of segregation contains all the predictive power of the full set of eight measures.

The coefficients and hypothesis tests in Tables 6 and 7 tell a very consistent story. In each model, we cannot reject the null hypothesis that the residential segregation terms are not predictive of achievement gaps, conditional on the school segregation terms. We can, however, reject the opposite hypothesis (that school segregation is uninformative, conditional on residential segregation). In other words, segregation of schools is predictive of achievement gaps; net of that, variation in neighborhood segregation patterns is not correlated with achievement gaps.

Likewise we cannot reject the null hypothesis that between-district segregation (whether residential or school segregation) is non-predictive once we include measures of total between-school and between-tract segregation in the model. But we reject the opposite hypothesis: total district segregation measures are predictive of achievement gaps, net of between-district segregation. It appears irrelevant whether between-school segregation is due to between- or within-district segregation.

The *p*-values from the 5th and 6th hypothesis tests show that differential exposure to same-race

schoolmates and neighbors is not predictive of achievement gaps, conditional on differential exposure to poverty. Differential exposure to poor schoolmates and neighbors is predictive, however, conditional on racial exposure patterns.

Together the first six hypothesis tests strongly suggest that differential exposure to poor schoolmates is the key dimension of segregation associated with racial achievement gaps. The seventh hypothesis test indicates whether excluding the four residential segregation measures and the two measures of exposure to same-race schoolmates reduces the fit of the model. For both the white-black (Table 6) and white-Hispanic models (Table 7), we fail to reject the hypothesis that all six of those terms can be excluded from model 3. We also fail to reject the hypothesis (hypothesis 8) that 7 of the 8 terms can be excluded (all but the measure of differential exposure to school poverty) from the model. Models 4 and 5 include only the differential exposure to poor school- and district-mates measures. The district-level measure is not significant in model 4, leaving model 5 as the preferred model.

Discussion

The results in tables 6 and 7 are unequivocal. The racial difference in the proportion of students' schoolmates who are poor is the key dimension of segregation driving the association between segregation and achievement gaps. Conditional on that measure, the other seven measures collectively explain no additional variance in achievement gaps. The adjusted R^2 is nearly identical in model 5 and model 3 (which includes 7 additional measures of segregation).

These findings are somewhat at odds with those in Card and Rothstein (2007), who found that black-white differences in poor neighbors was the key mechanism driving the association between segregation and racial achievement gaps. However, Card and Rothstein did not include differential exposure to both poor classmates and poor neighbors in their models simultaneously. When I include both in the model (see Model 2 in Tables 6 and 7), I find that school differences in exposure to poverty

are strong predictors of achievement gaps, while residential differences in exposure to poverty are not statistically significant predictors (though, in models not shown, I find that neighborhood differential exposure to poverty is a strong predictor of achievement gaps if school differential exposure to poverty is not in the model, a finding consistent with Card and Rothstein's results). This suggests that their conclusion might have been different had they included both terms in their models. Nonetheless, both their findings and those reported here suggest that it is differential exposure to poverty that is more important than differential exposure to black or Hispanic schoolmates or neighbors.

The coefficients on the difference in exposure to poor schoolmates in model 5 in in Tables 6 and 7 are relatively large. To get a sense of their magnitude, consider Figure 1, which shows that in some metropolitan areas, there is no difference in exposure to poor classmates between black or Hispanic and white students, while in others the difference is as high as 40%. The coefficients in Tables 6 and 7 imply that a 40% difference in exposure to poverty corresponds to a roughly 0.25 standard deviation increase in the achievement gap relative to a metropolitan area where there is no racial difference in exposure to poverty. The average 20% difference in exposure to poverty corresponds to an achievement gap of 0.12, roughly 20% the size of the average achievement gap.

Figure 1 here

The coefficients here can also be thought of as estimates of the association between school poverty rates and average achievement levels. Estimating the association between achievement gaps and racial differences in school poverty rates, as I do here, is akin to estimating, in a metropolitan fixed-effects model, the average within-metropolitan area association between a racial group's average achievement and its average exposure to poverty. The results here therefore are consistent with a model in which high-poverty schools are, on average, less effective at promoting achievement than lower-poverty schools. In metropolitan areas where black or Hispanic students disproportionately attend high-poverty schools, then, achievement gaps will be larger.

Of course, the coefficients in Tables 6 and 7 should not be interpreted causally. They do not imply that reducing segregation will reduce achievement gaps. The models here simply provide evidence that segregation—specifically racial differences in exposure to poor schoolmates—is strongly correlated with achievement gaps net of a wide range of covariates that are strongly related with achievement gaps, including racial disparities in family income, poverty rates, unemployment rates, and parental education. In metropolitan areas that are more segregated than average, given their racial disparities in socioeconomic conditions, achievement gaps are larger. One might imagine that metropolitan areas that are more segregated than expected are those in which racial prejudice and discrimination are particularly high in general; if such discrimination affected students' opportunity through some mechanism other than segregation, this might explain the observed association between segregation and achievement gaps. The association between segregation and achievement gaps is large, however, so such an alternate pathway would need to lead to sizeable effects on achievement gaps. It is not immediately obvious whether there are plausible candidate explanations that would explain the association. Thus, the results presented here are suggestive of powerful effects of segregation, but are not completely definitive.

Importantly, the pattern of results here strongly suggests that the mechanisms through which segregation is related to achievement gaps are related to differences in students' exposure to poor schoolmates. That is not to say that having poor classmates impacts students' achievement directly. Rather, exposure to poor classmates is best understood as a proxy for general school quality—quality of instruction and opportunities to learn. High-poverty schools may have fewer resources, a harder time attracting and retaining skilled teachers, more violence and disruption, and poorer facilities. The parents of students in such schools generally have fewer resources—economic, social, and political—that can be used to the schools' benefit. High-poverty schools also typically have more low-performing students than do schools with fewer poor students; this may impact they curricular focus and type and quality of instruction. In a classroom where most students' skills are well below grade level, students—even those

at grade level—are unlikely to encounter challenging instruction. The data here do not speak to which, if any of these aspects of school quality drive the association between school poverty and academic achievement, of course; there are clearly many such potential mechanisms.

The fact that differential exposure to school poverty alone explains all of the association between segregation and achievement gaps does not imply that other forms of segregation do not affect achievement gaps. Residential segregation and between-district segregation may contribute to achievement gaps, for example, but they may do so primarily through their effect on school segregation patterns. As Tables A1 and A2 show, racial differences in exposure to poor schoolmates are strongly correlated (0.78 and 0.73, respectively, in the black-white and Hispanic-white cases) with racial differences in poor neighbors. This is not surprising, given that most students attend schools relatively close to home; residential segregation is one factor shaping school segregation patterns. Likewise, racial differences in exposure to minority schoolmates and neighbors may contribute to achievement gaps, because of the disproportionately high poverty rates among minority students.

Moreover, other forms of segregation—such as racial segregation *per se*—may affect outcomes other than academic achievement gaps. In *Brown*, the Court was concerned with the psychological harms of racial segregation, not its effects on academic achievement. Nothing in the results presented here should be construed as demonstrating that there are no direct harms from racial isolation. It is certainly possible that *de facto* racial segregation, even in the absence of *de jure* segregation and differences in exposure to poverty, may damage minority students' self-concept in the ways documented by Kenneth and Mamie Clark and others cited in the *Brown* decision (Clark & Clark, 1939a, 1939b; Clark & Clark, 1950; Deutscher, Chein, & Sadigur, 1948). It may also lead to lower-between-group understanding and empathy and increased prejudice (Pettigrew & Tropp, 2006). It may degrade students' ability to collaborate in diverse settings and may hamper the collective functioning of a democratic society (Page, 2008). It may lead to segregated social networks that persist long beyond high school and create unequal

opportunities in the labor market and unequal access to social and political capital. My finding here that racial segregation *per se* is not independently associated with academic achievement gaps, net of racial differences in exposure to poverty, does not rule out these many other potential consequences of racial isolation.

This study is not new in identifying a strong association between racial segregation and academic achievement gaps. It does, however, provide a much sharper description of what features of segregation patterns are most strongly predictive of academic achievement gaps. The evidence here very clearly shows that racial differences in exposure to poor schoolmates is linked to achievement gaps. Black and Hispanic students' test scores, relative to whites', are much lower when black and Hispanic students attend schools with more poor classmates.

These results imply that reducing school segregation—in particular, reducing racial disparities in exposure to poor classmates—might lead to meaningful reductions in racial achievement gaps. This might be accomplished in many ways. Although it is not the racial composition of schools that appears to drive the effects here, eliminating racial segregation would necessarily eliminate racial differences in exposure to school poverty (if all schools have identical racial composition, then students of all races necessarily attend schools with the same average poverty levels). Eliminating economic segregation among schools would also eliminate racial differences in exposure to poverty. Substantially reducing poverty—particularly among black and Hispanic families—would sharply reduce racial disparities in exposure to poverty as well, particularly if racial segregation is high. Regardless of the method of achieving it, reducing differences in exposure to poverty may be an effective means of improving the equality of students' access to high-quality educational opportunities.

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Table 1

Dimensions of Metropolitan Area Segregation

	Residential Segregation		School Segregation	
	Total	Between-District	Total	Between-District
Black Students' Exposure to:				
Black Neighbors/Classmates	x	x	x	x
Poor Neighbors/Classmates	x	x	x	x
Difference Between Black and White Students' Exposure to:				
Black Neighbors/Classmates	x	x	x	x
Poor Neighbors/Classmates	x	x	x	x

Table 2

Bivariate Correlations Between White-Black Achievement Gap and Various Dimensions of Segregation, 325 Metropolitan Areas, 2009-2012

	School Segregation		Residential Segregation	
	Total	Between-District	Total	Between-District
Black Students' Exposure to:				
Black Neighbors/Classmates	0.394 ***	0.350 ***	0.363 ***	0.332 ***
Poor Neighbors/Classmates	0.222 ***	0.154 **	0.208 ***	0.002
Difference Between Black and White Students' Exposure to:				
Black Neighbors/Classmates	0.432 ***	0.340 ***	0.410 ***	0.316 ***
Poor Neighbors/Classmates	0.623 ***	0.452 ***	0.474 ***	0.348 ***

Note: each cell is the bivariate correlation between the pooled white-black achievement gap and a measure of segregation. * p<.05; ** p<.01; *** p<.001.

Table 3

Bivariate Correlations Between White-Hispanic Achievement Gap and Various Dimensions of Segregation, 328 Metropolitan Areas, 2009-2012

	School Segregation		Residential Segregation	
	Total	Between-District	Total	Between-District
Hispanic Students' Exposure to:				
Hispanic Neighbors/Classmates	0.402 ***	0.350 ***	0.327 ***	0.316 ***
Poor Neighbors/Classmates	0.141 *	-0.031	0.036	-0.111 *
Difference Between Hispanic and White Students' Exposure to:				
Hispanic Neighbors/Classmates	0.599 ***	0.507 ***	0.520 ***	0.499 ***
Poor Neighbors/Classmates	0.678 ***	0.516 ***	0.461 ***	0.388 ***

Note: each cell is the bivariate correlation between the pooled white-Hispanic achievement gap and a measure of segregation. * p<.05; ** p<.01; *** p<.001.

Table 4

Partial Correlations Between White-Black Achievement Gap and Various Dimensions of Segregation, 325 Metropolitan Areas, 2009-2012

	School Segregation		Residential Segregation	
	Total	Between-District	Total	Between-District
Black Students' Exposure to:				
Black Neighbors/Classmates	0.153 **	0.104	0.124 *	0.081
Poor Neighbors/Classmates	0.084	0.023	0.116 *	-0.062
Difference Between Black and White Students' Exposure to:				
Black Neighbors/Classmates	0.336 ***	0.252 ***	0.322 ***	0.215 ***
Poor Neighbors/Classmates	0.464 ***	0.409 ***	0.382 ***	0.319 ***

Note: each cell is the partial correlation between the pooled white-black achievement gap and a measure of segregation, conditional on metropoltian area characteristics. The top panel (partial correlations with exposure measures) includes controls for racial disparities in family socioeconomic status and metropolitan area fragmentation. The bottom panel (partial correlations with differential exposure measures) includes the same covariates as the top panel plus additional controls for metropolitan area racial and socioeconomic composition as well as per pupil average spending. See text for details. * p<.05; ** p<.01; *** p<.001.

Table 5

Partial Correlations Between White-Hispanic Achievement Gap and Various Dimensions of Segregation, 328 Metropolitan Areas, 2009-2012

	School Segregation		Residential Segregation	
	Total	Between-District	Total	Between-District
Hispanic Students' Exposure to:				
Hispanic Neighbors/Classmates	0.202 ***	0.148 *	0.160 **	0.120 *
Poor Neighbors/Classmates	-0.150 *	-0.261 ***	-0.127 *	-0.306 ***
Difference Between Hispanic and White Students' Exposure to:				
Hispanic Neighbors/Classmates	0.220 ***	0.086	0.128 *	0.029
Poor Neighbors/Classmates	0.350 ***	0.222 ***	0.171 **	0.173 **

Note: each cell is the partial correlation between the pooled white-Hispanic achievement gap and a measure of segregation, conditional on metropoltian area characteristics. The top panel (partial correlations with exposure measures) includes controls for racial disparities in family socioeconomic status and metropolitan area fragmentation. The bottom panel (partial correlations with differential exposure measures) includes the same covariates as the top panel plus additional controls for metropolitan area racial and socioeconomic composition as well as per pupil average spending. See text for details. * p<.05; ** p<.01; *** p<.001.

Table 6: Coefficient Estimates and Hypothesis Tests from Multivariate Regression Models of the Association Between White-Black Achievement Gap and Segregation, 325 Metropolitan Areas, 2009-2012

	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5
Difference Between Black and White Students' Exposure to:						
a. District enrollment proportion black		0.256		0.306		
		(0.278)		(0.301)		
b. District residents proportion black		-0.432		-0.632 *		
		(0.299)		(0.301)		
c. District enrollment proportion poor		0.680 ***		0.286	0.111	
		(0.160)		(0.220)	(0.144)	
d. District residents proportion poor		0.137		-0.062		
		(0.543)		(0.561)		
e. School enrollment proportion black			-0.157	0.020		
			(0.157)	(0.219)		
f. Neighborhood residents proportion black			0.145	0.172		
			(0.151)	(0.159)		
g. School enrollment proportion poor			0.636 ***	0.371	0.597 ***	0.687 ***
			(0.134)	(0.207)	(0.142)	(0.079)
h. Neighborhood residents proportion poor			0.267	0.347		
			(0.293)	(0.313)		
Adjusted R-squared	0.620	0.681	0.698	0.702	0.698	0.698
N	325	325	325	325	325	325
Hypothesis tests (*p*-values)						
residential exposure = 0 (b=d=f=h=0)		0.342	0.301	0.132		
educational exposure = 0 (a=c=e=g=0)		0.000 ***	0.000 ***	0.000 ***		
district composition = 0 (a=b=c=d=0)				0.111	0.442	
school/neighborhood composition = 0 (e=f=g=h=0)				0.000 ***	0.000 ***	
exposure to racial composition = 0 (a=b=e=f=0)		0.200	0.582	0.155		
exposure to poverty = 0 (c=d=g=h=0)		0.000 ***	0.000 ***	0.000 ***	0.000 ***	
only educational exposure to poverty ≠ 0 (a=b=d=e=f=h=0)		0.315	0.492	0.155		
only school exposure to poverty ≠ 0 (a=b=c=d=e=f=h=0)				0.192		

Table 7: Coefficient Estimates and Hypothesis Tests from Multivariate Regression Models of the Association Between White-Hispanic Achievement Gap and Segregation, 328 Metropolitan Areas, 2009-2012

	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5
Difference Between Hispanic and White Students' Exposure to:						
a. District enrollment proportion Hispanic		0.161		0.124		
		(0.239)		(0.302)		
b. District residents proportion Hispanic		-0.544		-0.475		
		(0.315)		(0.307)		
c. District enrollment proportion poor		0.401 *		-0.256	-0.265	
		(0.189)		(0.248)	(0.160)	
d. District residents proportion poor		0.476		0.670		
		(0.711)		(0.749)		
e. School enrollment proportion Hispanic			0.120	0.251		
			(0.218)	(0.280)		
f. Neighborhood residents proportion Hispanic			-0.221	-0.181		
			(0.268)	(0.269)		
g. School enrollment proportion poor			0.667 ***	0.744 ***	0.796 ***	0.593 ***
			(0.153)	(0.216)	(0.155)	(0.095)
h. Neighborhood residents proportion poor			-0.321	-0.390		
			(0.364)	(0.397)		
Adjusted R-squared	0.727	0.743	0.760	0.762	0.762	0.761
N	328	328	328	328	328	328
Hypothesis tests (*p* -values)						
residential exposure = 0 (b=d=f=h=0)		0.226	0.331	0.358		
educational exposure = 0 (a=c=e=g=0)		0.014 *	0.000 ***	0.000 ***		
district composition = 0 (a=b=c=d=0)				0.261	0.099	
school/neighborhood composition = 0 (e=f=g=h=0)				0.000 ***	0.000 ***	
exposure to racial composition = 0 (a=b=e=f=0)		0.114	0.701	0.449		
exposure to poverty = 0 (c=d=g=h=0)		0.001 ***	0.000 ***	0.001 ***	0.000 ***	
only educational exposure to poverty ≠ 0 (a=b=d=e=f=h=0)		0.226	0.507	0.554		
only school exposure to poverty ≠ 0 (a=b=c=d=e=f=h=0)				0.368		

Figure 1

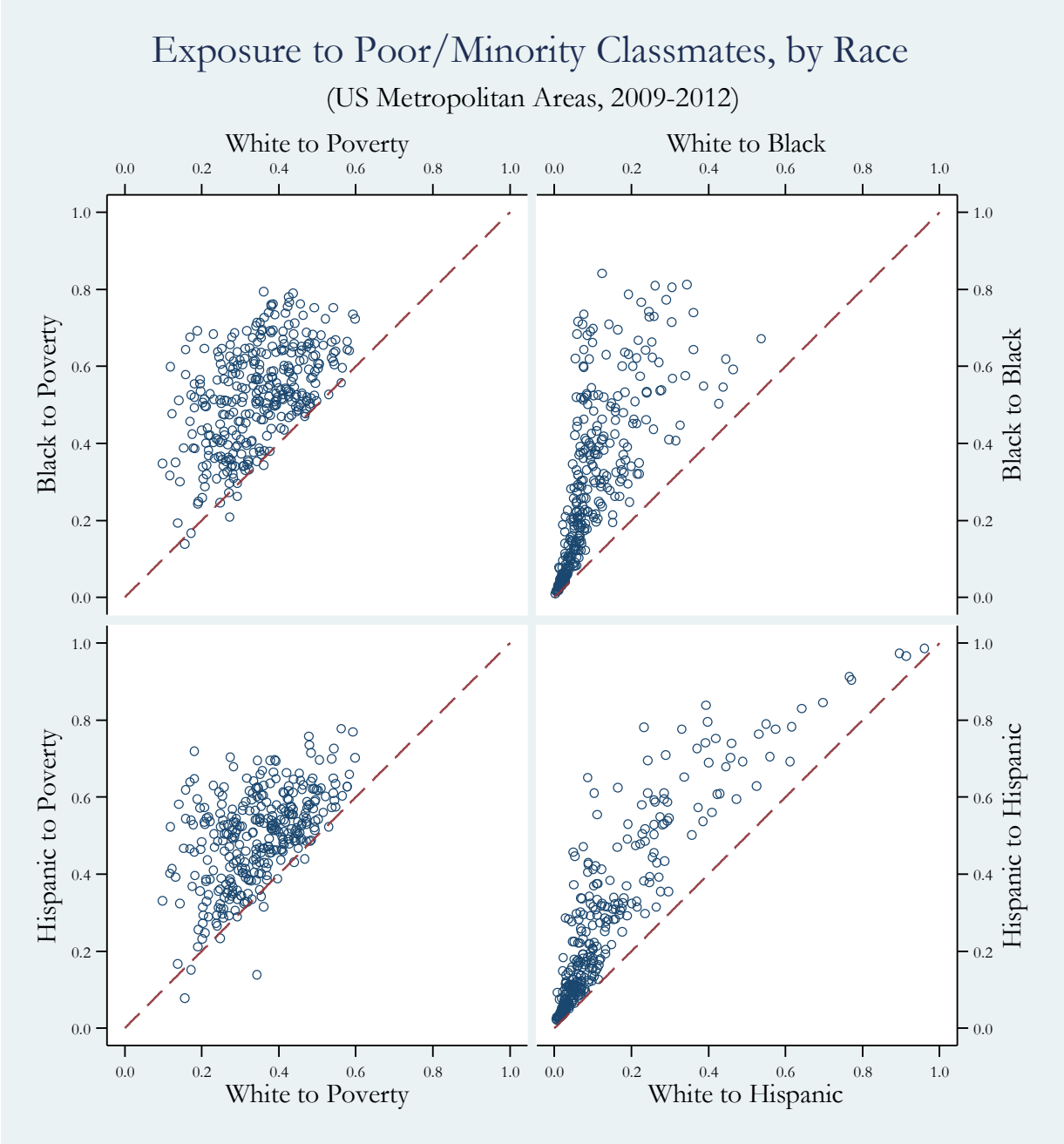
Exposure to Poor/Minority Classmates, by Race
(US Metropolitan Areas, 2009-2012)
White to Poverty
White to Black
Black to Poverty
Black to Black
Hispanic to Poverty
Hispanic to Hispanic
White to Poverty
White to Hispanic
0.0
0.2
0.4
0.6
0.8
1.0

Table A1: Correlation Matrix of Metrorpolitan Area Black-White Segregation Measures

	Exposure to…								Black-White Difference in Exposure to…							
	Black				Poor				Black				Poor			
	Students in…		Neighbors in…		Students in…		Neighbors in…		Students in…		Neighbors in…		Students in…		Neighbors in…	
	District	School	District	Tract	District	School	District	Tract	District	School	District	Tract	District	School	District	Tract
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1)	1.00															
(2)	0.97	1.00														
(3)	0.99	0.97	1.00													
(4)	0.94	0.97	0.95	1.00												
(5)	0.63	0.62	0.62	0.62	1.00											
(6)	0.61	0.64	0.61	0.65	0.93	1.00										
(7)	0.51	0.47	0.50	0.46	0.76	0.70	1.00									
(8)	0.56	0.56	0.54	0.54	0.69	0.70	0.74	1.00								
(9)	0.81	0.74	0.78	0.70	0.61	0.52	0.57	0.54	1.00							
(10)	0.89	0.92	0.88	0.89	0.63	0.63	0.51	0.59	0.88	1.00						
(11)	0.80	0.73	0.79	0.71	0.58	0.50	0.57	0.52	0.98	0.87	1.00					
(12)	0.85	0.90	0.86	0.95	0.63	0.65	0.48	0.57	0.78	0.94	0.79	1.00				
(13)	0.53	0.47	0.51	0.45	0.59	0.49	0.53	0.41	0.81	0.66	0.79	0.58	1.00			
(14)	0.60	0.62	0.59	0.60	0.59	0.63	0.46	0.49	0.74	0.78	0.72	0.72	0.87	1.00		
(15)	0.54	0.47	0.52	0.44	0.55	0.44	0.66	0.52	0.81	0.66	0.81	0.56	0.89	0.76	1.00	
(16)	0.62	0.63	0.60	0.62	0.63	0.65	0.55	0.80	0.69	0.74	0.67	0.72	0.67	0.78	0.71	1.00

Table A2: Correlation Matrix of Metrorpolitan Area Hispanic-White Segregation Measures

	Exposure to…								Hispanic-White Difference in Exposure to…							
	Hispanic				Poor				Hispanic				Poor			
	Students in…		Neighbors in…		Students in…		Neighbors in…		Students in…		Neighbors in…		Students in…		Neighbors in…	
	District	School	District	Tract	District	School	District	Tract	District	School	District	Tract	District	School	District	Tract
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1)	1.00															
(2)	0.99	1.00														
(3)	1.00	0.98	1.00													
(4)	0.98	0.98	0.98	1.00												
(5)	0.21	0.23	0.19	0.22	1.00											
(6)	0.38	0.43	0.37	0.39	0.89	1.00										
(7)	0.31	0.30	0.32	0.33	0.66	0.58	1.00									
(8)	0.36	0.36	0.36	0.38	0.50	0.48	0.77	1.00								
(9)	0.63	0.63	0.60	0.57	0.31	0.41	0.27	0.27	1.00							
(10)	0.70	0.76	0.67	0.68	0.33	0.52	0.21	0.27	0.89	1.00						
(11)	0.38	0.38	0.36	0.32	0.29	0.29	0.22	0.23	0.88	0.75	1.00					
(12)	0.78	0.83	0.76	0.80	0.35	0.51	0.28	0.32	0.82	0.94	0.65	1.00				
(13)	0.20	0.23	0.17	0.16	0.44	0.42	0.28	0.25	0.75	0.65	0.78	0.53	1.00			
(14)	0.37	0.43	0.33	0.35	0.44	0.57	0.20	0.24	0.72	0.80	0.70	0.70	0.87	1.00		
(15)	0.06	0.08	0.03	0.04	0.38	0.28	0.44	0.36	0.56	0.45	0.71	0.35	0.86	0.69	1.00	
(16)	0.40	0.44	0.38	0.42	0.45	0.49	0.50	0.67	0.61	0.63	0.61	0.63	0.69	0.73	0.72	1.00