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The Geography of Racial/Ethnic Test Score Gaps

AUTHORS

Sean F. Reardon
Stanford University

Demetra Kalogrides
Stanford University

Ken Shores
Stanford University

ABSTRACT

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Sean F. Reardon

Demetra Kalogrides

Kenneth Shores

Stanford University

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Abstract

We estimate racial/ethnic achievement gaps in several hundred metropolitan areas and several thousand school districts in the United States using new data based on the results of roughly 200 million standardized math and reading tests administered to elementary and middle school students from 2009-2012. We find substantial geographic variation in the magnitude of achievement gaps, ranging from nearly 0 in some places to larger than 1.2 standard deviations in others. A vector of economic, demographic, segregation and schooling characteristics variables explains roughly three-quarters of the geographic variation in these gaps. The strongest correlates of achievement gaps are racial/ethnic differences in parental income, parental education, and racial/ethnic segregation. Nonetheless, even after adjusting for racial socioeconomic inequality and segregation, many school districts and metropolitan areas have larger or smaller achievement gaps than predicted, suggesting that other forces are at work as well.

Introduction

Racial and ethnic disparities in children's academic performance are a stubborn feature of the US educational landscape. Though these achievement gaps are substantially smaller than they were 40 years ago, they remain quite large, on the order of two-thirds to three-quarters of a standard deviation (Neal 2006; Reardon, Robinson-Cimpian and Weathers 2015). They are large when children enter kindergarten and remain large through high school (Fryer and Levitt 2004; Hemphill, Vanneman and Rahman 2011; Phillips, Crouse and Ralph 1998; Reardon and Galindo 2009; Vanneman et al. 2009).

The size and trends of these gaps vary among states (Hemphill, Vanneman and Rahman 2011; Reardon 2015; Vanneman et al. 2009), though in no state are they near zero. National- and state-level patterns, however, may mask considerable variation in academic achievement patterns at smaller geographic scales. Metropolitan areas and counties, for example, vary widely in demographic composition, patterns of racial socioeconomic inequality and racial segregation, and in the structure of their schooling systems. The roughly 14,000 school districts in the U.S. likewise differ substantially in their demographics, patterns of inequality and segregation, and educational resources. They also each have autonomy over some—but not all—important features of the schooling system, including their curricula, their student and teacher assignment policies, and how resources are distributed among and within schools. These demographic and institutional factors may lead to significant variation in the size of achievement gaps among both metropolitan areas and school districts.

In this paper, we provide a detailed descriptive analysis of the patterns of white-black and white-Hispanic academic achievement gaps across US metropolitan areas and school districts. We use new data to estimate achievement gaps in almost every metropolitan area and school district in the US with a significant population of black or Hispanic students. The precision and detail of our estimates—which are based on the results of roughly 200 million standardized math and reading tests administered to elementary and middle school students from 2009-2012—far surpasses that of any previously available

data. Using these estimates, we first describe the geographic patterns of achievement gaps among metropolitan areas, and school districts in the US. We then examine the extent to which these gaps are correlated—in both bivariate and multivariate models—with socioeconomic characteristics of the white, black, and Hispanic populations, with patterns of residential and school segregation, and with local features of the educational system.

We find that racial/ethnic achievement gaps average roughly 0.5 to 0.7 standard deviations among school districts and metropolitan areas. There is substantial geographic variation in the magnitude of achievement gaps, ranging from nearly 0 in some places to larger than 1.2 standard deviations in others. A vector of economic, demographic, segregation and policy variables explains roughly three-quarters of the geographic variation in these gaps. The strongest correlates of achievement gaps are racial/ethnic differences in parental income and education, and racial/ethnic segregation. After adjusting for variation among places in racial socioeconomic inequality and segregation, many school districts and metropolitan areas have larger or smaller achievement gaps than predicted, suggesting that other forces are at work as well.

Our goal is not to estimate the causal effects of any one particular feature of children's environments or of schools on achievement gaps, but rather to ask a set of descriptive questions whose answers may help to build intuition and generate hypotheses regarding the causes of the observed achievement gaps. Think of this as a necessary, but not sufficient, analysis for understanding the causes of academic achievement gaps—providing a detailed description of the "stylized facts" regarding racial/ethnic achievement gaps.

Background Theoretical Framework

One of the central sets of questions in the sociology of education for the last 50 years—since the publication of the Coleman Report (Coleman, et al., 1966)—concerns the primary causes of racial and

ethnic achievement gaps and disparities in educational outcomes more generally. To what extent are these disparities the result of racial/ethnic differences in socioeconomic family background and circumstances, and to what extent are they the result of racial/ethnic differences in school quality? Put differently, to what extent should racial/ethnic disparities in educational outcomes be attributed to institutional features of the US educational system—features that may be malleable through changes in organizational, institutional, and policy features of schooling—and to what extent should they be attributed to factors outside the school system's control, such as racial/ethnic disparities in socioeconomic family and neighborhood conditions?

Framed this way—as if inequalities inside the school system are distinct from inequalities outside of schools—the question implies a false dichotomy. Differences in socioeconomic conditions are not fully separable from disparities in educational conditions. Socioeconomic inequality may lead to inequality between and within schools, as communities with greater resources are able to better fund their local schools (in taxes and other ways). Parents in such communities may also use their greater social capital to secure better educational opportunities (better teachers, smaller classrooms, for example) for their children than less advantaged children within the same schools. Moreover, school systems react to social inequalities in ways that may reduce or exacerbate these inequalities. In many states, spending is greater in schools enrolling low-income students, for example; this may attenuate differences in out-of-school opportunities. Conversely, school systems may also reinforce social inequalities by segregating children from low-income families into less demanding academic programs and/or into high poverty schools or by providing fewer resources to the classrooms and schools that enroll low-income students.

[Figure 1 Here]

Figure 1 illustrates—in highly stylized form—some of the complex relationships between schooling and non-schooling factors that might affect achievement gaps. On the left of the figure are two primary categories of distal influences on achievement gaps. First are racial family socioeconomic

disparities (i.e., racial differences in family income, parental education, and other forms of social and economic resources). These disparities are quite large in the U.S. For example, the median incomes of black and Hispanic families are 38% and 36% lower, respectively, than that of white, non-Hispanic families;[1] median black and Hispanic household wealth are less than 10% as large as median white wealth (Sullivan et al. 2015; Wolff 2014); and only 22% of black adults and 15% of Hispanic adults hold a bachelor's degree, compared to 36% of white adults.[2] Second are education policies and structures (such as school finance policies, student assignment policies, and the like); we discuss these at more length below. Both of these factors may lead to academic achievement gaps through multiple pathways.

On the center right of the figure are four categories of potential proximal sources of academic achievement gaps: racial differences in children's home environments; racial differences in children's neighborhood contexts (distinct from home and school environments); between-school racial differences in schooling experiences and opportunities; and within-school racial differences in schooling experiences and opportunities. Each of these might encompass many potential mechanisms.

First, racial differences in children's home environments include differences in opportunities for learning at home—differences in the amount of time parents have to read to their children; in children's access to computers, libraries, and museums; in parental investments in tutoring and other educational activities; in parental human and social capital; and differences in parental stress and depression. All of these experiences are affected by family socioeconomic status; high-income and highly-educated parents have, on average, more resources to foster and support their children's academic skills outside of school (Bassok et al. 2015; Bradley et al. 2001; Chin and Phillips 2004; Lareau 2003; Phillips 2011). To the extent that these affect students' academic achievement, it follows that racial differences in socioeconomic status would then lead to racial differences in academic achievement, net of other factors. Recent studies

[1] http://www.census.gov/compendia/statab/2012/tables/12s0697.pdf; retrieved September 3, 2015.
[2] See Table 3 at http://www.census.gov/hhes/socdemo/education/data/cps/2014/tables.html; retrieved September 3, 2015.

indicate this is the case; income affects children's academic achievement (Dahl and Lochner 2012; Duncan, Morris and Rodrigues 2011), though the exact pathways through which these effects operate are not clear. Moreover, racial differences in family socioeconomic conditions explain a large portion of racial achievement gaps present when children enter kindergarten (Fryer and Levitt 2004; Fryer and Levitt 2006; Reardon and Galindo 2009; Rothstein and Wozny 2013). There is less clarity about whether achievement gaps grow in ways unrelated to socioeconomic background differences as children progress through school.

Second, racial differences in family economic circumstances affect residential segregation patterns (though housing discrimination and racial preferences shape segregation patterns as well; for a review, see Lareau and Goyette 2014). This means that black and Hispanic children live, on average, in poorer neighborhoods than white children. In fact, black and Hispanic children live in much poorer neighborhoods, relative to white children, than would be expected based on their family income (Logan 2011; Pattillo 2013; Reardon, Fox and Townsend 2015; Sharkey 2014). Poorer neighborhoods typically have higher violent crime rates (Sampson, Raudenbush and Earls 1997) and weaker non-school social institutions (such as availability of high-quality child care and pre-school programs; safe parks and playgrounds; and constructive after-school activities, such as clubs and sports teams (Small 2006). These and other factors have long been hypothesized to affect schooling outcomes (Jencks and Mayer 1990; Leventhal and Brooks-Gunn 2000; Sampson 1998), and new evidence from the MTO experiment and other studies confirms that neighborhood conditions affect educational attainment (Burdick-Will et al. 2011; Chetty, Hendren and Katz 2015; Sampson, Sharkey and Raudenbush 2008; Sharkey 2010; Wodtke, Harding and Elwert 2011). This implies that residential segregation patterns may lead to disparities in educational outcomes (see, for example, Ananat 2009; Card and Rothstein 2007; Cutler and Glaeser 1997).

While the top two boxes at the right of Figure 1 describe potential out-of-school influences on

racial achievement gaps, the bottom two describe potential school-related influences. These are divided into within- and between-school factors. The key to both is that achievement gaps may be caused, in part, by racial differences in school experiences and opportunities. These differences in experiences and opportunities may result from students attending different schools (between-school segregation) or they may occur even among students attending the same school. Between-school segregation is a necessary (though not sufficient) condition for between-school differences in educational experiences and opportunities to contribute to achievement gaps; if black, Hispanic, and white students are equally represented in each school, then each group will experience the same average level of (and the same variation in) school quality. In the presence of segregation, however, if school racial composition is correlated with school resources (which affect the ability to attract and retain skilled teachers; teacher/student ratios; the quality of instructional materials, equipment, and facilities; the availability of support staff; and less tangible factors like school climate), then black and Hispanic students will, on average, experience fewer opportunities for learning than their white peers. Although the effects of school segregation are difficult to estimate, recent research suggests that school segregation tends to widen racial educational disparities in achievement and educational attainment, as well as adult income (Ashenfelter, Collins and Yoon 2005; Card and Rothstein 2007; Guryan 2004; Johnson 2011).

Historically, fewer resources were available to school districts serving large proportions of black, Hispanic, and poor children compared to those serving predominantly white and middle-class students; however, this pattern has been eliminated or reversed in many states. As a result of state school financing reforms enacted by state legislatures or ordered by courts, per-pupil revenues are now modestly *positively* correlated with districts' enrollment rates of poor and minority students within most states (Cornman 2015). This means that in most states—conventional wisdom notwithstanding—poor and minority students are enrolled in districts with higher per-pupil spending than white and middle-class students, although there are notable exceptions. Cost-adjustments can affect this inference, as high

poverty school districts have greater costs than low poverty districts (Bifulco 2005). Given recent evidence indicating that school spending positively affects student achievement and graduation rates (Jackson, Johnson and Persico 2014; Lafortune, Rothstein and Schanzenbach 2015), this suggests that school policies affecting the distribution of resources among school districts may have important effects on achievement gaps.

Despite the fact that in some states, school districts serving predominantly poor students spend more per pupil than those serving higher-income students, low-income and non-white students are, on average, more likely to have inexperienced teachers and greater teacher turnover (Clotfelter, Ladd and Vigdor 2005; Lankford, Loeb and Wycoff 2002; Scafidi, Sjoquist and Stinebrickner 2007), some of which may be due to the fact that high poverty districts must pay teachers more to attract them (Clotfelter et al. 2008). Higher salaries are thought to be necessary because teachers value working conditions that tend to be correlated with the demographic composition of schools such as safety, proximity of the school to their place or residence, leadership stability, availability of support staff (Boyd et al. 2011; Boyd et al. 2005a; Boyd et al. 2005b).

The reason that we cannot cleanly distinguish between the influence of out-of-school family socioeconomic disparities and the role of schooling policies and practices in producing achievement gaps is that school segregation is shaped by both factors (as well as by other forces, including housing policy, housing discrimination and preferences, and private school enrollment patterns). Moreover, the extent to which school segregation is linked to between-school racial disparities is dependent on educational policies and practices. If education policy were successful at achieving the "separate but equal" standard articulated in *Plessy v. Ferguson*, school segregation would not be linked to between-school differences in the quality of educational experiences. While there is no evidence that this has ever been, or is likely to be, achieved, education policy may nonetheless moderate the relationship between segregation and unequal school quality. Policies that provide extra resources to schools serving large proportions of poor

and minority students, for example, may weaken the link between school racial and socioeconomic composition and school quality. The effect of such policies is signified by the dashed line in Figure 1.

The processes sketched in Figure 1 suggest that the factors that produce academic achievement disparities cannot be neatly separated into inequalities in family socioeconomic background and inequalities in schooling experiences. Rather there are three sets of forces at work—1) differences in children's home and neighborhood environments that are due to family socioeconomic resources; 2) differences in children's schooling experiences that are due to education policy and practice rather than family socioeconomic differences; and 3) differences in children's schooling experiences that are jointly produced by racial disparities in family resources—which lead to school segregation—and by educational policies and practices which more or less tightly link school segregation to patterns of unequal school quality.

Figure 1 highlights how differences between racial/ethnic groups along a variety of dimensions contribute to achievement gaps. However, these are not necessarily the only factors at play. For example, within-school racial differences in experiences and opportunities to learn may also play a role. Within any school, teachers' skills vary, as do the curricula, instructional practices, and peer composition of different classrooms. If these differences are patterned by race—because of tracking, differences in teacher expectations, differences in parents' effectiveness at advocating for their children, or other reasons—then these within-school racial differences in educational opportunities and experiences may lead to achievement disparities.

In addition, although Figure 1 highlights racial disparities in socioeconomic, neighborhood, and school conditions as contributors to racial achievement gaps, achievement gaps may also covary with average socioeconomic conditions. Some existing scholarship notes that the white-black achievement gap is often large even in relatively affluent, racially diverse communities (Lewis and Diamond 2015; Ogbu 2003), and suggests that this may be due to processes within schools that provide more opportunities to

white students than minority students, even in contexts of relative affluence. It is not clear, however, whether the achievement gaps in such communities are larger or smaller than in poorer communities with similar levels of racial socioeconomic disparity and segregation. For example, racial socioeconomic disparities and patterns of segregation may affect educational opportunities less in contexts of relative advantage than do comparable disparities in disadvantaged communities. Resource and context differences may be more salient when there are few resources to go around. On the other hand, given the sometimes competitive focus on academic success in affluent communities, racial socioeconomic disparities may be particularly salient, as economic and social capital may matter in such contexts. Hanushek and Rivkin (2009), for example, show that school segregation appears most harmful to high-achieving minority students, possibly because differences in access to the best schools particularly limits high-achieving students' educational opportunities. This is consistent with a substantial body of ethnographic and social psychological work that illustrates how subtle structural and exclusionary processes may limit minority students' opportunities and advantage white students, even in (or perhaps particularly in) schools enrolling largely middle- and high-income white and minority students (Carter 2012; Lewis and Diamond 2015; Ogbu 2003).

Finally, it is worth noting that Figure 1 describes a set of uni-directional relationships between family and educational effects on achievement gaps. Racial family socioeconomic disparities and education policies affect achievement gaps, in this stylized model, but not vice-versa. However, over a longer time period, there are certainly processes that work in the other direction as well. Racial achievement gaps in one generation shape racial disparities in the next generation's parental educational attainment and family income (Carneiro, Heckman and Masterov 2003; Neal and Johnson 1996) and public policy reactions (such as school desegregation or changes in school funding policies) to persistent racial achievement disparities may shape children's schooling environments. A full model of the dynamic associations among socioeconomic inequality, schooling conditions, and achievement gaps would take

these feedback processes into account, but that is beyond the scope of our analyses here.

The Geographic Scale of Achievement Gaps

The conceptual model illustrated in Figure 1 suggests that racial achievement gaps are dependent partly on local racial socioeconomic disparities, segregation patterns, and school policies, practices, and conditions. To the extent that these factors vary geographically, our model predicts corresponding variation in achievement gaps. To date, however, we have little systematic evidence regarding the geographic variation in these gaps.

The best evidence on racial/ethnic achievement gaps in the US comes from the National Assessment of Educational Progress (NAEP), a set of reading and math assessments that have been administered to large, national representative samples of students since 1971. Since 1990, NAEP assessments have been administered to state-representative samples as well. The NAEP assessments indicate that the white-black achievement reading and math gaps were both over 1 standard deviation in the 1970s; by 2012, those gaps had shrunk to roughly 0.60 and 0.80 standard deviations, respectively. The white-Hispanic gaps in reading and math have historically been slightly smaller than white-black gaps, but have followed a similar trend over the last 4 decades, and now are roughly 0.50 and 0.60 standard deviations in reading and math, respectively (National Center for Education Statistics 2013; Reardon 2015; Reardon, Robinson-Cimpian and Weathers 2015).

At the state level most states' white-black achievement gaps in the last decade are between 0.75 and 1.10 standard deviations, though in states with small black populations, the gaps are generally smaller, in some cases less than 0.50 standard deviations. State white-Hispanic gaps generally range from 0.50 to 1.0 standard deviations in this same time period. On average, state achievement gaps have narrowed slightly in the last two decades, though this varies among states (Hemphill, Vanneman and Rahman 2011; Reardon 2015; Vanneman et al. 2009). Reardon (2015) shows that state-level achievement

gaps are correlated with state racial socioeconomic disparities: achievement gaps are largest, on average, in states with large racial differences in family income, poverty rates, educational attainment, and unemployment rates.

Evidence about the national and state-level patterns and trends of achievement gaps are useful as descriptors of overall patterns of inequality in educational outcomes in the U.S. Nonetheless, they reveal little about local patterns of racial inequality and are, by themselves, relatively uninformative regarding the processes that produce and sustain achievement gaps. Large national and state-level achievement gaps do not necessarily imply that gaps are large in most school districts. If most black and Hispanic students are in school districts where all students—white students included—perform poorly on standardized tests, and most white students are in school districts where all students—including black and Hispanic students—perform well, then most students would encounter little racial achievement inequality in their own district, even while state and national achievement gaps are large.

Such patterns would suggest that the forces producing achievement gaps do not operate primarily *within* schools and districts, but *between* school districts. The primary candidates for between-district mechanisms are residential segregation and inequality among school district in resources and quality. Conversely, if gaps are large within individual school districts, between-district forces cannot fully account for achievement gaps; instead, within-district racial socioeconomic inequality, between-school segregation, and the unequal distribution of resources and opportunities to learn within schools are the likely suspects.

Given the potential importance of variation in local conditions in shaping achievement gaps, our goal in this paper is to provide detailed descriptions of 1) the size and variation in racial/ethnic achievement gaps among both school districts and metropolitan areas; and 2) the associations of these gaps with a set of measures of family socioeconomic conditions, segregation patterns, and school policies and characteristics. We focus on both school districts and metropolitan areas for complementary

reasons.

School districts are a key organizational unit of the U.S. public school system. They have a large—though not complete—degree of autonomy over curricula, instruction, student assignment, teacher hiring, and the distribution of resources among schools. Thus there is reason to think that school districts may vary substantially in practices that affect between- and within-school disparities in educational opportunities. Districts are also organizational units with clear geographic boundaries and relatively well-known "brands" (based on easily observable features, such as average test scores and student body composition), which means that families with sufficient resources can choose to live in the most desirable districts. This leads to relatively high levels of socioeconomic variation among school districts (Owens 2015). Finally, districts vary enormously in size; in large districts there is far more possibility of between-school segregation and between-school differences in school quality and opportunities. These factors suggest that the conditions that lead to achievement gaps may differ markedly among school districts.

A focus on school districts may obscure patterns of inequality evident at larger geographic scales, however. Because housing prices differ markedly among school districts, socioeconomic and racial differences among districts can be larger than those within districts. For example, roughly two-thirds of all school segregation is due to between-district patterns of segregation (Reardon, Yun and Eitle 2000; Stroub and Richards 2013). Racial socioeconomic disparities are likewise smaller within school districts than in the population at large. We examine achievement gaps within metropolitan areas in order to account for these between-district sorting processes. Although metropolitan areas are not part of the formal organizational structure of the public schooling system, they encompass much of the relevant ecosystem for studying residential and school segregation, in part because most of the residential segregation relevant to inequality occurs within metropolitan areas, not between them (Cutler and Glaeser 1997). As a result, a great deal of social science research treats metropolitan areas as a key geographic unit for studying the patterns and consequences of segregation (see, for example, Card and

Rothstein 2007; Logan, Oakley and Stowell 2008; Owens 2015; Reardon, Yun and Eitle 2000). We follow this tradition in including metropolitan area achievement gaps in our analyses.

Estimating School District and Metropolitan Area Racial Achievement Gaps

Our analysis relies on the construction of reliable and comparable measures of racial achievement gaps at the school district and metropolitan area levels. To construct these measures, we rely on a newly available source of data, containing aggregated data on the scores of roughly 200 million tests taken by some 40 million 3rd-8th grade students in U.S. public schools from 2009 to 2012. Because the test scores available are reported in ordered proficiency categories rather than continuous scale scores, we estimate achievement gaps using new methods for estimating between-group differences from coarsened data (Ho and Reardon 2012; Reardon and Ho 2015). Because these data and methods have not been used before to construct and compare racial achievement gaps, we describe the data and our methods below in some detail.

Achievement Data Source and Geographic Coverage

We use data from the federal EDFacts data collection system, which were provided to us by the National Center for Education Statistics under a restricted data use license. The data include, for each public school 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 (we 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). We aggregate the school-level counts to the district level. We combine the proficiency counts of 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, in our analysis, a

"school district" includes students in all local charter schools as well as in traditional public schools. For metropolitan areas, we aggregate data from all public schools and 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 we cannot construct aggregated data for metropolitan areas that cross state boundaries. Only 45 of 384 metropolitan areas cross state lines, however.

There are 384 metropolitan areas and roughly 12,200 school districts serving grades 3-8 in the United States. The EdFacts data span 6 grades, 2 subjects, and 4 years, making a total of roughly 585,600 possible district-grade-subject-year combinations and 18,400 possible metropolitan area-grade-subject-year combinations. In each of these cells, we compute both the white-black and white-Hispanic achievement gap. We exclude cells with fewer than 20 white and/or 20 black students, because achievement gaps in such cells cannot be estimated with sufficient precision to be useful. After excluding cells with too few students, we are able to estimate white-black achievement gaps in at least one grade-year-subject for 2,875 school districts and 339 metropolitan areas. We estimate white-Hispanic gaps in at least one cell for 3,585 districts and 339 metropolitan areas. Table 1 includes information on data availability.[3]

[Insert Table 1 Here]

Given the 4 years and 6 grades and 2 subjects for which achievement data are available, up to 48 gaps can be estimated for a district or metropolitan area. On average, in the districts and metropolitan areas in our sample (those for which at least one gap is available), the mean number of available gaps is 42 (for metropolitan areas) and 34 (for districts). The reason that some districts and metropolitan areas do not have the expected 48 estimated gaps is almost entirely due to the fact that some districts have fewer than 20 minority or white students in some grade-year-subject cells but not others. Because district

[3] The estimated achievement gap data are available at seda.stanford.edu.

enrollments are smaller than metropolitan area enrollments, cell sizes fall below the 20-student threshold more commonly in districts than in metropolitan areas. In addition, we cannot compute achievement gaps in several states in particular years because of insufficient data in the EdFacts system.[4] In total, we have 99,713 estimated white-black achievement gaps and 113,625 white-Hispanic achievement gaps at the district level; and 14,200 and 14,100, respectively, at the metropolitan area level.

Although our analytic sample includes estimated achievement gaps from less than a quarter of all public school districts in the US, the excluded districts enroll relatively few minority students. Most black (88%) and Hispanic (88%) public school students in grades 3-8 in the US are enrolled in districts included in our analytic sample. That so many minority students are enrolled in such a small subset of school districts simply reflects the spatial concentration of minority students in the United States. Our metropolitan area analytic sample likewise includes 81% of black and 92% of Hispanic public school students in grades 3-8 in metropolitan areas (69% and 79% of black and Hispanic students in the U.S); the remaining black and Hispanic students are in 45 metropolitan areas that are excluded from our sample because they cross state lines.[5]

Achievement Gap Measure

Every state uses different standardized tests, and within a state, these tests vary across subjects, grades, and often across years. Moreover, the data provided by NCES do not include group-specific means and standard deviations, but instead include counts of students in a set of ordered proficiency

[4] EdFacts data include only two proficiency categories (which is insufficient to compute an achievement gap) in FL in 2009, in FL in 2009-2011, in SC in 2011, and in TX in 2012. There is no data for WY in 2010. In 2009, NE did not use the same math or ELA test in all districts in 2009, and did not use the same math test in 2010. Students in grades 7 and 8th grade in CA do not take a common math test. These state-grade-year-subjects are therefore not included in our estimates.

[5] Some of the larger metropolitan areas that are excluded are the metropolitan area that includes New York City; the metropolitan area that includes Washington, DC; and the metropolitan areas of Minneapolis-St. Paul; St. Louis; Newark; and Kansas City.

categories whose definitions vary across states, grades, subjects, and sometimes years. Because these definitions vary, simple racial differences in proficiency rates cannot do not provide measures of achievement gaps that are comparable across states, subjects, grades, and years (Ho 2008; Ho and Reardon 2012). Nonetheless, counts of students scoring in different proficiency categories can be used to estimate achievement gaps interpretable as effect sizes (Ho and Reardon 2012; Reardon and Ho 2015), as we describe below.

The most conventional measure of achievement gaps is the standardized mean difference in test scores between two groups, defined as

$$d = \frac{\mu_a - \mu_b}{\sigma_p}, \tag{1}$$

where μ_a and μ_b are the mean test scores in groups a and b, respectively, and σ_p is the pooled standard deviation of test scores (the square root of the average of the test score variances in groups a and b):

$$\sigma_p = \sqrt{\frac{\sigma_a^2 + \sigma_b^2}{2}}. \tag{2}$$

This measure, sometimes called Cohen's d (Hedges and Olkin 1985), is a measure of the relative difference in the test score distributions of two groups. It is relative in the sense that it measures gaps as the ratio of mean differences to the average spread of the two distributions. It can be thought of, loosely, as a measure of the extent to which the distribution of scores in group a is higher than the distribution in group b.

Two factors complicate the use of d for our purposes here. First, Computing d requires estimates of the mean and standard deviation of each district's test score distributions, by race; these statistics are not generally publicly available except from a few state websites in select years. Second, d is sensitive to the scale in which test scores are reported. Although d would be unchanged by any linear transformation

of test scores (such a transformation would multiply both the difference in means and the pooled standard deviation by the same factor, leaving their ratio unchanged), it will be altered by a non-linear transformation of scores. Unless the metric in which achievement is measured is inherently meaningful, then, d is sensitive to arbitrary scaling decisions. In order to compare test score gaps across states, grades, subjects, and years in which different tests are used, it is necessary to use a gap measure that is not sensitive to differences in how test scores are scaled.

An alternate measure of the relative difference in distributions, one that is immune to scale transformations of the test score metric, is based on the probability that a randomly chosen observation from distribution a has a higher value than a randomly chosen observation from distribution b. Like d, this measure, denoted $P_{(a>b)}$, can be loosely thought of as a measure of the non-overlap of distributions a and b, or as a measure of the extent to which distribution a contains higher values than distribution b. The value of $P_{(a>b)}$ may range from 0 to 1, with values greater than 0.5 indicating that distribution a is higher than b, and vice versa. Applying a probit transformation to $P_{(a>b)}$ produces the V-statistic (Ho 2009; Ho and Haertel 2006; Ho and Reardon 2012):

$$V = \sqrt{2}\Phi^{-1}\left(P_{(a>b)}\right) \tag{3}$$

The V-statistic has three useful properties for our purposes. First, it is readily interpretable as an effect size. Essentially, Equation (3) converts $P_{(a>b)}$ to an effect size by computing the standardized difference between two normal distributions that would yield the observed value of $P_{(a>b)}$. As a result, if the test score distributions of groups a and b are both normal (regardless of whether they have equal variance), then V will be equal to Cohen's d (Ho and Reardon 2012). Thus, V can be thought of as measuring gaps in a familiar "effect size" metric.

Second, V is invariant to monotonic transformations of test scales: if a test metric is transformed by a non-linear monotonic transformation, Cohen's d will be changed, but V will not. Thus, V can be

understood as the value of Cohen's d if the test score metric were transformed into a metric in which both groups' scores were normally distributed. This transformation-invariance property of V is particularly useful when comparing gaps measured using different tests. In order to compare gaps across tests using Cohen's *d*, we would have to assume that each test measures academic achievement in an interval-scaled metric (so that a score on any test can be written as a linear transformation of a score on any other test). To compare gaps using V, however, we need only to assume that each test measures achievement in a way that orders two groups the same way (so that the overlap between two groups' distributions would be the same in either test), a much more defensible assumption.[6]

A final advantage of the V-statistic is that it can be estimated very reliably from either student-level continuous test score data or coarsened data indicating the number of students of each group in each of several (at least three) proficiency categories (Ho and Reardon 2012; Reardon and Ho 2015). That is, we do not need to know the means and standard deviations of each group's test score distribution; we need only the counts of black, Hispanic, and white students who score "Far Below Basic," "Below Basic," "Basic," "Proficiency," and "Advanced," for example. This is the form of the achievement data available at the district- and metro-level. Because V is estimable with such little ordinal information, it is possible to easily estimate achievement gaps based on state accountability tests in each district/metro-year-grade-subject for which subgroup-specific proficiency category counts are available.

We estimate V for each district/metro-grade-subject-year cell in which there are at least 20 white students and 20 black or Hispanic students tested. We use the maximum likelihood (ML) algorithm described by Ho and Reardon (2012) and Reardon and Ho (2015) (and implemented in the Stata `rocfit` command) to obtain estimates of V and its standard error. Ho and Reardon (2012)

[6] In a set of validation exercises (not shown), we compare state-level achievement gaps estimated from state accountability tests (which differ among states) with achievement gaps estimated for those same states, grades, and years from NAEP tests (which are identical across states, within a grade, year, and subject). The correlation between the two sets of is consistently above 0.90, indicating that different state tests order students similarly enough that the V-statistic can be used to compare achievement gaps across a wide range of state and NAEP tests.

demonstrate that the ML estimator is unbiased under the assumption of respective normality, and is very nearly unbiased even under large departures from respective normality.

For both white-black and white-Hispanic gaps, we have up to 24 estimated math and 24 ELA achievement gap estimates (for each of six grades and 4 school years) in each geographic unit (school district or metropolitan area). For our purposes here, we pool these (up to) 48 gap estimates to construct a single estimate of the achievement gap in each unit. This pooling increases precision substantially, and discards very little information, as gaps vary little across grades, years, and subjects within a unit.[7]

Covariate Data

We examine the association of racial achievement gaps with four sets of covariates that describe: 1) local socioeconomic characteristics, including racial/ethnic disparities in socioeconomic conditions; 2) racial/ethnic composition and demographics; 3) patterns of residential and school segregation; and 4) features of the local schooling system.

Our measures of socioeconomic characteristics include median family income, parental education, the proportion of parents employed in managerial occupations, poverty rates, unemployment rates, SNAP receipt rates, single parent household rates, residential mobility rates, free-lunch eligibility rates, median rent, median housing value, and income inequality. For all but a few of these, we also include racial/ethnic disparities in all but a few of these measures (free lunch eligibility rates and median house value are not available separately by race). Socioeconomic variables come from the American Community Survey (ACS). For districts we select the cross-tabulation of families with children for children enrolled in public schools, corresponding to the availability of achievement data. For metropolitan areas we aggregate these count data to the metro level. ACS conducts annual surveys. The 5-year 2006-2010

[7] In the technical Appendix, we provide evidence that pooling gap estimates within districts is an acceptable data aggregating technique.

pooled data file we use provides information for the entire universe of districts.[8]

As measures of racial/ethnic composition, we include the proportion of students in public schools who are black and Hispanic. We also include a set of measures of measures of the national origin, foreign-born status, and English fluency on Hispanics. School composition variables are computed using the CCD; Hispanic origin and fluency variables come from the ACS.

We include three-types of measures of segregation: measures of racial segregation, measures of income segregation, and measures of racial differences in exposure to poverty. For each of these, we include between-school measures, between-district measures, and measures of residential segregation. We also include indicators of the white-minority private school enrollment rate difference and of the proportion of local school districts that were ever, or are still, under a court order to desegregate (for districts these are binary measures). Measures of racial segregation that include within district school segregation and between district school segregation are calculated using data from the CCD. Between tract residential segregation are calculated using data from the ACS. For CCD variables, we compute the measures of interest for each year and then aggregate across years 2006-2010, taking the means.

Finally, we include a set of proxy measures of school quality. These include per-pupil expenditures and student-teacher ratios, the proportion of teachers who are novice teachers in a given year, and rates of teacher absenteeism. We also include the percent of the student population that is enrolled in charter schools (and racial/ethnic disparities in charter school enrollment rates), given evidence that some charter schools have been shown to be very effective at raising minority students' achievement (Abdulkadiroglu et al. 2011; Angrist et al. 2012; Angrist, Pathak and Walters 2011). We include measures of the oversight/accountability strength of a state's charter school policies as a proxy for quality of charter schools. Finally, we include several measures of school accountability, including measures of whether a state's proficiency standards are high or low (as classified by Dee and Jacob 2011)

[8] See Appendix for description of how variables are constructed.

and the proportion of minority students who are in schools where there were enough members of their subgroup to trigger reporting under the No Child Left Behind policy. Sufficient minority enrollment is an important variable is an indicator for whether schools in districts or metros are likely to face race-specific accountability pressure, under the assumption that if counts are too small for test reporting, the school will not be held accountable for those students' performance.

For class size and expenditure variables, data are from the CCD and NCES F-33 expenditures files. We compute white-black and white-Hispanic differences in per-pupil expenditures by taking the weighted average of per pupil expenditures across all districts within the metropolitan area, where the weight is the number of white, black or Hispanic students in the district. These measures are not available for districts. These measures are all computed using the CCD, computing the measures for each unit in each year and then averaging over the years 2006-2010. For measures of teacher absenteeism and novice teachers, we use school-level data from the Office of Civil Rights (OCR). These data are reported as counts of teacher absences by school, or counts of novice teachers by school.[9] Charter school enrollment data are taken from the CCD.

These variables are listed in Appendix Table A2. Table 2 reports means and standard deviations for a subset of them.

[Table 2 here]

Because data come from different sources and because of minimum group size requirements for reporting (e.g., income is not reported for districts or tracts with small populations), our analytic sample is restricted to those districts and metros for which there are no missing data for all variables. At the metro level, when all covariates are included we preserve 85 to 88 percent of metropolitan areas in the sample, compared to the sample that includes only achievement gaps. At the district level, we preserve 72 to 75

[9] As bivariate predictors, we also include ethnic differences in rates of suspension. These data are not included in our main models,

percent. Comparing the sample for which we have achievement gaps and the sub-sample for which we have achievement gaps and covariate data, at the district level, the sub-sample tends to be slightly less poor (44 percent qualify for free lunch compared to 40 percent with the gaps only sample) and more black (22 to 15 percent for white-black gaps) or Hispanic (21 to 21 percent for white-Hispanic gaps). Average achievement gaps between the two samples are nearly identical. At the metro level, the samples and sub-samples are nearly identical, as there are less missing covariate data at the metro level.

Models & Methods

A Descriptive Model of Achievement Gaps

We begin with a description of the magnitudes and spatial variation in white-black and white-Hispanic achievement gaps. Following these descriptive analyses, we examine the bivariate correlations between achievement gaps and a set of district/metropolitan area covariates. We conclude with a set of descriptive multivariate regression models that provide estimates of the partial associations of specific covariates with achievement gaps. Both the bivariate and multivariate models have the form

$$\hat{G}_u = \alpha + (\mathbf{X}_u - \overline{\mathbf{X}})\mathbf{B} + \mathbf{\Delta}_u\mathbf{\Gamma} + \lambda_s + e_u + v_u;\ e_u \sim N[0, \tau];\ v_u \sim N[0, \hat{\omega}_u^2], \quad (1)$$

where $\hat{G}_u$ is the estimated white-black or white-Hispanic achievement gap in district or metropolitan area u; $\mathbf{X}_u$ is a vector of district or metropolitan area covariates (including socioeconomic characteristics, demographic composition, and school quality characteristics); $\mathbf{\Delta}_u$ is a vector of covariates describing racial/ethnic *differences* in context or experience (including racial/ethnic differences in average socioeconomic characteristics, segregation indices, and differences in exposure to dimensions of school quality); λ_s is a state fixed effect (included in the district models but not the metropolitan area models); and e_u and v_u are error terms. The error term e_u is the residual error term, and is assumed to have constant variance τ; the error term v_u is the sampling error in $\hat{G}_u$ (that is, $v_u = \hat{G}_u - G_u$) and has error

variance ω_u^2. The two error terms are assumed independent of one another. Because they may not be independent of $\mathbf{X}_u$ and $\mathbf{\Delta}_u$, we cannot interpret the estimated coefficient vectors $\widehat{\mathbf{B}}$ and $\widehat{\mathbf{\Gamma}}$ in causal terms. We center $\mathbf{X}_u$ at the sample mean, but leave $\mathbf{\Delta}_u$ uncentered. This means that the intercept α is interpreted as the average achievement gap in a district with average values of $\mathbf{X}$ and in which white and black/Hispanic students experience equal values of the contextual factors contained in $\mathbf{\Delta}$.

Models with the error structure of Model (1) are sometimes referred to as meta-analytic regression models or precision-weighted random effects models. Such models are appropriate when the outcome variable for each observation represents an estimated value (with known error variance) of a parameter from a different site, and where the true values of that parameter are assumed to vary among sites. We fit these models using Stata's `–metareg–` command.

Results

The white-black and white-Hispanic achievement gaps vary considerably in magnitude across the U.S. Table 3 reports the average achievement gaps at different levels of spatial aggregation: school districts, counties, commuting zones,[10] and metropolitan areas. Across school districts, the average white-black and white-Hispanic gaps are 0.75 and 0.55 standard deviations, respectively. The gaps vary considerably among school districts, however: the standard deviation of district achievement gaps is 0.21-0.22. Unsurprisingly, the gaps are larger, on average, in areas of larger aggregation, likely because school systems, neighborhoods, and socioeconomic conditions are more homogenous, on average, in smaller geographical units. Correspondingly, there is more variation in the size of achievement gaps among school districts than among metropolitan areas or commuting zones, likely a reflection of greater between-unit heterogeneity in school, neighborhood, and socioeconomic conditions. The final column in

[10] Commuting zones are combinations of counties that are similar to metropolitan areas but that cover the entire U.S.

Table 5 shows that the reliability of the estimated achievement gaps is very high, ranging from 0.87 for school district gaps to 0.97-1.00 for metropolitan areas gaps.

[Table 3 here]

Spatial Variation of Achievement Gaps

Figures 2 and 3 illustrate the geographic variation of commuting zone achievement gaps across the U.S.[11] We show commuting zone achievement gaps here because commuting zones cover the entire U.S. at a geographic scale that is visible in a national map (many school districts are too small to be resolvable in a national map). The maps show that white-black gaps are generally largest in coastal areas around major cities, in parts of the South, and in the Rust Belt, though they vary considerably within these regions as well. White-Hispanic gaps are generally largest in the West and along the East Coast from Philadelphia to Boston.

[Figures 2 and 3 here]

Although we do not include a map here of district-level achievement gaps, we can examine the extent to which district-level achievement gaps vary within and between states by comparing the residual variance (τ) from versions of Model (1) with and without state fixed effects (including no covariates in the model). These analyses show that only 13-14% of the variance in district-level gaps is due to between-state variation. Within a given state, achievement gaps vary almost as much as they do nationwide. This indicates that examinations of variation in achievement gaps between states (see, for example, Hemphill, Vanneman and Rahman 2011; Vanneman et al. 2009) miss almost all of the geographic variation in achievement gap patterns.

One thing that is not clear in Figures 2 and 3 is the extent to which achievement gaps vary across

[11] When commuting zones cross state boundaries, we split them into separate components in Figures 2 and 3 because our method of computing achievement gaps all students in a geographic unit to take the same test.

the U.S. because of variation in white students' academic performance or because of black and Hispanic students' performance. For example, the white-black and white-Hispanic achievement gaps are relatively small in West Virginia and Appalachia; is this due to lower than average performance of white students in Appalachia or higher than average performance of minority students? Given the high poverty rates (among whites as well as black and Hispanic populations) in Appalachia, one might guess that this is due to below average performance of white students, but the map (and our methods of computing achievement gaps) does not provide evidence of this. Thus, the data illustrated in these maps is informative about relative performance, but not of absolute performance.

Districts with the Smallest and Largest Achievement Gaps

One might wonder which school districts have particularly large or particularly small academic achievement gaps. Figures 4 and 5 show the 20 districts with the largest and smallest estimated achievement gaps.[12] We rank school districts here based on the "shrunken" Empirical Bayes (EB) estimate of the achievement gap, so that districts with few students of a given race and imprecisely estimated gaps do not show up as the places with the most extreme gaps simply because of sampling error. These EB estimates are constructed from the version of Model (1) above that includes the full set of covariates in $\boldsymbol{\Delta}_u$ and $\mathbf{X}_u$, as well as the state fixed effects λ_s. The inclusion of the covariates and state fixed effects provides more information for the EB estimates when precision is low and has little impact on EB estimates when precision is high.

[Figures 4 and 5 here]

The lists of districts with large white-black achievement gaps includes several large and medium-sized school districts (Atlanta, GA; Washington DC; Tuscaloosa, AL; Charleston, SC; Auburn City, AL;

[12] A full list of the race/ethnic achievement gaps in all school districts in our sample is available online at cepa.stanford.edu.

Oakland, CA), most of which are in the South and are generally highly segregated, with large white-black socioeconomic disparities. But it also includes a number of smaller school districts that are home to prominent universities (Berkeley, CA, Chapel Hill, NC, Charlottesville, VA, Evanston, IL, and University City, MO) as well as a set of small, relatively affluent suburban/exurban school districts (Shaker Heights, OH; Wheaton, IL (CUSD 200, IL); LaGrange, IL; Huntington Union, NY). The districts with the smallest white-black achievement gaps includes a number of districts with relatively small black populations as well as several large and medium-sized, racially diverse, and relatively poor school districts (notably Detroit, MI; Clayton County, GA; as well as Lawrence, MA; Pawtucket, RI).

Many of the districts with the larges white-black achievement gaps also appear on the list of place with the largest white-Hispanic gaps (Atlanta, GA; Washington, DC; Chapel Hill, NC; Berkeley, CA), suggesting that the local forces producing racial/ethnic inequality are not specific to one race/ethnic group. Many of the districts with the largest white-Hispanic gaps are in the Bay Area in California (Menlo Park, Mountain View, San Rafael, Cabrillo Unified (Half Moon Bay), and Berkeley), where white-Hispanic socioeconomic inequality and segregation are very high. Among the districts with the smallest white-Hispanic achievement gaps, many are in small, relatively low-income school districts in Texas and California.

Correlates of Racial/Ethnic Achievement Gaps

The lists of school districts with the largest and smallest achievement gaps hints at a few patterns: achievement gaps are largest in places with large racial/ethnic differences in socioeconomic status, in more segregated places, and in more affluent places, and are smallest in smaller, poorer school districts where socioeconomic disparities are relatively small. We next use data from all school districts and metropolitan areas to examine whether these patterns hold more generally. We first show in Table 4 the pairwise correlations between achievement gaps and a set of district and metropolitan area

characteristics.[13] As above, these characteristics are organized into four categories: socioeconomic characteristics, racial/ethnic composition; segregation; and school quality measures. We show only a subset of the full set of covariates here, in the interest of space. Those displayed here generally have the strongest bivariate correlations with achievement gaps of the measures in each of the four covariate categories.

[Table 4 here]

Many of these characteristics are significantly correlated with achievement gaps. Racial/ethnic differences in income, parental education levels, and single parenthood are relatively strong correlates of gaps, ranging from 0.44 to 0.67 across measures, groups, and geographic units. Achievement gaps are also larger, on average, in higher income and more educated areas, and places with fewer students eligible for free lunch. These patterns comport with the set of places with very large and small gaps shown in Figures 4 and 5 above. The associations between achievement gaps and single-parenthood rates are also significant, though in the opposite direction as the associations with family income and parental education. That is, achievement gaps are larger, on average, in places with more single-parent families. Of course, these are simple bivariate correlations, so one should not make too much of them.

Interestingly, racial and ethnic composition is only weakly associated with academic achievement gaps in metropolitan areas (the correlations are 0.17-0.18), and not at all correlated with district-level achievement gaps. Our measure of the Hispanic population's English proficiency is modestly associated with the white-Hispanic achievement gap, but the sign of the association differs for metropolitan areas and school districts: metropolitan areas where more Hispanics speak English well have smaller achievement gaps than those with more non-English-proficient Hispanics, a pattern that makes intuitive sense given the fact that the achievement tests used here are administered in English. Surprisingly,

[13] Specifically, the correlation coefficient is the precision weighted correlation coefficient whereby the weighting variable is equal to $\frac{1}{\tau + \sigma_u^2}$, where τ is equal to the estimate of the true variance and σ_u^2 is the variance of the gap estimate in district or metropolitan area u. τ is estimated from a random effects meta-analytic regression model.

however, the opposite is true in school districts. This may be a reflection of the fact that second- and third generation Hispanic families tend to live, on average, in places with higher socioeconomic status, which is positively associated with achievement gaps (see above).

Districts and metropolitan areas with higher levels of racial and economic segregation have larger achievement gaps, on average, than less segregated places. Although all the measures of segregation we examine are significantly correlated with achievement gaps, the most highly correlated measure is the difference in the extent to which white and minority students have schoolmates who are eligible for free lunch. In metropolitan areas and districts where black and Hispanic students attend schools with higher average poverty rates than white students, achievement gaps are larger, on average, than in places with smaller differences in exposure to school poverty.

Finally, none of our indices of school quality, including school spending and charter school enrollment, are strongly correlated with racial/ethnic achievement gaps. The measure of per pupil spending is positively associated with achievement gaps—achievement gaps are larger, on average, in school districts that spend more. This correlation, like the others here, should not be interpreted as evidence of a causal relationship: spending differences are not exogenous (for recent evidence on the effects of school funding on academic outcomes, see Jackson, Johnson and Persico 2014; Lafortune, Rothstein and Schanzenbach 2015). In many states spending is higher in large urban districts and districts serving more low-income students; in others spending is higher in more advantaged districts. Charter school enrollment rates are generally not associated with achievement gaps, though metropolitan areas in which black students are enrolled in charter schools at lower rates than white students have, on average, somewhat smaller achievement gaps. Again, this should not be interpreted as evidence that charter schools are less effective than traditional public schools, as patterns of charter school enrollment are not exogenous (for evidence on the effectiveness of charter schools, see Bifulco and Bulkley 2015; Tuttle, Gleason and Clark 2012).

Socioeconomic disparities and racial/ethnic achievement gaps

Given the relatively strong correlations between each of the racial/ethnic socioeconomic disparities measures and achievement gaps, one might wonder a) how much variation in achievement gaps can be accounted for by socioeconomic disparities; b) whether achievement gaps are zero, on average, in places with no racial/ethnic socioeconomic disparities; and c) how the partial associations of the other covariates in Table 6 with achievement gaps change once we condition on the full set of socioeconomic disparity measures? To answer these questions, we fit Model (1) including only a vector $\mathbf{\Delta}_u$ of socioeconomic disparity measures;[14] we exclude state fixed effects, as well as measures of socioeconomic composition, demographic composition, segregation, and school quality variables.

From this model, we compute $\mathbf{\Delta}_u\hat{\mathbf{\Gamma}}$, the predicted contribution of racial socioeconomic disparities to the local academic achievement gap. We also compute the EB estimate of the achievement gap from this model, $\hat{G}_u^*$, and plot $\hat{G}_u^*$ against $\mathbf{\Delta}_u\hat{\mathbf{\Gamma}}$ (Figures 6-9). We also plot the fitted line $\hat{G}_u = \hat{\alpha} + \mathbf{\Delta}_u\hat{\mathbf{\Gamma}}$. The intercept of this line indicates the estimated average achievement gap in a districts or metropolitan areas in which there is no racial/ethnic socioeconomic disparity (i.e., in places where there is socioeconomic racial equality).

Figures 6 and 7 display scatter plots of white-black and white-Hispanic achievement gaps in metro areas, respectively, where each point corresponds to a metro area. The points are weighted by the average number of black or Hispanic students, respectively, in the metropolitan areas. Several patterns are evident in these figures. First, there is considerable variation among metropolitan areas in the magnitude of racial/ethnic socioeconomic disparities. In a few metropolitan areas (albeit ones with small black or Hispanic populations) there is no substantial racial/ethnic socioeconomic disparity; in others the disparities are large—large enough to be predicted to contribute two thirds of a standard deviation or

[14] The variables in $\mathbf{\Delta}_u$ are white-minority differences in: family income, parental education, occupation type, unemployment rates, poverty rates, SNAP receipt rates, single-parent household rates, homeownership rates, and residential mobility rates.

more to the achievement gap. Second, there is a strong association between socioeconomic disparities and achievement gaps: the R^2's from these models are 0.42 and 0.58, respectively (implying that the correlation between metropolitan area achievement gaps and an index of racial socioeconomic differences is roughly 0.65-0.76). Socioeconomic disparities are strong predictors of academic achievement gaps. Third, there nonetheless remains considerable variation in achievement gaps, even conditional on racial socioeconomic disparities. The conditional standard deviation of achievement gaps around the fitted line is roughly 0.15; metropolitan areas with similar socioeconomic disparities vary by as much as half a standard deviation in their achievement gaps. And fourth, the intercept of the fitted line is well above 0 in the white-black model and slightly above 0 in the white-Hispanic model. That is, the metropolitan area average achievement gap is not zero even when whites and blacks/Hispanics come from relatively equal socioeconomic backgrounds. Racial/ethnic socioeconomic disparities alone do not account for the large racial achievement gaps, despite being highly predictive of the magnitudes of the gaps.

[Figures 6-7 here]

Figures 8 and 9 are similar to the Figures 6 and 7, but illustrate the patterns for school districts. The R^2's from these models are 0.43 and 0.40, respectively (implying that the correlation between district-level achievement gaps and an index of racial socioeconomic differences is roughly 0.66-0.63); as is the case for metropolitan areas, racial/ethnic socioeconomic disparities are strong predictors of academic achievement gaps. Moreover, the general patterns in Figures 8 and 9 are very similar to Figures 6 and 7. There is considerable variation in the magnitude of achievement gaps, even among school districts with similar degrees of racial socioeconomic inequality. Moreover, the average achievement gaps are roughly 0.45 and 0.35 in districts with no white-black or white-Hispanic socioeconomic disparities, respectively.

[Figures 8-9 here]

Multivariate regression model results

We conclude our descriptive analyses with a set of regression models that include our full set of covariates ($\mathbf{X}_u$ and $\mathbf{\Delta}_u$). This is not intended to provide evidence of the "causes" of achievement gaps, but rather to identify the best unique predictors of academic achievement gaps.

[Table 5 here]

Several things stand out in Table 5. First, among the socioeconomic characteristics, racial differences in parental education as well as overall levels of parental education are the strongest of the predictors of achievement gaps. Achievement gaps are larger in both school districts and metropolitan areas with both high levels of educational attainment and large racial/ethnic gaps in attainment. These associations are strong and statistically significant, despite the fact that there the models include dozens of other highly-correlated covariates.

Second, among the segregation variables, the one consistent predictor of achievement gaps is the differential rate of exposure between whites and minorities to poor classmates. This does not mean that other forms of segregation are not correlated with achievement gaps or that they do not cause gaps; rather the correlation between racial segregation and achievement gaps may arise precisely because racial segregation generally leads to large racial disparities in exposure to poor classmates (Reardon 2016).

Third, there is little or no association between achievement gaps and measures of school quality or charter school enrollment rates, net of the other variables in the model. Nor is there evidence of any independent association of racial/ethnic composition and achievement gaps. In sum, the three strongest predictors of achievement gaps are 1) racial disparities in parental educational attainment; 2) racial differences in exposure to poor classmates; and 3) overall local educational attainment levels.

Conclusion

The analyses presented here are the first to examine geographic variation in racial academic achievement gaps for the entire country at a fine geographic scale. Our aim was to present a detailed description of the patterns and correlates of achievement gaps to stimulate and inform future research and policy regarding educational inequality. Our findings should not be taken as causal estimates; as we argue here, the forces producing racial/ethnic inequality in educational outcomes are complex, interactive, and self-reinforcing, meaning that correlational analyses may not be predictive of the effects of changing social or educational conditions.

A few key findings emerge from our descriptive analyses. First, there is considerable variation in white-black and white-Hispanic achievement gaps across school districts and metropolitan areas. Most of the variation in district achievement gaps lies within, rather than between, states. State-level processes do not appear to be a dominant force in shaping patterns of racial/ethnic academic achievement gaps.

Second, of the several thousand school districts we analyze, which enroll almost 90% of all black and Hispanic students in the U.S., there are but a handful where the achievement gap is near zero. With the notable exceptions of the Detroit, MI and Clayton County, GA school districts, these tend to be districts that enroll few minority students where achievement gaps are very imprecisely estimated even in our large data set. And while Detroit and Clayton County do have achievement gaps near zero, this does not appear, at least in the case of Detroit, to be the kind of equity that we would like to reproduce: Census data and NAEP TUDA data show that both white and black families in Detroit are very poor, on average, and white and black students' average test scores in Detroit are (equally) far below the national average. In other words, there is no school district in the U.S. that serves a moderately large number of black or Hispanic students where achievement is high and achievement gaps are near 0.

Third, roughly half the variance in local achievement gaps can be explained by racial/ethnic disparities in socioeconomic status. The bivariate associations between achievement gaps and

racial/ethnic differences in family income and parental education are strong, and remain strong in models controlling for other variables. This is not surprising, given the many studies showing the clear association between individual socioeconomic background and test performance documented and that racial/ethnic differences in socioeconomic status explain a substantial proportion of achievement gaps (Fryer and Levitt 2004; Fryer and Levitt 2006; Reardon and Galindo 2009; Rothstein and Wozny 2013). Nonetheless, the evidence here clearly indicates that those same associations appear to account for a significant proportion of geographic variation in achievement gaps as well.

Fourth, although racial/ethnic differences in socioeconomic status explains much of the variation in achievement gaps, socioeconomic disparities are far from determinative. Achievement gaps vary substantially even among places with similar socioeconomic disparities, and remain large even where white and minority students come from relatively similar socioeconomic backgrounds. There are clearly factors other than racial/ethnic socioeconomic disparities at play in generating academic achievement gaps. Chief among these factors is racial segregation. Our analyses indicate that, net of socioeconomic disparities, general socioeconomic levels, demographic composition, and several (admittedly crude) measures of school quality, segregation is a significant predictor of achievement gaps. In particular, achievement gaps are larger, all else equal, in places where black and Hispanic students attend higher poverty schools than their white peers. This suggests that school poverty may be a proxy for school quality.

Our descriptive analyses reveal one additional puzzling pattern. Achievement gaps are larger, on average, in districts and metropolitan areas with higher levels of parental education, even after we control for many other variables, including racial socioeconomic disparities and segregation. As noted above, one possible explanation for this is the possibility that socioeconomic disparities—and corresponding disparities in social capital, social networks, and access to school district leaders—are more salient in competitive, high resource communities. Another possibility is that social psychological

processes that inhibit minority students' performance, such as stereotype threat, are particularly strong in the most affluent places where academic performance is seen as a particularly important marker of intelligence and success and where minority students often comprise only a small share of school district enrollment (Steele 1997).

Another noteworthy finding is that while many of our measures of segregation are correlated with achievement gaps, the one that consistently remains statistically significant in our multivariate models is racial differences in exposure to poverty. This is in line with the argument that race, *per se*, is not the causal factor linking segregation to worse outcomes for minority students. Rather, racial isolation is correlated with other negative conditions such as exposure to more low-income peers, more crime, fewer positive role models, schools with fewer resources, etc. Studies suggest that long-term exposure to poverty can have negative effects on cognitive and educational outcomes (Chetty, Hendren and Katz 2015; Sampson, Sharkey and Raudenbush 2008), which is consistent with our finding here that achievement gaps are larger when minority students, relative to white students, are more exposed to low-income peers.

It is also worth noting that, among all the covariates included in our models, our measures of school quality explain the smallest amount of the variance in achievement gaps. There are two possible explanations for this. First, as has been documented as far back as the Coleman Report (1966) the effect of schools on academic achievement may be relatively small relative to the impact of families. Second, it is possible that our measures of school quality are not sufficient to capture the important features of schools that can contribute to smaller or larger levels of racial inequality. In fact, our measures of school quality are quite limited and their relationship with achievement uncertain *ex ante.* While studies of class size (one of our measures) consistently show that smaller classes lead to better student achievement (Finn and Achilles 1990; Finn and Achilles 1999; Nye, Hedges and Konstantopoulos 2000), studies of the effects of per pupil expenditures and charter school enrollments (our other measures of school quality)

on academic achievement are less clear. In either case, class size and student spending are endogenous regressors and may reflect the fact that schools with larger achievement gaps spend more and have smaller class sizes.

But overall school quality may not be as consequential for achievement gaps as is the racial/ethnic difference in access to high quality schools. Indeed, the importance of racial/ethnic difference in exposure to poverty may actually indicate that school quality – as proxied by school poverty rates – is a key factor shaping achievement gaps. In this account, school quality per se does not affect achievement gaps (though it may affect overall achievement levels); rather it is differences in school quality that lead to larger achievement gaps. So our segregation measure may in fact be a measure of differential exposure to school quality.

The last point worth noting is that many school districts have achievement gaps that are larger or smaller than would be expected, given their socioeconomic conditions and segregation levels. What leads some districts to exhibit much larger or smaller gaps than others that appear socioeconomically and ethnically similar is a critical policy question. We hope the data here can help researchers identify school districts or metropolitan areas where achievement is high, and achievement gaps are small; we may then be able to learn from such places how to reduce achievement gaps elsewhere.

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Tables

Table 1. Gap Data Coverage by Subject, Group and Unit

		White-Black Gaps		White-Hispanic Gaps	
		ELA	Math	ELA	Math
Number with 1 or More Gaps in Any Grade or Year					
	Metros	335	335	336	337
	Districts	2,856	2,855	3,577	3,544
Mean Number of Gaps, Among those with 1 or More Gaps (max=24)					
	Metros	21.25	21.12	21.01	20.96
	Districts	17.96	17.85	16.69	16.47
Percent with 18 or More Gaps, Among those with 1 or More Gaps					
	Metros	0.90	0.90	0.86	0.88
	Districts	0.69	0.68	0.61	0.59
Percent of Minority Students Nation-Wide in a Unit w/1 or More Gaps					
Metros					
	2009	0.69	0.69	0.79	0.79
	2010	0.69	0.69	0.79	0.79
	2011	0.69	0.69	0.78	0.78
	2012	0.69	0.69	0.78	0.78
Districts					
	2009	0.88	0.88	0.87	0.87
	2010	0.88	0.88	0.87	0.87
	2011	0.88	0.88	0.87	0.87
	2012	0.88	0.88	0.87	0.87

Between 47 and 49 states are represented each year. Gaps in Rhode Island are never available to due to insufficient minority group size. Gaps are missing in Colorado in 2009, 2010 and 2011 and in Florida in 2009 due to an insufficient number of achievement categories. For these states only 2 achievement categories are provided on the data in these years, which does not give us enough information to estimate a gap.

Table 2. Means and Standard Deviations of Gap Correlates

	White-Black				White-Hispanic			
	Metros		Districts		Metros		Districts	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Socioeconomic and Family Structure								
White-Minority Income V Gap	0.76	0.34	0.65	0.46	0.69	0.29	0.63	0.45
White-Minority Education V Gap	0.25	0.23	0.18	0.36	0.67	0.33	0.72	0.41
Single Parent Household Rate Difference-- Minority-White	0.30	0.17	0.28	0.17	0.09	0.12	0.05	0.17
Median Income	5.75	1.20	5.93	2.47	5.74	1.21	6.45	2.74
Proportion of Adults, Aged 25+ with a Bachelor's Degree or Higher	0.27	0.08	0.27	0.15	0.27	0.09	0.28	0.15
Single Parent Household Rate	0.35	0.06	0.37	0.12	0.35	0.06	0.32	0.11
Percent Receiving Free Lunches in Public Schools	0.38	0.11	0.44	0.20	0.38	0.11	0.39	0.20
Segregation								
Between School Racial Segregation	0.28	0.14	0.08	0.10	0.20	0.11	0.06	0.08
Between School Free Lunch, Not Free Lunch Segregation	0.16	0.09	0.05	0.06	0.16	0.10	0.05	0.07
Between Tract Racial Segregation	0.27	0.11			0.16	0.08		
Between Tract Poor-Non-Poor Segregation	0.10	0.04			0.10	0.04		
Difference in Tract Poverty Rates- Minority-White	0.08	0.05			0.06	0.04		
Difference in Free Lunch Rates- Minority-White	0.17	0.11	0.04	0.07	0.15	0.10	0.05	0.06
Racial/Ethnic Composition								
Percent Black in Pubic Schools	0.15	0.14	0.22	0.20	0.15	0.14	0.12	0.15
Percent Hispanic in Pubic Schools	0.17	0.19	0.18	0.20	0.17	0.20	0.27	0.23
Hispanics, Speak English Well or Very Well	0.49	0.18	0.49	0.26	0.50	0.18	0.53	0.22
School Quality								
Ratio of White PP Expenditures to Minority PP Expenditures	0.96	0.08			0.98	0.06		
Student-Teacher Ratio: Minority/White	0.98	0.07	1.01	0.04	0.98	0.08	1.01	0.04
White-Minority Charter School Enrollment Rate Difference	-0.02	0.06	0.00	0.07	0.00	0.04	0.01	0.05
PP Expenditures in Average Student's School	11614	2520	12027	3615	11602	2526	12181	4060
Average Student-Teacher Ratio	16.86	2.84	16.62	6.54	16.91	2.85	16.72	3.96
Percent Attending Charter Schools	0.03	0.04	0.02	0.06	0.03	0.04	0.02	0.06

Table 3. Means, Standard Deviations and Reliabilities of Average Test Score Gaps

	White-Black				White-Hispanic			
	Mean	SD	N	Reliability	Mean	SD	N	Reliability
Metropolitan Areas	0.735	0.194	329	0.967	0.547	0.209	328	1.000
Commuting Zones	0.677	0.185	364	0.947	0.494	0.189	455	0.947
Counties	0.667	0.204	1426	0.912	0.498	0.214	1557	0.892
Districts	0.618	0.214	2876	0.875	0.476	0.217	3594	0.868

Note: Estimated from a 2-level HLM model using random effects meta-analytic regression

Table 4. Pairwise Correlations Among Average Achievement Gaps in Each Metro/District and Other Factors

	White-Black Gaps				White-Hispanic Gaps			
	Metros		Districts		Metros		Districts	
Socioeconomic and Family Structure								
White-Minority Income V Gap	0.59	**	0.41	**	0.63	**	0.42	**
White-Minority Education V Gap	0.42	**	0.54	**	0.57	**	0.42	**
Single Parent Household Rate Difference-- Minority-White	0.42	**	0.27	**	0.32	**	0.15	**
Median Income	0.35	**	0.26	**	0.52	**	0.20	**
Proportion of Adults, Aged 25+ with a Bachelor's Degree or Higher	0.49	**	0.54	**	0.56	**	0.44	**
Single Parent Household Rate	0.01		-0.09	**	-0.37	**	-0.10	**
Percent Receiving Free Lunches in Public Schools	-0.18	**	-0.24	**	-0.37	**	-0.15	**
Segregation								
Between School Racial Segregation	0.41	**	0.18	**	0.57	**	0.30	**
Between School Free Lunch, Not Free Lunch Segregation	0.25	**	0.26	**	0.41	**	0.25	**
Between Tract Racial Segregation	0.38	**			0.51	**		
Between Tract Poor-Non-Poor Segregation	0.46	**			0.31	**		
Difference in Tract Poverty Rates- Minority-White	0.34	**			0.35	**		
Difference in Free Lunch Rates- Minority-White	0.59	**	0.34	**	0.63	**	0.38	**
Racial/Ethnic Composition								
Percent Black in Pubic Schools	0.20	**	-0.01		-0.20	**	-0.01	
Percent Hispanic in Pubic Schools	-0.19	**	-0.08	**	0.24	**	0.01	
Hispanics, Speak English Well or Very Well	0.14	*	0.08	**	0.40	**	0.20	**
School Quality								
Ratio of White PP Expenditures to Minority PP Expenditures	-0.19	**			-0.09			
Student-Teacher Ratio: Minority/White	-0.15	*	0.13	**	0.04		0.16	**
White-Minority Charter School Enrollment Rate Difference	-0.31	**	0.02		-0.01		0.02	
PP Expenditures in Average Student's School	0.24	**	0.19	**	0.31	**	0.22	**
Average Student-Teacher Ratio	-0.13	*	-0.03		0.10		-0.07	**
Percent Attending Charter Schools	0.12	*	0.00		0.14	*	0.05	*

The correlations for districts include state fixed effects and are therefore within state correlations. The correlations for metros do not include state fixed effects because there are not sufficient metros within each state to support including the state fixed effects.

Table 5. Full Models, Select Coefficients

	White-Black Metro	White-Hisp. Metro	White-Black District	White-Hisp. District
Socioeconomic and Family Structure				
White-Minority Income V Gap	0.005	0.032	0.005	0.036***
	(0.059)	(0.054)	(0.012)	(0.010)
White-Minority Education V Gap	0.162***	0.191***	0.168***	0.166***
	(0.047)	(0.051)	(0.012)	(0.011)
Single Parent Household Rate Difference-- Minority-White	0.143	0.071	0.084***	0.002
	(0.080)	(0.087)	(0.023)	(0.020)
Median Income	-0.007	-0.009	-0.008	-0.012***
	(0.025)	(0.021)	(0.005)	(0.003)
Proportion of Adults, Aged 25+ with a Bachelor's Degree or Higher	0.696**	0.666**	0.580***	0.502***
	(0.243)	(0.212)	(0.059)	(0.051)
Single Parent Household Rate	0.650	-0.011	0.044	-0.087
	(0.404)	(0.340)	(0.071)	(0.061)
Percent Receiving Free Lunches in Public Schools	-0.070	-0.417**	-0.139**	-0.080*
	(0.165)	(0.147)	(0.043)	(0.035)
Segregation				
Within District Racial Segregation	0.253	0.213	-0.098	-0.097
	(0.232)	(0.281)	(0.053)	(0.076)
Between School Free Lunch, Not Free Lunch Segregation	-0.711*	-0.071	-0.191*	-0.158*
	(0.293)	(0.257)	(0.082)	(0.068)
Between Tract Racial Segregation	-0.246	-0.267		
	(0.176)	(0.237)		
Between Tract Poor-Non-Poor Segregation	-0.160	-0.164		
	(0.327)	(0.278)		
Difference in Tract Poverty Rates- Minority-White	0.174	0.037		
	(0.315)	(0.396)		
Difference in Free Lunch Rates- Minority-White	0.813***	0.660**	0.798***	0.858***
	(0.227)	(0.214)	(0.098)	(0.102)
Racial/Ethnic Composition				
Percent Black in Pubic Schools	0.065	0.154	0.063	-0.025
	(0.117)	(0.111)	(0.033)	(0.032)
Percent Hispanic in Pubic Schools	0.218*	0.117	0.056	0.059*
	(0.093)	(0.080)	(0.033)	(0.026)
Hispanics, Speak English Well or Very Well	0.004	-0.002	0.007	0.006
	(0.071)	(0.077)	(0.014)	(0.020)
School Quality				
Ratio of White PP Expenditures to Minority PP Expenditures	-0.226	-0.035		
	(0.121)	(0.118)		
Student-Teacher Ratio: Minority/White	-0.050	0.041	-0.065	-0.031
	(0.122)	(0.081)	(0.079)	(0.085)
White-Minority Charter School Enrollment Rate Difference	-0.044	-0.109	-0.058	-0.107*
	(0.183)	(0.234)	(0.043)	(0.054)
PP Expenditures in Average Student's School	-0.000	-0.000	0.000*	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Average Student-Teacher Ratio	-0.009	-0.009*	0.000	-0.003*
	(0.005)	(0.004)	(0.000)	(0.001)
Percent Attending Charter Schools	0.253	-0.104	-0.140**	-0.011
	(0.240)	(0.199)	(0.053)	(0.047)
Constant	-0.389	-0.539	0.002	0.004
	(0.595)	(0.507)	(0.003)	(0.003)
N	276	284	2205	2813

Figure 1:

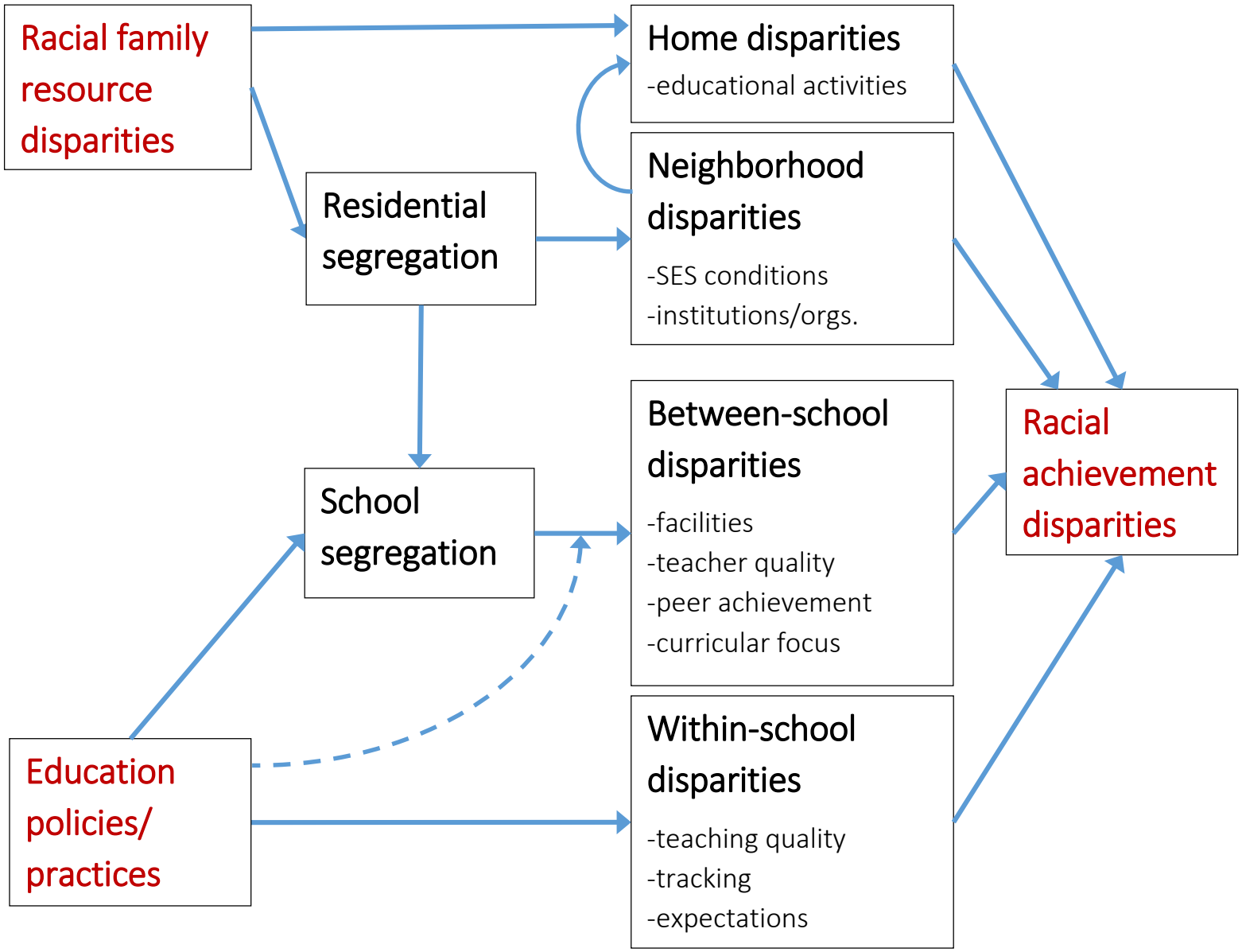

Racial family resource disparities
Residential segregation
School segregation
Education policies/ practices
Home disparities
-educational activities
Neighborhood disparities
-SES conditions
-institutions/orgs.
Between-school disparities
-facilities
-teacher quality
-peer achievement
-curricular focus
Within-school disparities
-teaching quality
-tracking
-expectations
Racial achievement disparities

Figure 2

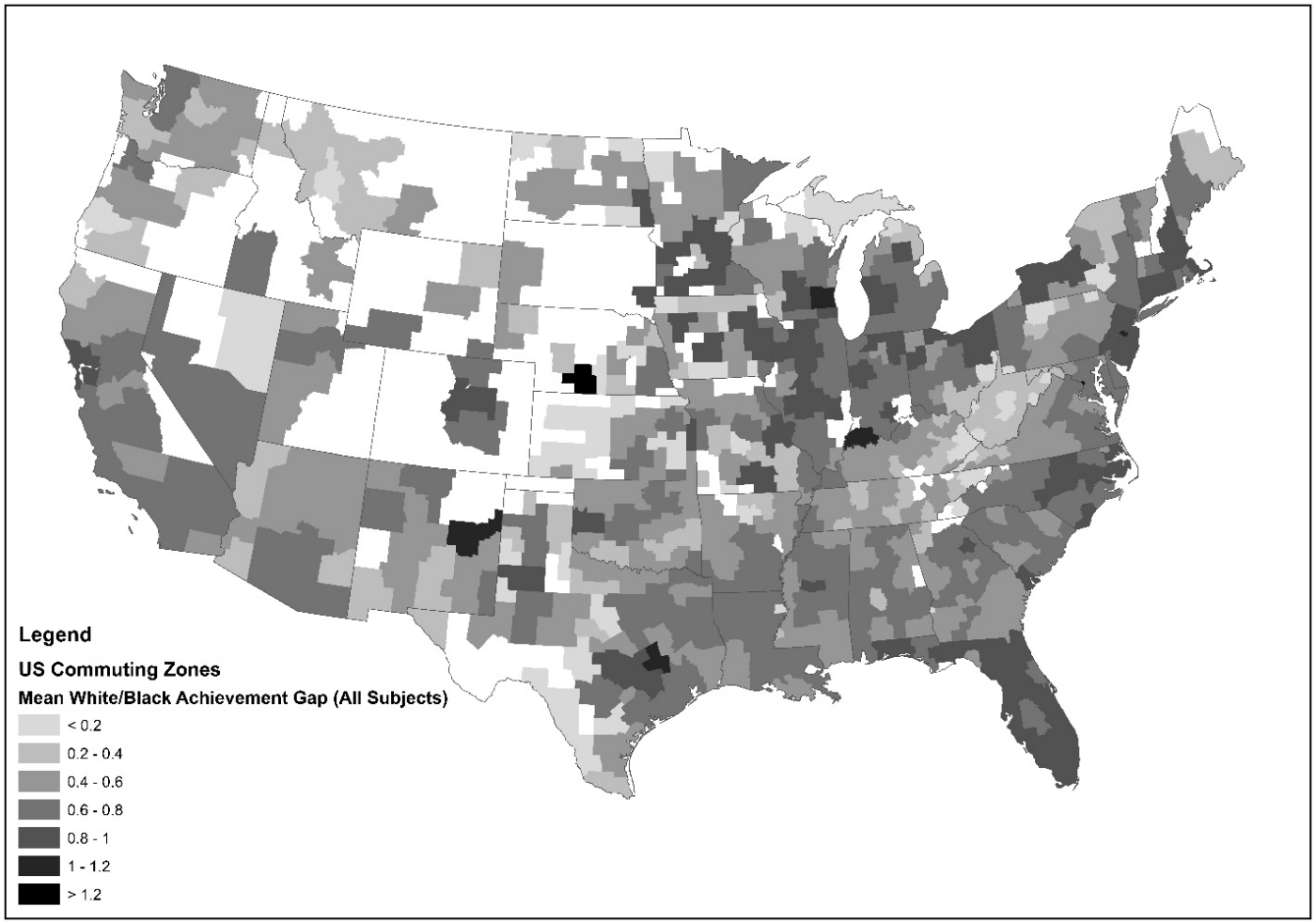

Legend
US Commuting Zones
Mean White/Black Achievement Gap (All Subjects)
< 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1
1 - 1.2
> 1.2

Figure 3

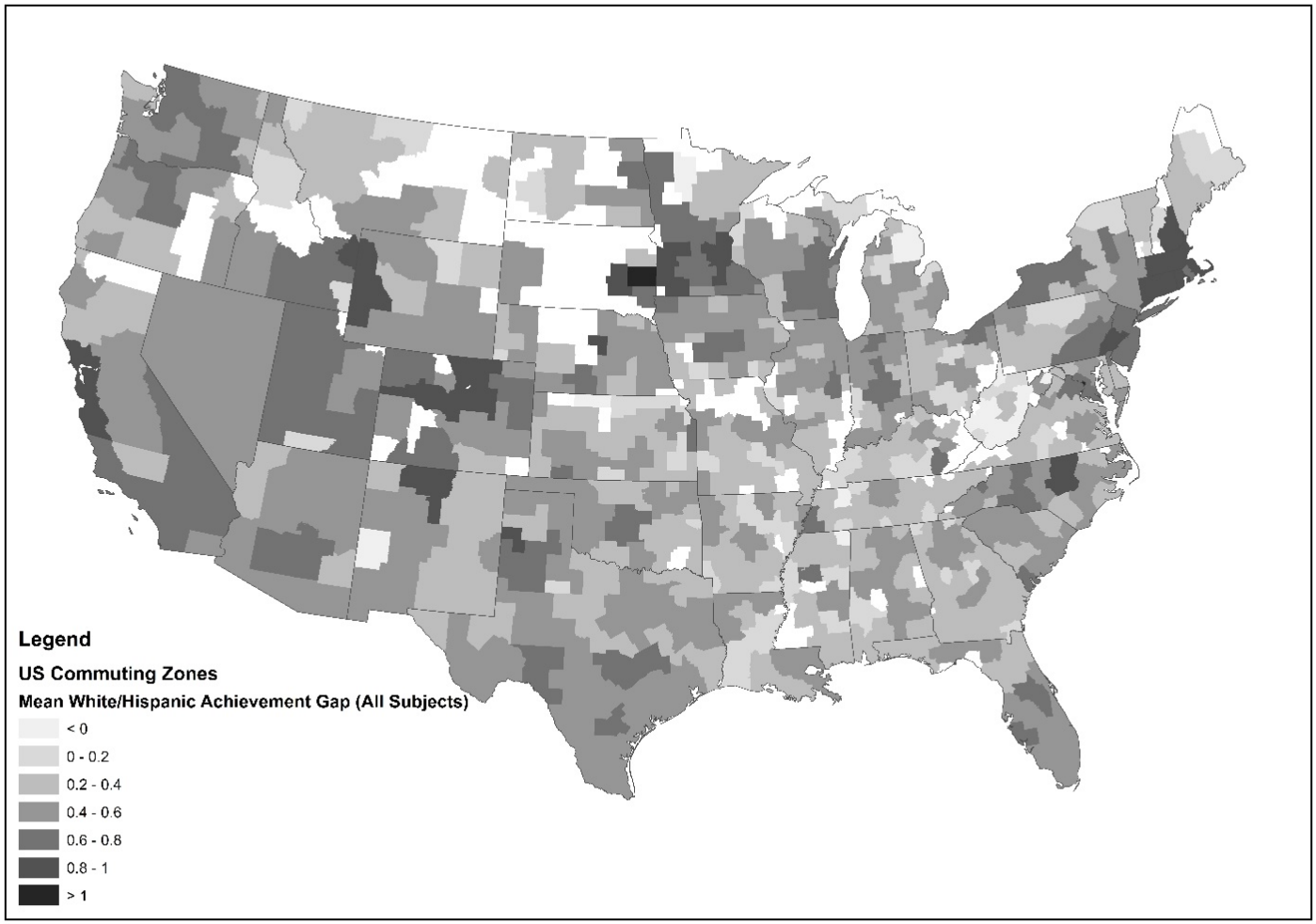

Legend
US Commuting Zones
Mean White/Hispanic Achievement Gap (All Subjects)
< 0
0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1
> 1

Figure 4

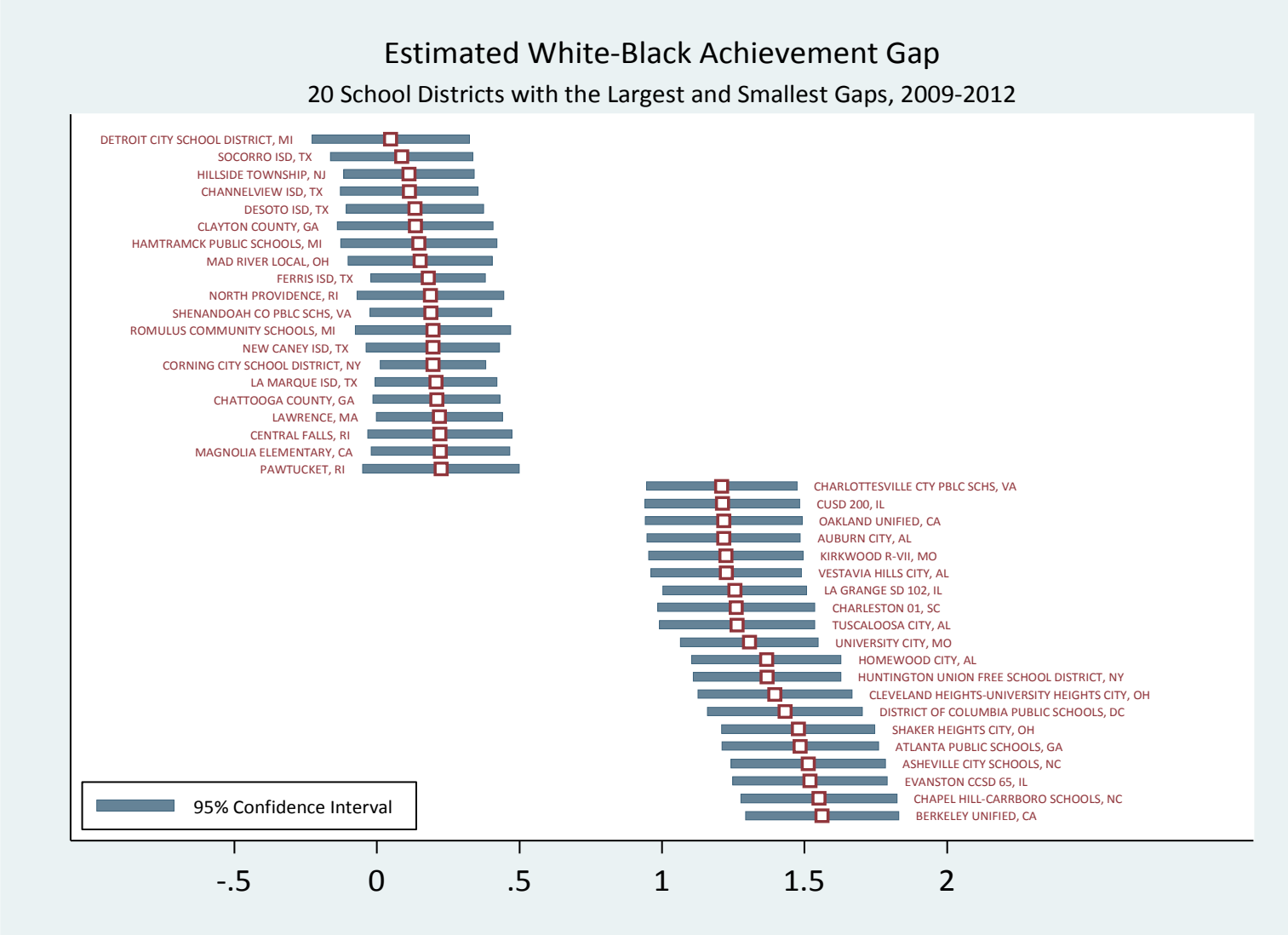

Estimated White-Black Achievement Gap
20 School Districts with the Largest and Smallest Gaps, 2009-2012
DETROIT CITY SCHOOL DISTRICT, MI
SOCORRO ISD, TX
HILLSIDE TOWNSHIP, NJ
CHANNELVIEW ISD, TX
DESOTO ISD, TX
CLAYTON COUNTY, GA
HAMTRAMCK PUBLIC SCHOOLS, MI
MAD RIVER LOCAL, OH
FERRIS ISD, TX
NORTH PROVIDENCE, RI
SHENANDOAH CO PBLC SCHS, VA
ROMULUS COMMUNITY SCHOOLS, MI
NEW CANEY ISD, TX
CORNING CITY SCHOOL DISTRICT, NY
LA MARQUE ISD, TX
CHATTOOGA COUNTY, GA
LAWRENCE, MA
CENTRAL FALLS, RI
MAGNOLIA ELEMENTARY, CA
PAWTUCKET, RI
CHARLOTTESVILLE CTY PBLC SCHS, VA
CUSD 200, IL
OAKLAND UNIFIED, CA
AUBURN CITY, AL
KIRKWOOD R-VII, MO
VESTAVIA HILLS CITY, AL
LA GRANGE SD 102, IL
CHARLESTON 01, SC
TUSCALOOSA CITY, AL
UNIVERSITY CITY, MO
HOMEWOOD CITY, AL
HUNTINGTON UNION FREE SCHOOL DISTRICT, NY
CLEVELAND HEIGHTS-UNIVERSITY HEIGHTS CITY, OH
DISTRICT OF COLUMBIA PUBLIC SCHOOLS, DC
SHAKER HEIGHTS CITY, OH
ATLANTA PUBLIC SCHOOLS, GA
ASHEVILLE CITY SCHOOLS, NC
EVANSTON CCSD 65, IL
CHAPEL HILL-CARRBORO SCHOOLS, NC
BERKELEY UNIFIED, CA
95% Confidence Interval
-.5
0
.5
1
1.5
2

Figure 5

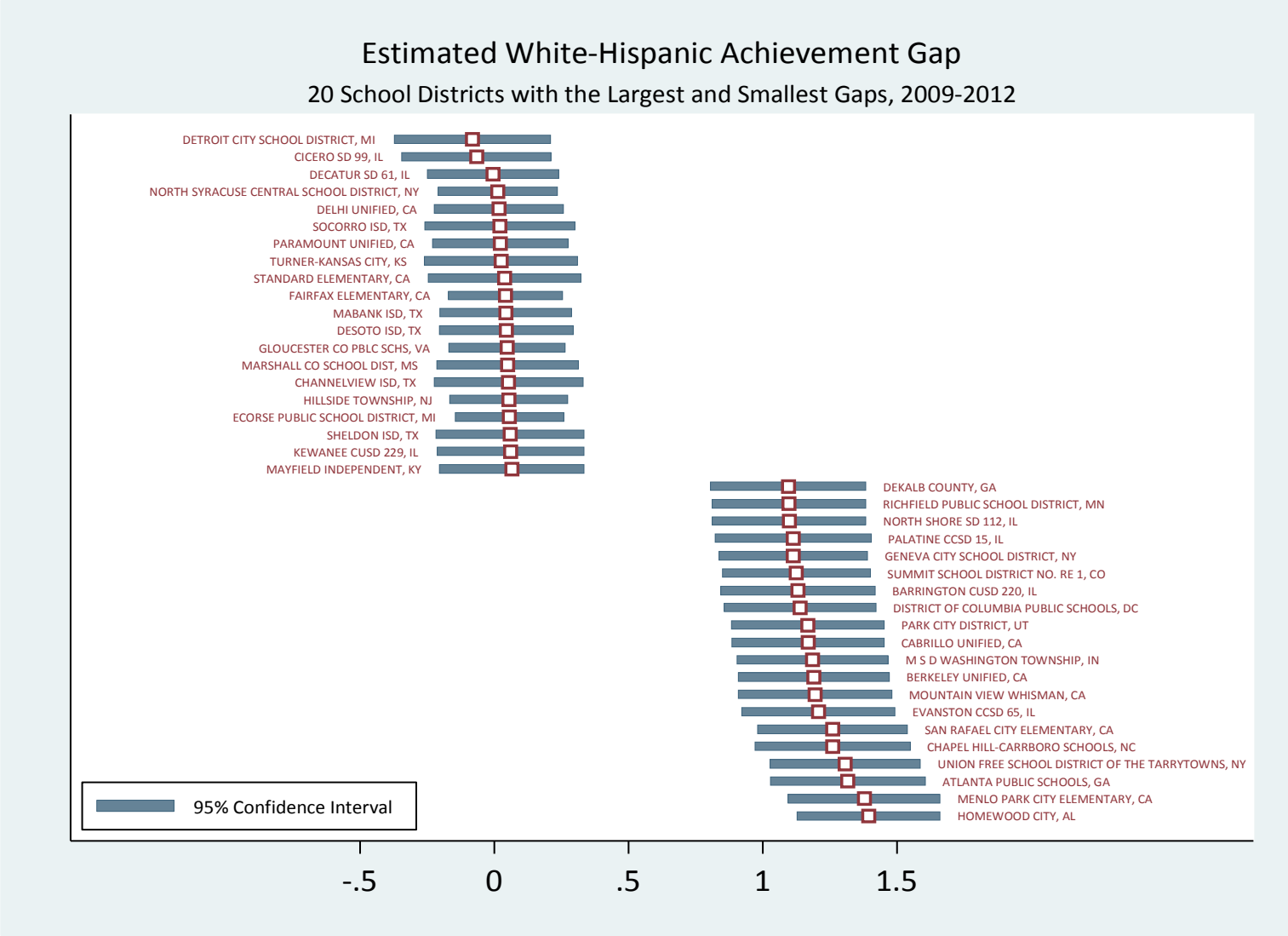

Estimated White-Hispanic Achievement Gap
20 School Districts with the Largest and Smallest Gaps, 2009-2012
DETROIT CITY SCHOOL DISTRICT, MI
CICERO SD 99, IL
DECATUR SD 61, IL
NORTH SYRACUSE CENTRAL SCHOOL DISTRICT, NY
DELHI UNIFIED, CA
SOCORRO ISD, TX
PARAMOUNT UNIFIED, CA
TURNER-KANSAS CITY, KS
STANDARD ELEMENTARY, CA
FAIRFAX ELEMENTARY, CA
MABANK ISD, TX
DESOTO ISD, TX
GLOUCESTER CO PBLC SCHS, VA
MARSHALL CO SCHOOL DIST, MS
CHANNELVIEW ISD, TX
HILLSIDE TOWNSHIP, NJ
ECORSE PUBLIC SCHOOL DISTRICT, MI
SHELDON ISD, TX
KEWANEE CUSD 229, IL
MAYFIELD INDEPENDENT, KY
DEKALB COUNTY, GA
RICHFIELD PUBLIC SCHOOL DISTRICT, MN
NORTH SHORE SD 112, IL
PALATINE CCSD 15, IL
GENEVA CITY SCHOOL DISTRICT, NY
SUMMIT SCHOOL DISTRICT NO. RE 1, CO
BARRINGTON CUSD 220, IL
DISTRICT OF COLUMBIA PUBLIC SCHOOLS, DC
PARK CITY DISTRICT, UT
CABRILLO UNIFIED, CA
M S D WASHINGTON TOWNSHIP, IN
BERKELEY UNIFIED, CA
MOUNTAIN VIEW WHISMAN, CA
EVANSTON CCSD 65, IL
SAN RAFAEL CITY ELEMENTARY, CA
CHAPEL HILL-CARRBORO SCHOOLS, NC
UNION FREE SCHOOL DISTRICT OF THE TARRYTOWNS, NY
ATLANTA PUBLIC SCHOOLS, GA
MENLO PARK CITY ELEMENTARY, CA
HOMEWOOD CITY, AL
95% Confidence Interval
-.5
0
.5
1
1.5

Figure 6

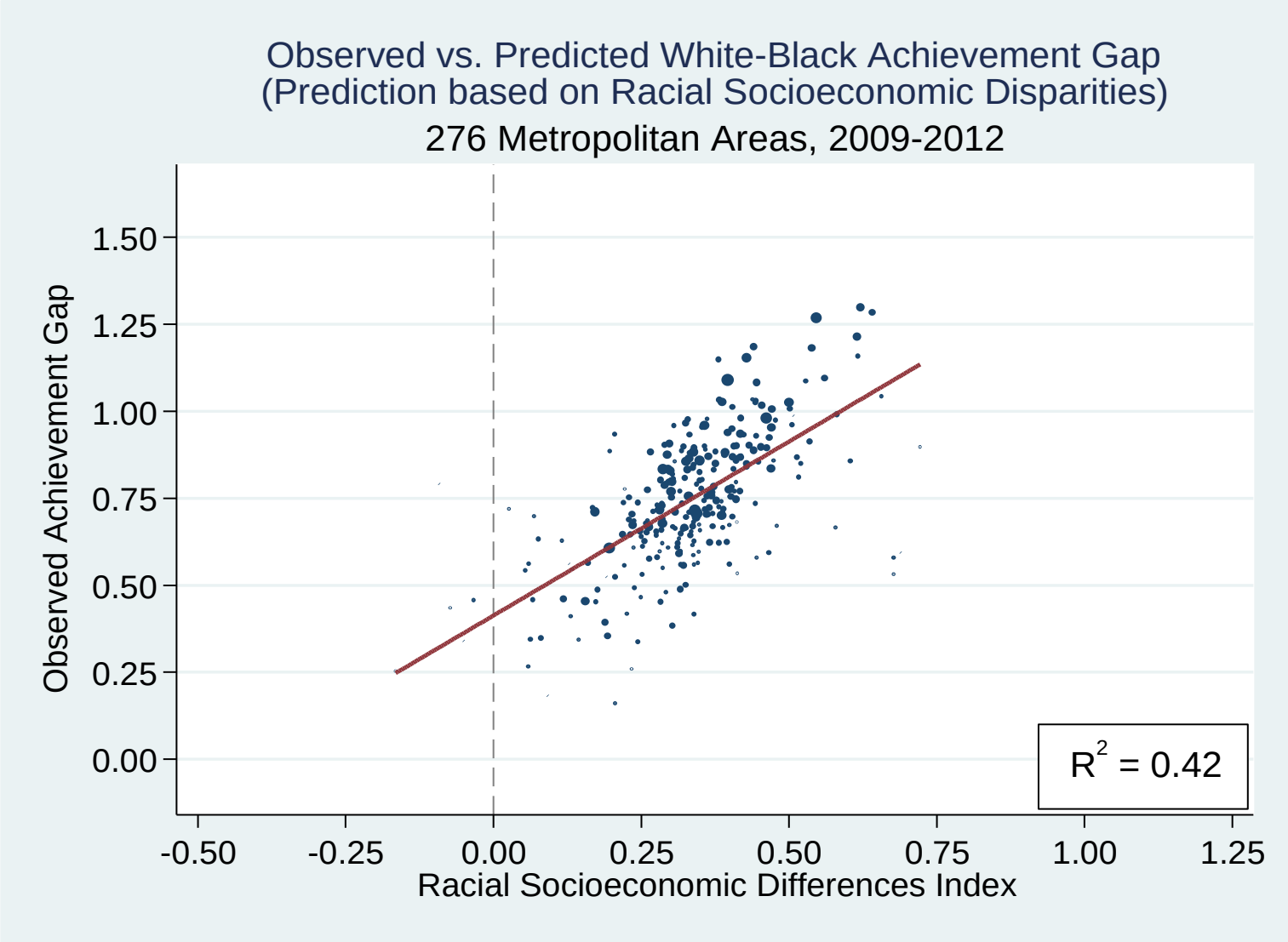

Observed vs. Predicted White-Black Achievement Gap
(Prediction based on Racial Socioeconomic Disparities)
276 Metropolitan Areas, 2009-2012
Observed Achievement Gap
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.50
-0.25
0.00
0.25
0.50
0.75
1.00
1.25
Racial Socioeconomic Differences Index
R^2 = 0.42

Figure 7

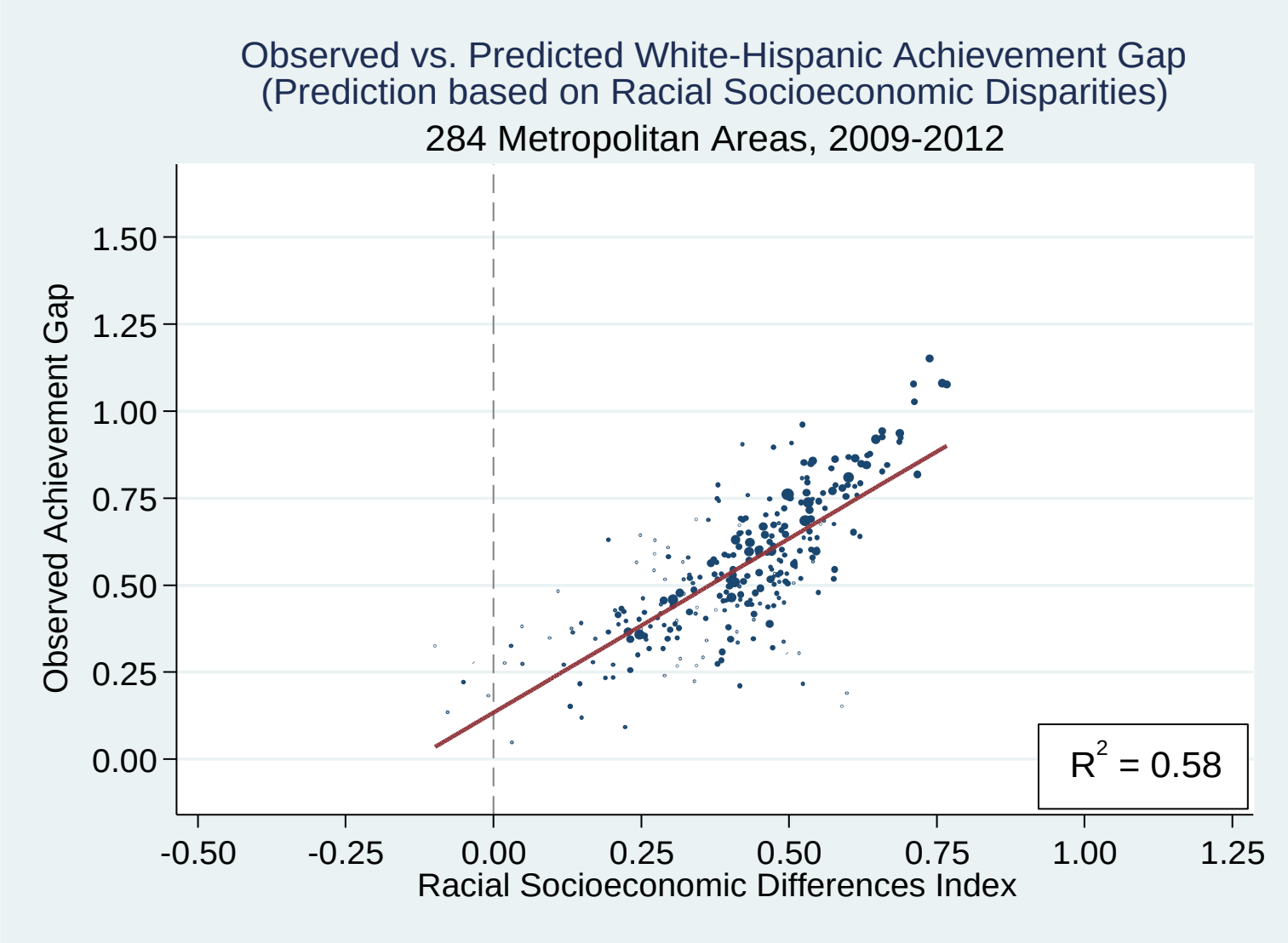

Observed vs. Predicted White-Hispanic Achievement Gap
(Prediction based on Racial Socioeconomic Disparities)
284 Metropolitan Areas, 2009-2012
Observed Achievement Gap
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.50
-0.25
0.00
0.25
0.50
0.75
1.00
1.25
Racial Socioeconomic Differences Index
R^2 = 0.58

Figure 8

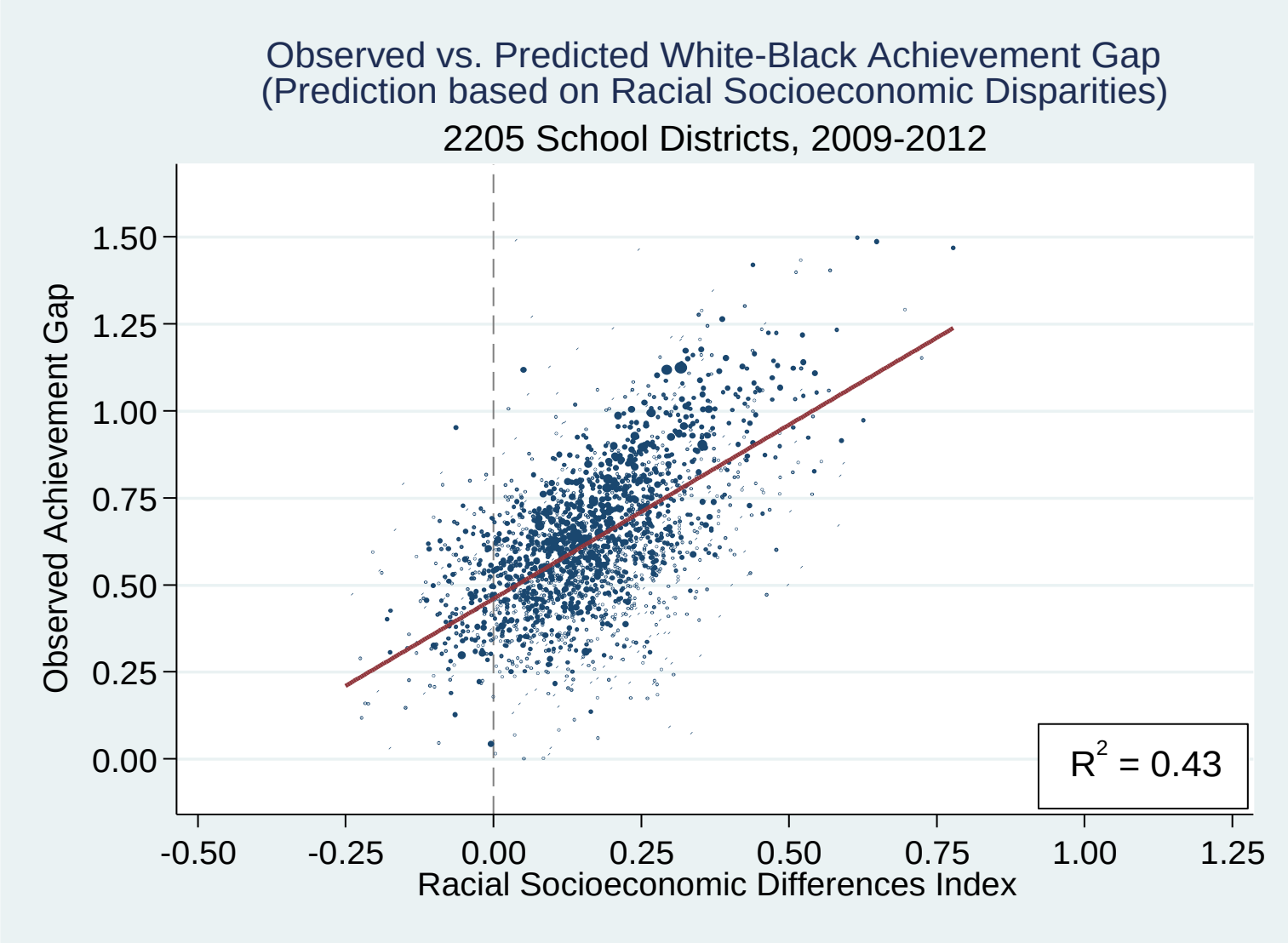
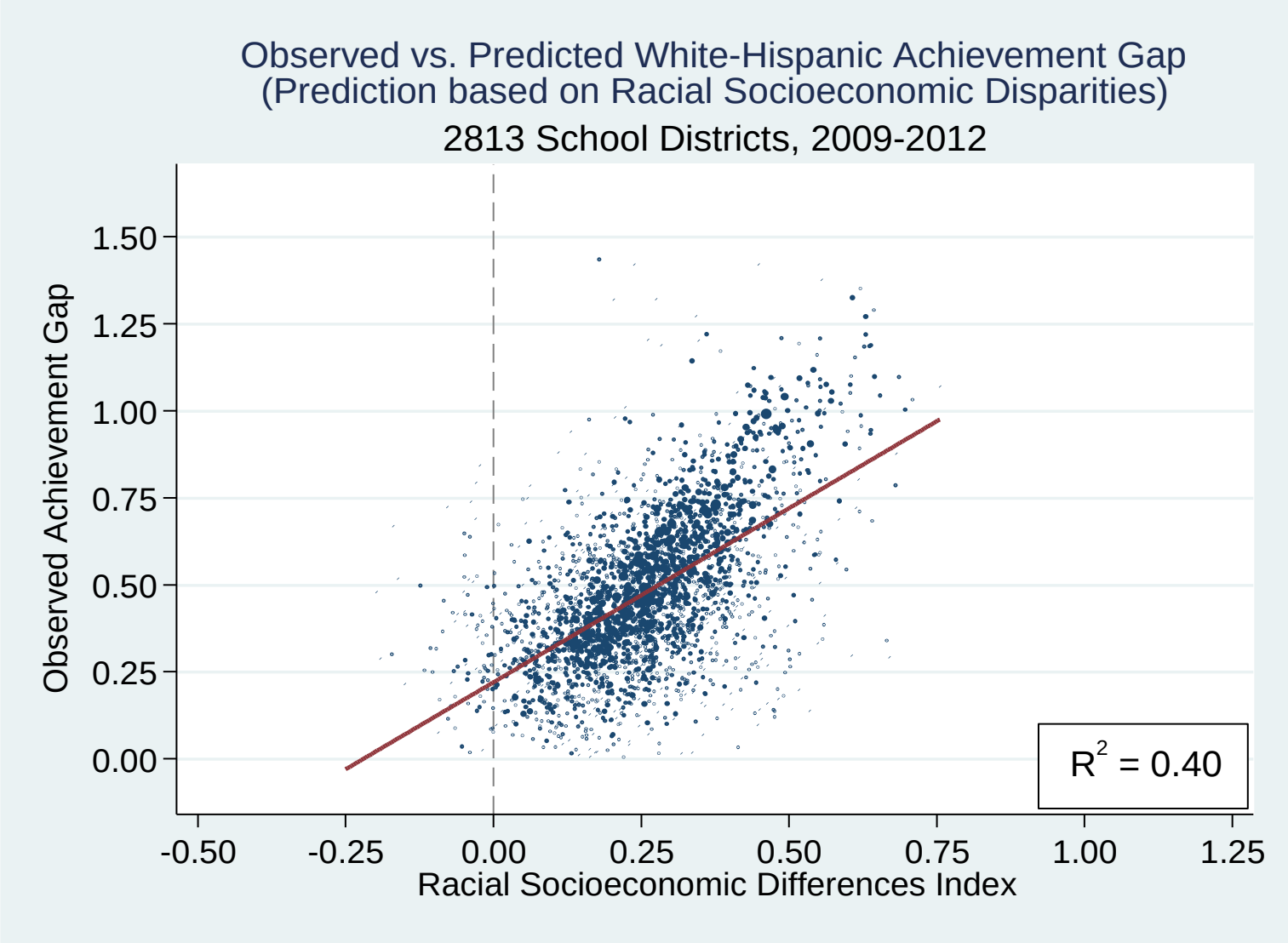

Observed vs. Predicted White-Black Achievement Gap
(Prediction based on Racial Socioeconomic Disparities)
2205 School Districts, 2009-2012
Observed Achievement Gap
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.50
-0.25
0.00
0.25
0.50
0.75
1.00
1.25
Racial Socioeconomic Differences Index
R^2 = 0.43

Figure 9


Observed vs. Predicted White-Hispanic Achievement Gap
(Prediction based on Racial Socioeconomic Disparities)
2813 School Districts, 2009-2012
Observed Achievement Gap
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.50
-0.25
0.00
0.25
0.50
0.75
1.00
1.25
Racial Socioeconomic Differences Index
R^2 = 0.40

Appendix A1: Pooling Achievement Gaps within Districts

To assess whether pooling the 48 gaps within a unit is likely to obscure important within-district variation in gaps across grades, year, and subject, we fit the following precision-weighted random effects model, using all estimated white-black (or white-Hispanic) gaps in the data:

$$\hat{G}_{usgy} = \left[\gamma_{m0} + \gamma_{m1}\left(g_g - 5.5\right) + \gamma_{m2}\left(y_y - 2010.5\right) + v_{mu}\right]M_s + \left[\gamma_{e0} + \gamma_{e1}\left(g_g - 5.5\right) + \gamma_{e2}\left(y_y - 2010.5\right) + v_{eu}\right]E_s + e_{usgy} + \epsilon_{usgy}$$

$$\epsilon_{usgy} \sim N\left[0, \hat{\omega}^2_{usgy}\right]$$

$$e_{usgy} \sim N[0, \sigma^2]$$

$$\begin{bmatrix} v_{mu} \\ v_{eu} \end{bmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \tau_{mm} & \tau_{me} \\ \tau_{me} & \tau_{ee} \end{pmatrix}\right]$$

(A1)

Here, $\hat{G}_{usgy}$ is the estimated achievement gap for unit u in subject s in grade g and year y; its estimated standard error is $\hat{\omega}_{usgy}$. The variables M_s and E_s indicate, respectively, whether $\hat{G}_{usgy}$ describes a math or ELA gap. Grade (g_g) and year (y_y) are centered around 5.5 and 2010.5, respectively, so that the math and ELA intercepts (γ_{m0} and γ_{e0}, respectively) describe the average achievement gap at the midpoint of the years (2009 to 2012) and grades (3 to 8) represented in our data. The error terms in the model indicate that estimated gaps may vary in three ways, net of linear subject-specific grade and year trends. First, estimated gaps may differ from their true values because of sampling variance; this is indicated by the error term ϵ_{usgy}, which is assumed to be normally distributed with a known variance equal to $\hat{\omega}^2_{usgy} = var\left(\hat{G}_{usgy}\right)$. Second, gaps may differ from their unit-specific grade-year-subject predicted value because of within-unit variation not captured by the subject-specific grade and year trends; this is indicated by the error term e_{usgy}, which is assumed normally distributed with a constant variance σ^2 that must be estimated. Third, unit-specific average math and ELA gaps may deviate from the mean math and ELA gaps among units (which are denoted by γ_{m0} and γ_{e0}, respectively). We allow these deviations (v_{mu} and v_{eu}) to differ for math and ELA; they are assumed multivariate normal with a

variance matrix $\tau = \begin{pmatrix} \tau_{mm} & \tau_{me} \\ \tau_{me} & \tau_{ee} \end{pmatrix}$ that must be estimated.

The key parameters of interest here are the variance components σ^2 and τ. If σ^2 is small compared to τ_{mm} and τ_{ee} (that is, if the intraclass correlations $\rho_m = \frac{\tau_{mm}}{\tau_{mm}+\sigma^2}$ and $\rho_e = \frac{\tau_{ee}}{\tau_{ee}+\sigma^2}$ are large), then there is little variation within units relative to the variation in gaps among units, implying that we can pool gaps within units and subjects with little loss of information. If the correlation between v_{mu} and v_{eu}, $\rho_{me} = \frac{\tau_{me}}{\sqrt{\tau_{mm} \cdot \tau_{ee}}}$, is high, then the math and ELA gaps in a unit contain little unique information, implying that we can pool gaps across subject within units as well.

The estimates from this model are shown in Table A1. We fit model (A1) separately for white-black and white-Hispanic gaps and for metropolitan areas and school districts. In the metropolitan area models, the intraclass correlations of achievement gaps are between 0.90 and 0.94; in the district models, the ICCs are between 0.87 and 0.91. In each case then, roughly 90% of the within-subject variation in achievement gaps is between metropolitan areas or districts. The correlations between average math and ELA gaps within geographic units are also quite high, ranging from 0.91 to 0.95. These results indicate that we can pool estimated gaps within geographic units with little loss of information. Moreover, Table A1 indicates that the pooled estimates are sufficiently precise that we can very reliably distinguish among geographic units: the reliability of metropolitan-level pooled (subject-specific) estimates is 0.95-0.96; for district level estimates it is 0.85-0.87. Note that these are subject specific reliabilities; the reliability of estimates pooled across subjects is even higher: 0.97-0.98 for metropolitan areas; 0.90-0.93 for school districts (models not shown).

TABLE A1 HERE

The results in Table A1 indicate that pooling gap estimates across years, grades, and subjects within geographic units results in very little loss of information (and a considerable increase in precision). In each metropolitan area and district, we compute the precision-weighted meta-analytic average,

controlling for grade, year, and test subject, of the (up to) 48 gap estimates available in each district or metropolitan area. We use these pooled estimates for the remainder of our analysis.

Appendix A2: Data Sources and Constructing Variables

TO BE ADDED

Appendix Tables

Table 1A. Comparison of Metro/District Gaps in Math and Reading

	Metropolitan Areas								Districts							
	White-Black				White-Hispanic				White-Black				White-Hispanic			
	Math		Reading		Math		Reading		Math		Reading		Math		Reading	
Average Gap	0.724	***	0.674	***	0.500	***	0.554	***	0.644	***	0.587	***	0.459	***	0.512	***
	(0.011)		(0.010)		(0.011)		(0.012)		(0.004)		(0.004)		(0.004)		(0.004)	
Average Grade Trend	-0.001		0.000		0.000		-0.003		0.005	**	0.002		0.001		0.001	
	(0.002)		(0.002)		(0.002)		(0.002)		(0.001)		(0.001)		(0.001)		(0.001)	
Average Year Trend	0.004	*	0.001		0.000		-0.004	***	-0.006	***	-0.002	***	-0.007	***	-0.006	***
	(0.001)		(0.001)		(0.001)		(0.001)		(0.001)		(0.001)		(0.001)		(0.001)	
SD -- Level 2	0.063		0.054		0.060		0.053		0.083		0.073		0.079		0.072	
SD -- Intercept	0.193		0.181		0.198		0.209		0.211		0.213		0.216		0.225	
Reliability	0.950		0.950		0.952		0.961		0.858		0.867		0.845		0.858	
Intraclass Correlation	0.903		0.918		0.917		0.940		0.867		0.894		0.882		0.906	
p-value: Math Intercept = Reading Intercept	0.000				0.000				0.000				0.000			
Correlation: Math Intercept, Reading Intercept	0.940				0.910				0.950				0.930			
Total Observations	14194				14123				102265				118080			
Metro/District Observations	335				337				2876				3595			

***p<=.001

Table 2A. Full List of Covariates Used

Measure	Source
Socioeconomic and Family Structure	SDDS, 2006-2010
White-Minority Income V Gap	SDDS, 2006-2010
White-Minority Education V Gap	SDDS, 2006-2010
Managerial/Professional Occupation Difference - White-Minority	SDDS, 2006-2010
Unemployment Rate Difference- Minority-White	SDDS, 2006-2010
Poverty Rate Difference- Minority-White	SDDS, 2006-2010
SNAP Rate Difference-- Minority-White	SDDS, 2006-2010
Single Parent Household Rate Difference-- Minority-White	SDDS, 2006-2010
Rental Rate Difference-- Minority-White	SDDS, 2006-2010
Same House as 1 Year Ago Difference-- White-Minority	SDDS, 2006-2010
Median Income	SDDS, 2006-2010
Proportion of Adults, Aged 25+ with a Bachelor's Degree or Higher	SDDS, 2006-2010
Proportion working in Managerial/Professional Occupations	SDDS, 2006-2010
Poverty Rate, Households with 5-17 Year Olds	SDDS, 2006-2010
Unemployment Rate	SDDS, 2006-2010
Percent of Households Receiving Food Stamps or SNAP	SDDS, 2006-2010
90/10 Income Ratio	SDDS, 2006-2010
Proportion Single Parent Households	SDDS, 2006-2010
Average Household Size	SDDS, 2006-2010
Median Housing Value	SDDS, 2006-2010
Median Rent	SDDS, 2006-2010
Same House as 1 Year Ago	SDDS, 2006-2010
Percent in Public Schools Receiving Free Lunches	CCD
Segregation	CCD
Between School Racial Segregation	CCD
Between District Racial Segregation	CCD
Within District Racial Segregation	CCD
Between School Free Lunch, Not Free Lunch Segregation	CCD
Between District Free Lunch, Not Free Lunch Segregation	CCD
Between Tract Racial Segregation	SDDS, 2006-2010
Between Tract Poor-Non-Poor Segregation	SDDS, 2006-2010
Between-District Inc Seg of Families with Children Enrolled in Public School	SDDS, 2006-2010
School District Fragmentation	CCD
Difference in Tract Poverty Rates- Minority-White	SDDS, 2006-2010
Difference in Free Lunch Rates- Minority-White	CCD
White-Minority Private School Enrollment Rate Difference	PSS
Percent Black/Hispanic Students' Whose District was Ever Under Court Order	Reardon et al (2012)
Percent Black/Hispanic Students' Whose District is Currently Under Court Order	Reardon et al (2012)
Racial/Ethnic Composition	
Percent Black in Pubic Schools	CCD
Percent Hispanic in Pubic Schools	CCD
Hispanics, Speak English Well or Very Well	SDDS, 2006-2010
Hispanics, Foreign Born	SDDS, 2006-2010
Percent of Hispanic Population that is Mexican	SDDS, 2006-2010
Percent of Hispanic Population that is Puerto Rican	SDDS, 2006-2010
Percent of Hispanic Population that is Cuban	SDDS, 2006-2010
Percent of Hispanic Population that is Central American	SDDS, 2006-2010
Percent of Hispanic Population that is South American	SDDS, 2006-2010
School Quality	
White Per Pupil Expenditures/Minority PPE	CCD
Student-Teacher Ratio: Minority/White	CCD
Difference, % First or Second Year Teachers: Minority-White	OCR
Difference, % Teachers Absent 10+ Days: MinorityWhite	OCR
Metro-Level White-Minority Charter School Enrollment Rate Difference	CCD
Percent Minority in the Unit in Schools with Enough Blacks/Hispanics for NCLB Reporting	CCD
PP Expenditures in Average Student's School	CCD
Pupil-Teacher Ratio-Weighted by Tot Enrl	CCD
Percent First or Second Year Teachers in Typical Student's School	OCR
Percent Teachers Absent 10+ Days in Typical Student's School	OCR
Percentage of Students in Metro/District Attending Charter Schools	CCD
Low Proficiency Standards (State-Level Measure)	Dee and Jacob (2011)
High Proficiency Standards (State-Level Measure)	Dee and Jacob (2011)
Strength of Charter Policies, version 1 (State-Level Measure)	Center for Education Reform
Strength of Charter Policies, version 2 (State-Level Measure)	National Alliance for Charter Schools